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ABSTRACT:

Introduction: Understanding the influences of early swallowing function and feeding environment on the development of communication will enhance prevention and intervention initiatives for young children. This scoping review will help elucidate key elements affecting the developmental trajectory of communicative systems, typically robust and well-developed by formal school entry. We aim to i) map the current state of the literature in a growing field of interest that has the potential to advance knowledge translation, ii) identify existing gaps, and iii) provide direction for future investigations.
Methods and analysis: We are proposing a scoping review to identify the breadth and depth of the existing literature regarding swallowing-feeding functions and environment relative to the onset and progression of communicative behaviours from infancy to six years of age. Our protocol delineates rigorous methods according to Arskey and O'Malley's framework and includes elaborations by Levac and colleagues. We will search the literature based on 10 databases 16 peer-reviewed journals, 4 conference proceedings, and 6 grey literature sources and use forward and backward chaining. Two authors will independently screen abstracts and review full articles, remaining blind to each other's results. A third author will contribute to resolving any discrepant results from both the abstract and article review. Subsequently, we will extract data and chart information from accepted articles using a pre-established data collection form. We will stratify results according to healthy versus impaired swallowing-feeding functions and communication development.
Ethics and dissemination: Our scoping review does not require ethical approval. We will disseminate our final study results through international and national conference presentations, publication in a peer-reviewed journal, and knowledge translation activities with stakeholders.

STRENGTHS AND LIMITATIONS OF THE STUDY:

- A key strength includes a first and comprehensive literature mapping for research on the influence of early swallowing-feeding behaviours and environment on communication development
- A second strength includes a rigorous search design involving multiple sources, such as databases, journals, conference proceedings, and the grey literature
- An inherent limitation of our scoping review is that we will not conduct quality appraisal for individual articles given anticipated breadth of results and research designs

BACKGROUND:

There has been growing interest in the effects of swallowing and feeding functions on the development of communicative systems in young children. Research is necessary to understand the complexity of influences that may foster optimal development and conversely forestall delays, especially in the wake of increasingly prevalent communication disorders. Whether children incur communication disorders via unknown causes or via predisposing conditions, a high proportion of newborn babies can be expected to develop a communication disorder, and they are vulnerable from birth through to diagnosis and beyond. Various prenatal, perinatal, or postnatal congenital abnormalities or conditions, including syndromes, cerebral palsy, and premature birth, may predispose children to impaired communication development. Currently, congenital syndromes affect about four percent of Canadian babies.[1] In particular, the birth prevalence of Down syndrome is 0.16 percent [2] and orofacial clefts are evidenced in 0.13 percent of live births.[3] Even more prevalent, cerebral palsy ranges from 0.31 to 0.36 percent of eight year old children in the USA.[4] Far exceeding the prevalence of other conditions, prematurity is currently estimated at 8 percent of all births,[5] and ensuing difficulties may persist throughout childhood.

In fact, eight percent of American children aged three to 17 years has a speech, language, voice, or swallowing disorder.[6] More specifically, a recent population study demonstrated a frequency of language disorders by entry to mainstream schooling in 10 percent of children.[7] Close to one-third of the sample had a language disorder of unknown cause,[7] which is often attributable to specific language impairment.[8] Similarly, the prevalence of language impairment in Canadian kindergarteners is about

eight percent.[9] Concerning speech acquisition, approximately 15 percent of three-year old and four percent of six-year old children have a speech sound disorder.[10] Speech and/or language impairments often co-occur, affecting over 10 percent of kindergarten children.[9] They may be also present in children with social communication impairments, such as autism spectrum disorder, which affects one and a half percent of Canadian children currently.[11]

