


Applying evidence to practice by increasing intensity of intervention for children with severe speech sound disorder: a quality improvement project

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To cite: McFaul H, Mulgrew L, Smyth J, *et al.* Applying evidence to practice by increasing intensity of intervention for children with severe speech sound disorder: a quality improvement project. *BMJ Open Quality* 2022;**11**:e001761. doi:10.1136/bmjopen-2021-001761

Received 1 December 2021
Accepted 26 April 2022

ABSTRACT

Speech sound disorder (SSD) affects up to 25% of UK children and may impact on: effective communication; the development of relationships; school progression and overall well-being. The evidence base shows that intervention for children with SSD is more effective and efficient when provided intensively in relation to the number of target sounds elicited in sessions (dose) and number of sessions per week (frequency). Southern Health and Social Care (HSC) Trust's baseline intensity of speech and language therapy (SLT) intervention was similar to that often found in current practice across the UK, where ~30 target sounds were elicited (dose) in once weekly sessions (frequency) over a 6-week block, followed by a break from therapy. This quality improvement (QI) project aimed to increase intensity of intervention for children with severe SSD within Southern HSC Trust's community SLT service to improve outcomes for children and their parents. QI methods supported accurate identification of ten 4–5 year olds with severe SSD and increased the intensity of their intervention over a 12-week period by measuring a range of data and speech outcomes. Findings showed a sustainable increase of dose (number of targets elicited per session) to levels recommended in the research (≥ 70). However, it was difficult to sustain increased frequency of appointments (to twice weekly) because of contextual factors such as sickness, etc. Accommodating this, measuring days between appointments captured an overall increase in the number of appointments attended across time. Child speech outcomes improved for direct speech measures and parent ratings of intelligibility. The intensive model of intervention has been implemented for children identified with severe SSD across Southern HSC Trust's community service with ongoing audit and development, and findings have been disseminated.

INTRODUCTION

Problem

The term speech sound disorder (SSD) describes difficulties children experience with production of speech, reducing their intelligibility to others. SSD may have an unknown or known cause (eg, cleft lip and palate) and may be associated with difficulties in other areas such as speech perception and oromotor skills.¹ This condition impacts on nearly a quarter of children in the UK,²

3%–4% of whom will have severe difficulties potentially extending through childhood and into adulthood.³ SSD poses a real challenge, impacting on: school achievement^{4 5}; the ability to make friends; mental health and future life opportunities.⁶ Children with SSD are the largest single paediatric group referred to speech and language therapy (SLT) community services,⁷ placing a heavy demand on National Health Service (NHS) resources (this paper follows SQUIRE 2.0 template guidelines (<http://squire-statement.org/index.cfm?fuseaction=Page.ViewPage&PageID=471>)).

Intervention for child SSD is more effective and efficient when provided at higher intensities impacting on dose (number of target trials per session) and frequency (number of sessions per week) across time, thereby improving outcomes for these children.^{8–10} However, there is a lack of application of this evidence to the management of children with SSD across the UK.^{11 12}

Consideration of the possible change mechanisms underpinning the success of high intensity intervention for children with severe SSD suggests that higher doses within sessions reach a threshold which supports an optimal practice/learning effect. Furthermore, more frequent appointments may allow the child to rapidly build on learning from previous sessions resulting in progressive, sustained change when compared with less frequent, once weekly appointments where the child requires more time to review learning from previous sessions (further compounded if the child is given regular breaks from therapy). Consequently, it is theorised that slower gains characterised by periods of regression are likely with current models of service delivery (figure 1, model A), compared with more rapid and progressive gains predicted for intensive intervention (figure 1, model B).