Despite good epidemiological information and a long history of research on speech and language development in the preschool years,[12-16] a significant gap exists concerning knowledge of the earliest precursors to communication.[12] They include vocalizations of the newborn infant such as cries, vegetative sounds, and comfort sounds such as cooing, as described in Stark and her colleague's (1978)[17] seminal study, all occurring well before the onset of reduplicated babbling.[12] Cooing is an early speech-like behaviour, occurring as early as one month of age,[17] and it may well be a hallmark indicator to the healthy progression of higher order speech and communicative systems because of its association with positive affect and relational interactions.[18] Notwithstanding, the nature and potential early facilitators of healthy or optimal development of communication remain elusive. Given the highly responsive and largely reflexive behaviours in the neonatal period, young infants are difficult to evaluate and monitor in a natural setting. Consequently, there remains a paucity of literature on very early onset of vocalizations and progression toward the development of symbolic communication. An ideal naturalistic early context for understanding communication development includes physiologically-driven periods when infants are alert, most notably prior to and during feeding sequences. For example, early vocalizations of contentment

may be inextricably linked to the feeding context.[19] Interestingly, infants remain by and large dependent for feeding, until just about the time when symbolic communication and joint attention emerge (8 to12 months).[20] Consequently, the feeding environment can promote optimal linguistic exposure and interactions, facilitating development of the auditory system and various basic motor functions of the vocal tract.[21]

Various theoretical premises exist regarding the development of communication: i) one revolving around the tightly-coordinated and integrative physiological development of the respiratory and vocal/articulatory systems,[22,23] ii) another particularly centered on intrinsic innate developmental stages for speech and language acquisition,[24,25] and iii) a third pertaining to a connectionist framework for speech production and/or processing alongside learning demands,[26] dependent on capacity for resource allocation.[27] By extension, a connectionist model could intuitively include physiological integrity as necessary for higher-level resource allocation, whereby excessive demands or dysfunction would preclude optimal activation of complex behaviours and cognitive processing. Conversely, physiological integrity coupled with environmental facilitators would permit the necessary resource allocation for the optimal development of integrated networks for communicative systems, ensuring appropriate stage to stage developmental progression.

To illustrate, from a physiological standpoint, both respiration and swallowing are primordial life-sustaining functions, and they are inextricably linked and tightly coordinated behaviours.[28,29,30] Consequently, integrity of swallowing depends upon adequate respiratory functions and together they provide the physiological and neurological basis for developing voice and speech functions.[22,23] Physiological

integrity of swallowing coupled with a facilitative feeding environment[21] may well optimize connections and prime the development of neural networks for communication. There is a need to collect additional knowledge about swallowing/feeding and speech/language relationships to help us improve our current understanding of healthy versus disordered development of communication. Specifically, we want to improve the processes of early detection, evaluation, and intervention for swallowing/feeding and associated communicative functions in an integrated manner.

Rationale:

Identifying relationships between early physiological functions (such as feeding and swallowing) and communication (from speech-like behaviours such as cooing to phonological development for meaningful word production and language use in discourse) will help us improve our understanding of the development of communication. We need to consider these relationships starting in early infancy because the feeding context has great potential as a facilitative environment for social interactions. Nevertheless, problems with swallowing function and/or suboptimal feeding environment may have a grossly prohibitive effect on optimal and healthy development of communicative systems. We still need a comprehensive understanding of precursors and determinants longitudinally from birth to the age of six, when most children begin formal schooling.

Objectives:

The primary objective of our scoping review is to provide an overview of the literature considering the association between swallowing physiology and feeding environment and the development of communicative functions, whether healthy or disordered. The specific objectives include: 1) identifying the number and design of articles over time, 2) mapping sample characteristics and study themes in the existing literature, and 3) identifying gaps in knowledge pertaining to the contribution of swallowing function and feeding environment to the development of communicative systems in infants and young children.

METHODS AND ANALYSIS

Operational Definitions

We have defined swallowing to include oropharyngeal and/or esophageal stages[31] involving anatomical, neurological (e.g. coordinated respiratory/swallowing behaviours), and/or physiological functions. Pediatric feeding includes i) interest in feeding[32] and consequent environmental engagement, ii) behavioural manifestations of dietary preferences, and/or iii) progression through developmentally appropriate food and/or liquid consistencies and type.[33] As such, feeding does not include nutritional aspects of intake and/or diet, such as adequacy of macro or micronutrients.

Communication refers to the exchange of information, ideas, needs, and desires between at least two persons.[20] It involves both linguistic and paralinguistic codes,[20] whereby methods of transmission include speech, intonation, gestures, and body language.[20] Examples of earliest behavioural manifestations may include first words or manual signs, presenting in children as young as 8 months,[20] rapidly increasing in

complexity.[34] For the purpose of this scoping review, the definition of communication encapsulates the entire developmental progression from earliest precursors in the newborn infant to the use of near adult-like constructs by school entry.[20]

Therefore, we need to appreciate factors involving swallowing physiology and feeding relative to the onset of pre-linguistic vocalisations and progression towards a highly complex communicative system. Such an understanding will help identify early facilitators or prognostic indicators of delay in the development of communication, whether speech, language, or social communication (or a combination therein). A recent shift in culture in health-care settings has already manifested, where recommended feeding practices follow from infant cues for readiness,[35,36] rather than from oral motor abilities (such as non-nutritive sucking) or from quantity of ingested feeds.[36] Accordingly, there has been a recent increase in attention to pediatric feeding-swallowing disorders and their relationship to communication development.[37-42] Research investigations involving swallowing behaviours and feeding are badly needed to guide preventative and clinical treatment initiatives to promote the healthy development of communication from infancy to school entry.

Framework

Given the breath of our topic, we chose to conduct a scoping review to provide an evidence map[43] for key concepts and definitions in the emerging evidence base.[43] Our scoping review follows Arskey and O'Malley's framework involving six stages,[44] including elaborations, such a clearly articulated reason and scope of inquiry as well as a transparent and replicable approach to study selection.[45] We will use the PRISMA-P

reporting checklist[46,47] as a guide for the process of literature appraisal and for reporting results.

Stage 1: identifying the research questions:

We have developed a single broad research question to inform our search strategy and to derive key domains for our results. We seek to understand the foundational underpinnings of the early development of communication in relation to its inherent physiological and environmental precursors surrounding early swallowing and feeding behaviours. The overarching broad question that our review addresses is:

"What early feeding/swallowing factors influence communication development from birth to six years of age?"

Our line of inquiry includes early child development in both health and congenital or acquired diseases/disorders. Consequently, our review will facilitate an appreciation of swallowing-feeding factors that relate to the development of communication within an epidemiological framework. Underlying secondary questions relate to swallowing physiology and the feeding environment more specifically. The development of our secondary questions results from an iterative process, whereby reformulations of the questions posed *a priori* (i.e, those identified herein) may result and/or new questions may arise. Our secondary questions currently include:

i. What underlying congenital problems (e.g., cerebral palsy, cardiac/respiratory/gastrointestinal anatomical defects, neurological syndromes, prematurity, transient birth-related distress) impact swallowing-feeding integrity and the development of communicative functions?

ii. What swallowing-related impairments (e.g., poor respiratory function, reflux, weak neonatal latch/sucking behaviours) compromise or delay the onset of communicative functions?

iii. How do feeding environments alter the onset and course of development of communicative functions?

a. feeding mode (breast, bottle, combination feeding, enteral feeding)

b. setting (neonatal intensive care unit stay, hospital stay, interventions such as incubation for phototherapy)

c. interactive constructs (quality and quantity of feeding-related verbal interactions and/or tactile interactions of dyads)

Stage 2: identifying relevant studies

The search strategy for Medline was developed in three steps by the first (HF) and third authors (ME) with input by the final author (SAS) through ongoing consultation with a research librarian. First, we undertook a consultative process, whereby we analysed and reviewed all MeSH terms associated with communicative functions and feeding/swallowing behaviours multiple times to maximize specificity while retaining the necessary scope of inquiry. Subsequently, the first and third authors chose MeSH terms for explosion if all subordinate terms were truly relevant to the content area and research questions. Second, review of other relevant systematic or scoping reviews revealed additional possibilities for MeSH terms and context-dependent terms (e.g., title, abstract, and key words) in the areas of swallowing-feeding[48-51] and communication[52-55]. The two authors (HF and ME) developing the search strategy selected terms for a

pediatric population from a published filter,[56] identified by the research librarian, rather than limit the search within Medline. Finally, we developed additional context-dependent terms that we felt were not be captured from the previous two steps based on our expert knowledge of the fields of swallowing and communicative sciences. The research librarian then confirmed the integrity of the terms and search strategy (Table 1) and provided consultation for additional databases to search.