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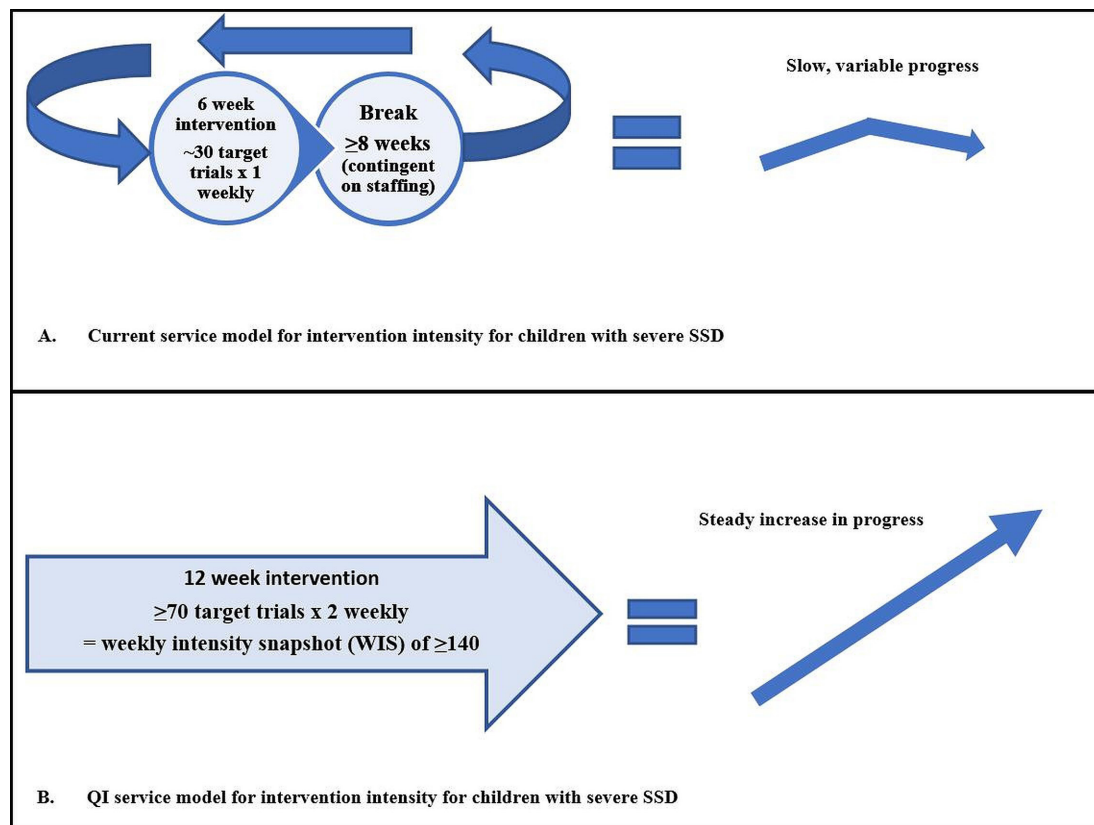


Figure 1 Theoretical model explaining the difference in child speech outcomes resulting from different models of intervention intensity (Note: created by the fourth author and used with permission). SSD, speech sound disorder; QI, quality improvement.

This paper outlines the development and rolling out of a quality improvement (QI) initiative by the SLT professional lead (author one) with the support of two specialists in SSD (authors two and three) within Southern HSC Trust to address this research-practice gap and improve effectiveness and efficiency of the community paediatric service. The drivers that have the potential to impact on achieving the aim of the project are illustrated in [figure 2](#).

Available knowledge

Narrowing the research-practice gap in SLT services for children with SSD is challenging.^{11–19} This is particularly so in relation to intensity of intervention. Investigation of the cumulative intervention intensity (CII) calculated as: number of target trials in a session (dose) x frequency of sessions x overall number of sessions until discharge,²⁰ shows that higher CII impact positively on outcomes and are a more efficient way to provide intervention for children with SSD.^{8–10 21}

The research evidence for intervention intensity in children with SSD indicates that one of the most popular intervention approaches for SSD arising from pattern-based errors of speech sounds (a phonological impairment) was generally provided in a dose of 100 target trials per twice weekly sessions for a total of ~18–36 sessions, resulting in a CII of 3600–7200 (100×2×18–36).^{11 22} Contrastively, a UK-wide survey found that in their current practice for a typical child with phonological impairment, SLTs' most frequent intensity provision was a dose of 10–30 target

trials delivered once weekly over 5–30 sessions.¹¹ This resulted in a CII of 50–900; vastly less than that found in the research evidence base.¹¹ Concerns about this research-practice gap are corroborated by findings that children with severe phonological impairment, require a dose of ≥70 target trials per session for intervention to be effective.¹⁰ Indeed, even children with moderate phonological impairment have been found to require a dose of at least 50 trials for effective intervention.¹⁰ These recommendations increase to a dose of 100–150 for children presenting with childhood apraxia of speech (a type of SSD underpinned by difficulties with oral motor co-ordination).²³ Furthermore, intervention provided more frequently within weeks is significantly more effective and efficient than the same overall amount of intervention provided once weekly for children with phonological impairment.⁸

While learning is still emerging around the interaction and importance of dose, dose rate and frequency; increasing intensity of intervention from that provided in routine care offers the potential, at least, of a more efficient service for children with significant SSD.^{24 25} This research-practice gap has partly arisen because of the lack of awareness of the importance of dosage until relatively recently.²¹

Rationale

Prior to this QI project, SLTs from Southern HSC Trust's community paediatric team were involved in training

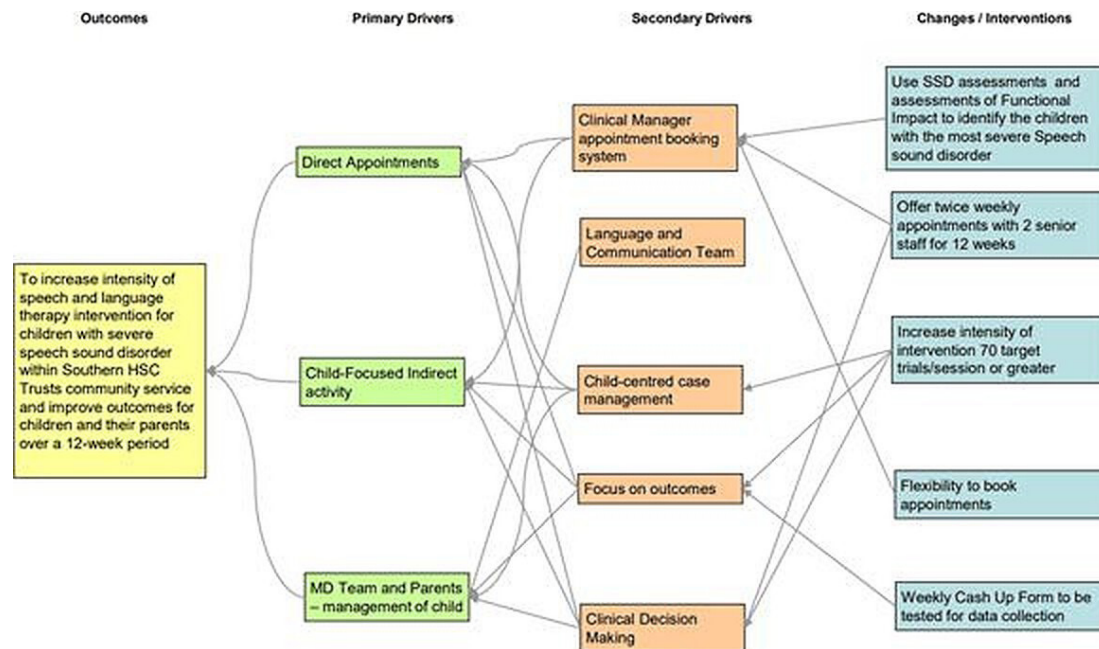


Figure 2 Driver diagram (Note. created by the first author and used with permission). SSD, speech sound disorder; HSC, Health and Social Care

up-dates delivered by the fourth author and in the co-production of an online clinical decision-making resource to support SLTs with evidence-based practice (supporting understanding of SSD (SuSSD)).²⁶ Consequently, increased awareness was triggered about the need to change Southern HSC Trust's current intervention intensity package for children with severe SSD in community services to improve outcomes.

Further drivers for change were the Trust's finding that progress was slow for these children with low satisfaction by parent and SLT alike. A review of the Trust's service delivery model prior to the project revealed baseline intervention intensities for children with severe SSD similar to those in a recent UK survey: a dose of ~30 target trials in once weekly sessions¹¹ provided over 6-weekly blocks alternated with breaks (see figure 1, model A). Consequently, the key focus of this QI project was to address government strategy to give every child the best start in life by increasing intervention intensity for children with severe SSD to improve their speech outcomes.^{27 28}

Aim

To increase the intensity of SLT intervention for 4-5 year olds with severe SSD within Southern HSC Trust's community service and improve outcomes for children and their parents across a 12-week treatment period.

Objectives

Process changes will drive:

- ▶ Accurate identification and prioritisation of children with severe SSD for intensive intervention across Southern HSC Trust's community SLT service through the use of a clear operational definition.
- ▶ Increased number of target trials (≥ 70) within sessions for identified children.

- ▶ Increased frequency of direct SLT appointments (twice weekly) for identified children.

Changed service delivery will improve:

- ▶ Speech outcomes for these children.
- ▶ Parent ratings about their child's speech intelligibility.

METHODS

Context

A total of 18.81 whole time equivalent staff were employed in Southern HSC Trust's community paediatric service which received a total of 2219 general referrals for children with speech, language and communication needs over the project's duration (2019–2020). Prior to the project, most children with severe SSD were referred into a specialist service for children with suspected/diagnosed developmental language disorder (DLI) and received intervention from specialist SLTs (authors 2 and 3).

Ten 4–5 year olds with severe SSD were identified as candidates for the project following QI principles of scale and spread (starting and testing change ideas on a small scale before moving to wider implementation) (figures for the entire caseload of children with SSD in the Trust's community SLT service were not available to support calculation of the proportion of that caseload represented by the sample selected.). Prior to project entry, the identified children had received varying numbers of intervention cycles as shown in figure 1, model A, equating to a dose of ~30 per session for a mean of 17.8 sessions (range: 7–26) across a mean of 87.6 weeks (range: 40–172). Several of these children experienced significant break periods which went far beyond the parameters set for the Trust's ≥ 8 week target (which was contingent on staffing levels).

Interventions

A team of key stakeholders was formed and included the head of the community paediatric SLT service, two specialist SLTs, two parents of children with severe SSD and the Head of the Language and Communication Team from the Education Authority. These stakeholders confirmed the steps required to implement the QI project and inputted into the development of proformas designed to drive changes delivered by the implementation team (the lead community paediatric SLT, two specialist SLTs and the community paediatric SLT team):

- ▶ Operational definition proforma: identified children with severe SSD for inclusion in the project.
- ▶ Process change proforma/‘cash-up form’: collated data on pre-established goals for intensity of intervention (dose and frequency).
- ▶ Speech outcomes proforma: collated data on child speech outcomes.

At the outset of the project, community paediatric SLTs were trained to complete the child assessments/analyses, apply the operational definition and identify eligible 4–5 year olds. The operational definition was agreed by the two specialist SLTs based on cut-offs for standardised and non-standardised assessments which would clearly differentiate children with more from less severe SSD. Children identified with severe SSD had to achieve: a score in the first percentile on a standardised test of speech, the Diagnostic Evaluation of Articulation and Phonology (DEAP)²⁹; a score of 70% or less on a non-standardised measure of sound knowledge, Powell and Miccio’s Stimulability Assessment³⁰ (calculated on all consonants for the purposes of this project); and an average score of 3 or less on a robustly validated and reliable scale against which parents rate their child’s intelligibility to others across a range of contexts (the Intelligibility in Context Scale (ICS)).^{31 32} Successful adherence to these cut-off points was the criteria set for child entry to the project and was measured to support and drive change around child identification using the operational definition proforma. Accurate identification of 4–5 year olds with severe SSD was achievable after purchasing an adequate number of standardised assessments (DEAPs)²⁹ and providing additional training for community paediatric SLTs.

Following identification, children were referred to specialist SLTs (authors 2 and 3) by the lead author. Specialists applied current evidence-based clinical thinking to select intervention approaches and targets dependent on each child’s presentation. They were trained to ensure that agreed intensity targets and speech outcome measures would be clearly annotated in the process change/‘cash-up’ and speech outcomes proformas. The project was rolled out until all children had the opportunity to avail of 12 weeks of intervention. Monthly meetings with SLTs completing the initial assessments, and weekly meetings with the specialist SLTs completing the intensive intervention ensured that training needs were kept up-to-date and that the proformas mapping changes to intensity of intervention and child speech outcomes

were adapted as appropriate. The stakeholder group met three times to provide support and input into developments required across the timespan of the project.

Measures

The outcome, process and balancing measure plan was as follows:

Outcome measures

- ▶ Percentage consonants correct³³ from the DEAP.²⁹
- ▶ Parental judgement score of intelligibility from the ICS.^{31 32}

Process measures

- ▶ Dose/number of target trials per session.
- ▶ Frequency of sessions per week.
- ▶ Weekly intensity snapshot (WIS)—dose × frequency (a target set of 140 (70 × 2) based on the evidence).^{8–10 20}

Balancing measures

- ▶ Waiting times for the specialist service for children with suspected/diagnosed DLD (from which the specialist SLTs time was taken).

Study of the interventions

This project aimed to prioritise 4–5 year olds with severe SSD and provide them with intensive intervention, thereby improving their outcomes.

Tests of change: increasing intensity of intervention to improve outcomes

Test 1

Plan-Do-Study-Act (PDSA) cycles 1–3: The driver to increase intensity of intervention for 4–5 year olds with severe SSD was the process change/‘cash-up’ proforma capturing dose per session and frequency of sessions. The third author tested the ‘cash-up’ proforma through three PDSA cycles with four children identified for the project until it captured the information required sensitively enough.

Test 2

PDSA 1: Reaching and sustaining the target WIS of 140 was tested with the third author. While from the outset, the target dose of ≥ 70 was delivered and sustained per session, meeting the target frequency of twice weekly appointments was more challenging due to issues impacting attendance such as illness, holidays, etc.

PDSA 2: To better capture changes to frequency of intervention, the measure was altered to capture a decrease in days between appointments (target: < 7 days) which was subsequently found to be the optimal means to capture an overall increase in frequency of sessions.

Analysis

Data collected and inputted into Excel was explored using X-bar charts to capture the mean change in the process of intervention intensity over time.

Table 1 Mean weekly intensity snapshot (WIS) for participants

Participant	Mean WIS (SD)
B	109 (70.31)
C	88 (66.81)
D	142 (86.96)
F	125 (105.05)
J	115 (86.59)
K	87 (54.29)
L	93 (76.74)
M	61 (61.38)
N	104 (57.08)
P	82 (58.13)

Created by the authors and used with permission. The SDs reflect variation in frequency of appointments.

RESULTS

Increasing intensity of intervention

The main outcome measure of interest in this QI project was the WIS. The target WIS was initially set at 140 (≥ 70 target trials \times twice weekly sessions). Following implementation, the WIS increased for all children (see table 1/figure 3³⁴ (mean:100.6, range: 61–142). Five children received a mean WIS of ≥ 100 (with child D receiving a mean WIS of 142). The remaining five children received a mean WIS ranging from 61 to 93 (see table 1/figure 3). Common cause variation in figure 3 shows stable sustainable change to the WIS. Dose and frequency each contribute to the WIS and

are considered separately below to further investigate these findings.

Increasing the dose within sessions to ≥ 70 was achieved consistently from implementation of the service delivery change with a mean dose per session of 87 (range: 73–112). It was clear that increasing the dose to evidence-based levels within sessions was both manageable and sustainable.

No participants reached the initial target of twice weekly appointments (a total of 24 intervention sessions across 12 weeks (mean: 13.7, range: 10–17): 2=16–17 sessions, 6=13–14 sessions, 1=12 sessions and 1 (child M)=10 sessions. The spacing of these missed sessions varied, leading to some children missing full weeks of intervention, with one child (M) being put on a 5-week break from therapy as the intensity of the intervention was initially challenging for her.

The final PDSA cycle increasing intensity of intervention highlighted the need to amend the measure of frequency to better capture the changes made to service delivery (to days between appointments (target: < 7 days)). The second X-bar chart captures the mean length of time in days between 24 consecutive appointments (figure 4).³⁴ Across the 12 days prior to the QI project, days between appointments were consistently variable, ranging from 8.10 (2.85) to 61.60 (38.81) (common cause variation (figure 4)). Commencement of intensive intervention showed a marked decrease in days between appointments. Special cause variation (a lack of stability in the system) is found in two instances and reflects the influence of a range of contextual factors: (1) The first eight consecutive appointments after the change in service fell below the central line of

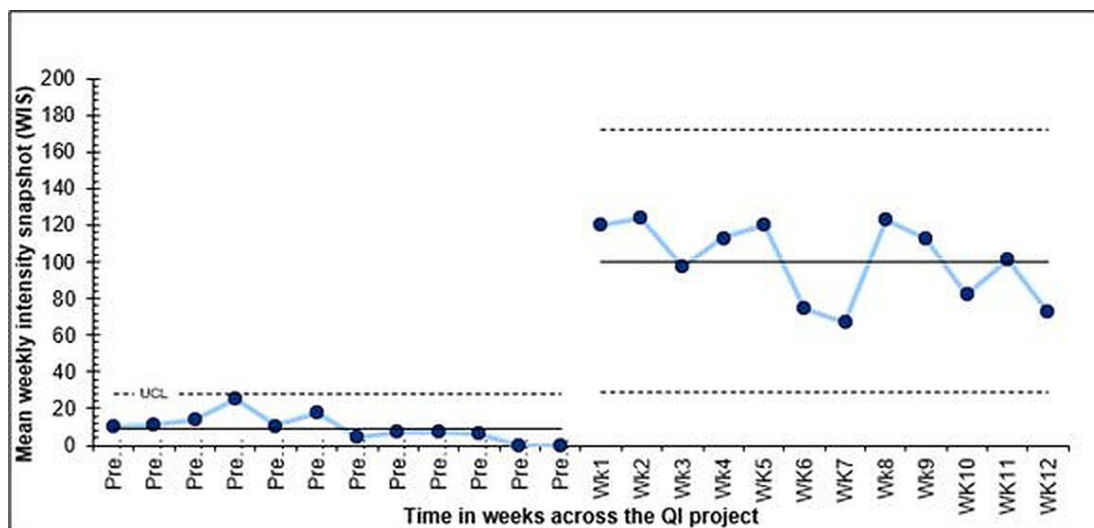


Figure 3 X-bar chart showing the mean WIS capturing increased intensity of intervention pre-and post-implementation of the QI project (across 24 weeks) (Note: created by the first author and used with permission. The solid line around which the data points cluster is the centre line (capturing the mean) and the dotted lines above that (the upper control limit (UCL)) and (where shown) below that (the lower control limit) are set at ± 3 SDs from the centre line. They support detection of meaningful process change where data points may fall beyond the control limits or are not randomly distributed (special cause variation)).³⁴ QI, quality improvement.

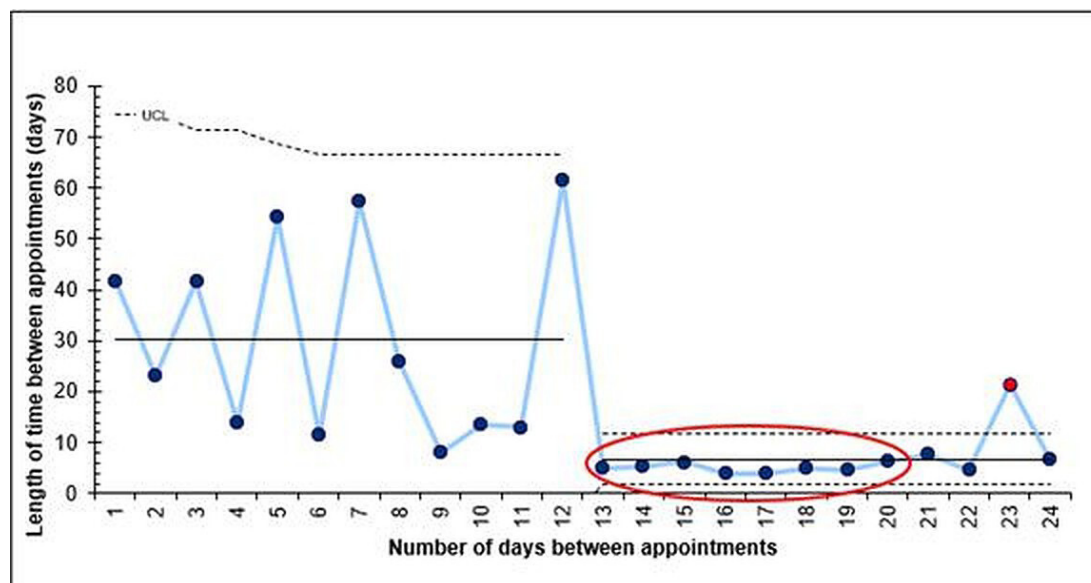


Figure 4 X-bar chart showing the mean number of days between appointments pre-implementation and post-implementation of the QI project (QI project starts on day 13) (Note: created by the first author and used with permission. The solid line around which the data points cluster is the centre line (capturing the mean) and the dotted lines above that (the upper control limit (UCL)) and (where shown) below that (the lower control limit) are set at ± 3 SDs from the centre line. They support detection of meaningful process change where data points may fall beyond the control limits or are not randomly distributed (special cause variation)).³⁴ QI, quality improvement.

6.7 days between appointments and (2) The data point at week 23 showed a marked increase in time between appointments due to two children requiring a short break from the intense provision (figure 4).

The balancing measure showed minimal to no impact on waiting times for the specialist community SLT service for children with suspected/diagnosed DLD (from which the two SLTs were withdrawn (0.55 whole time equivalent (WTE) resource)) because of: the particularly small numbers referred into that service at the time, the fact that candidates for the QI project came from that caseload, and the addition of some minimal staff support (0.1 WTE) into that service.

Improving child outcomes

All participants in the project made progress in their accuracy of speech production with an overall mean increase of 28% consonants correct (PCC)³³ (range: 11–53 PCC) (see table 2). Research into the ICS³¹ shows that totally intelligible children score 5 and children with a diagnosis of SSD score an average of 3.85.^{31 32} The most sensitive cut-off between children who are typically developing and those with SSD is advised to be set at 4.6.³² While all the children in the QI project continue to have difficulties making themselves understood to others (apart from N who attained

Table 2 Pre, post and difference scores for Percentage Consonants Correct (PCC) and the Intelligibility in Context Scale (ICS) for participants

Participant	PCC-pre	PCC-post	PCC diff	ICS-pre	ICS-post	ICS diff
B	19	30	+11	2.57	3.28	+0.71
C	41	69	+28	2.14	3.71	+1.57
D	24	77	+53	3.28	4	+0.72
F	13	56	+43	2.43	3.71	+1.28
J	39	62	+23	3.14	3.86	+0.72
K	21	57	+36	3.28	4	+0.72
L	25	36	+11	1.57	2.57	+1.00
M	48	62	+14	3	3.71	+0.71
N	34	71	+37	3.57	4.57	+1.00
P	16	51	+35	3.14	4	+0.86

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4.6 postintervention), they have all improved their intelligibility (see [table 2](#)). Importantly, the speech measures used to capture baseline performance and measure progress were not in use prior to starting the QI project which means that we cannot be sure that these improvements are the consequence of the more intensive model of intervention. Additionally, prior to implementation of the QI project, different formal and informal speech assessments were used pre- and post-intervention per child precluding calculation of PCCs across the baseline period because of the lack of comparability between the speech data targeted.³⁵

All participant data were included for analysis in this QI project which is important because contextual factors are fundamental influencers of how well intervention programmes are implemented in practice.^{36 37} Encouragingly, increasing target dose within sessions is achievable and sustainable, however, increasing frequency of sessions can prove challenging due to a range of important issues and may be easier for some children and families than others.

DISCUSSION

Summary

Children with severe SSD were successfully identified and received a higher intensity of intervention than would have typically been provided in the original model of service delivery. Child speech outcomes improved and parent ratings of their child's intelligibility increased. While we cannot prove the link between the progress seen in child speech and increased intensity of intervention, we can posit that the higher dose, delivered more frequently over a more concentrated period, may better support the nature of learning required for these children to make a clinically significant change in their speech development in comparison to the original model of service delivery (see [figure 1](#)).

A key strength of this project was the teamwork underpinning its delivery both in relation to the steering group and the SLTs delivering the changed service. Regular planning, feedback and review supported the project's roll out and sustainable change. Another strength of the project was that both the operational criteria for identifying children with severe SSD and the PDSA cycles put in place to drive increased dosage of intervention worked effectively and were sustainably rolled out across the Trust's community paediatric service. Finally, parental engagement and motivation for the intensive intervention model was generally high with many parents experiencing relief and joy to see their children beginning to be able to make themselves understood: 'My dad said he can now understand Jim (pseudonym) [.....] he had [previously] avoided talking to him as he felt frustrated/annoyed when he couldn't understand him and didn't want Jim to be disappointed in him for not understanding' (quote from parent).

Interpretation

Sustainably increasing the target dose (number of practice items) to evidence-based recommendations was clearly achievable in the current project. However, increasing frequency of sessions was more challenging. Changing the measure of intensity to capture days between sessions showed that increasing frequency of appointments was attainable. The initial special cause variation across eight sessions (showing less than 6.7 days between appointments) indicated that parent enthusiasm and motivation to support their children may result in an initial positive sustained attendance for more frequent appointments, which may then be subsequently influenced by other types of special cause variation such as child fatigue, holidays etc, negatively impacting on attendance. This highlights the importance of being aware of the influence of contextual factors when rolling out intensive intervention models.

Despite these issues, comparing dosage before and during the QI project reveals stark differences. During the QI project, target dose per session more than doubled and the continuous provision of more frequent sessions within the 12-week window contrasts with the disparate and discontinuous dosage across (at times extended) periods provided during routine service delivery (a target dose of ~30; a mean of 17.8 sessions (range: 7–26); across a mean of 87.6 weeks (range: 40–172)). It appears that the QI project's dosage model was clearly more efficient and potentially drove the more rapid progress observed in the children's speech development. Notably, the impact of breaks (characteristic of many SLT models of service delivery) cannot be captured by the formula for CII²⁰ (mean=1788, range=1049–2389 for the QI project). Further research is required to unpick the impact of the length, timing and nature of breaks on different types of speech, language and communication interventions and populations moving forward.

Lessons and limitations

This project's findings on increasing frequency of intervention in a typical paediatric NHS community service highlight the reflection that children, their parents and SLTs get sick, fatigue and have other commitments which impact on regular attendance at intensive face-to-face SLT appointments. Significantly, the fact that the dose within sessions can be so readily and sustainably increased to evidence-based levels by SLTs is encouraging and should be easily transferable across contexts.

The case of child M in the project also highlights that accurate identification of child readiness, and the nature of support provided to parents for intensive intervention requires further development. After reflection, child M's parents worried that they had perhaps been putting her under too much pressure by working intensely for long periods of time at home, potentially causing her to become upset when unable to achieve targets and ultimately requiring an agreed 5-week break to reduce pressure on their daughter. Clearly, empowering parents to



implement more intensive home support warrants further development and investigation when considering how to optimally increase frequency of intervention.³⁸

While measures of child speech outcomes and parental perception of intelligibility showed improvement, it is difficult to be sure that this impact was due to the intensity of the intervention. There is also no way of ensuring that some of the changes observed were not due to natural maturation. These issues could have been addressed by using a larger sample and gathering baseline speech outcomes over several time points prior to implementing the changes. In addition, the fact that the SLTs providing the intervention also carried out the speech outcome measures may have allowed positive bias to influence results.

CONCLUSION

This project has begun to address a largely unmet need to provide intensive intervention to young children with severe SSD in community SLT services. It is the first step towards changing services so that these children receive the level of intensity required to maximise effectiveness and efficiency of intervention following the evidence-base.^{8–10} Future cost analysis of savings made to the NHS may be worthwhile to justify this change to the model of service delivery and support other services to make similar changes beyond Southern HSC Trust.

The SLT Professional Lead will continue to support the two specialist SLTs and community SLTs across the Trust's community paediatric service to implement this model of service delivery for this population. As the NHS settles into more routine care alongside management of ongoing issues within the COVID-19 pandemic, an audit programme will be put in place to evaluate the sustainability and effectiveness of this service change and drive adaptations to it as appropriate.

Next steps will be to refine and test the operational criteria in relation to its sensitivity to child readiness, and to empower willing parents by training them to provide intensive intervention at home alongside direct SLT intervention.

This project's findings have been shared with the overall manager of children's services in Southern HSC Trust, Trust-wide and across HSC Trusts via Northern Ireland's NHS QI strategy, and have been well received at international conferences (ie, International Clinical Linguistics & Phonetics Conference, 2021).

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Acknowledgements The authors would like to acknowledge and thank all the parents and their children who participated in this project, and the community-based speech and language therapy staff who supported its roll out.

Contributors The first author (HM) of this paper designed and led the roll out of the QI project in the HSC Trust and is responsible for the overall content as the guarantor. The second (LM) and third (JS) authors worked with the first author to roll out the QI project; contributing to refinement of the project and collecting data to support analysis of the impact of the QI initiative. The fourth author (JT) wrote the paper based on information gathered from and provided by, the other authors. The

first and fourth author liaised closely on the writing up phase with the second and third authors contributing to the final drafts of the paper.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Ethics approval Ethical approval was not required for this QI project. Parents verbally consented for their children to participate and all information held and analysed was anonymised from data entry. There are no conflicts of interest for this project.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as online supplemental information.

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