We selected nine additional databases to search based on adaptations of the Medline search terms (Table 2). We did not include PubMed as part of the search, given the possibility of its referencing predatory journals.[57] We consider our set of selected databases sufficient to capture potentially-relevant PubMed citations. We will not apply date or language limits on the searches to the extent possible. That is, we will accommodate languages that we can read (including at least English, French, German, Italian, Persian, and Spanish) and seek translations for other languages (if possible) from colleagues and contacts within our scientific communities. All study designs are of interest, including case reports, case series, qualitative, cohort, case-control, and quasi-experimental studies, as well as randomised controlled trials. Further, we identified 16 journals, 4 conference proceedings, and 6 grey literature sources (Table 2). We will review the reference lists and citations of selected articles through Google Scholar using a process of forward and backward chaining.[58]

Table 1. Medline search strategy

Item	Term Set	Area
1	exp Deglutition/	swallowing
2	exp Gastroesophageal Reflux/	swallowing
3	Deglutition disorders/	swallowing
4	"Feeding and Eating Disorders of Childhood"/	swallowing
5	Breast feeding/	swallowing
6	Bottle Feeding/	swallowing
7	Feeding Methods/	swallowing
8	Enteral Nutrition/	swallowing
9	Parenteral Nutrition/	swallowing
10	Kangaroo-Mother Care Method/	swallowing
11	Pacifiers/	swallowing
12	sucking behaviors/	swallowing
13	((enteral or tube or gastric) adj (feed$)).ti,ab,kw.	swallowing
14	((deglut$ or feed$ or swallow$ or feed$-swallow$) adj3 (difficult$ or disorder$ or abnormal$ or delay$ or dysfunction$ or impair$ or problem$ or disabil$ or disabl$ or deficit$)) .ti,ab,kw.	swallowing
15	((deglut$ or feed$ or swallow$ or feed$-swallow$) adj3 (behavior or develop$ or neurodevelop$ or matur$ or function$)) .ti,ab,kw.	swallowing
16	(dysphag$).ti,ab,kw.	swallowing
17	((bottle fe$) or (bottlefe$) or (breast fe$) or (breastfe$) or (feeding mode) or (feeding methods)).ti,ab,kw.	swallowing
18	((gastroesophageal or gastro-esophageal or infantile or gastric) adj3 (reflux or regurgitat$)).ti,ab,kw.	swallowing
19	exp Speech/	comm
20	exp Speech disorders/	comm
21	exp Language development disorders/	comm
22	exp Child language/	comm
23	Speech sound disorder/	comm
24	Verbal behavior/	comm
25	Manual communication/	comm
26	Communication disorders/	comm
27	Social communication disorder/	comm
28	Autism Spectrum Disorder/	comm
29	Language disorders/	comm
30	Language Development/	comm
31	((speech or oromotor or "oral motor" or verbal$ or oro-motor or orofacial or oro-facial or "oral facial") adj3 (aprax$ or dysprax$ or prax$)).ti,ab,kw.	comm

32	((speech or speak$ or oral or language or verbal$ or communication or voice or vocal$ or babbl$ or coo$ or "oral motor" or oromotor or oro-motor or orofacial or oro-facial or "oral facial" or oralfacial or articulat$ or phonetic$ or phonologic$ or phonemic$ or pre-linguistic or prelinguistic) adj3 (difficult$ or disorder$ or abnormal$ or delay$ or dysfunction$ or impair$ or problem$ or disabil$ or disabl$ or deficit$)) .ti,ab,kw.	comm
33	((speech or speak$ or oral or language or verbal$ or communication or voice or vocal$ or babbl$ or coo$ or "oral motor" or oromotor or oro-motor or orofacial or oro-facial or "oral facial" or oralfacial or articulat$ or phonetic$ or phonologic$ or phonemic$ or pre-linguistic or prelinguistic) adj3 (behavior or develop$ or neurodevelop$ or matur$ or acqui$)) .ti,ab,kw.	comm
34	exp child/	population
35	exp infant/	population
36	adolescent/	population
37	(pediatric* or paediatric* or child* or newborn* or infan* or baby or babies or neonat* or pre-term or preterm* or premature birth* or NICU or preschool* or pre-school* or kindergarten* or kindergarden* or elementary school* or nursery school* or schoolchild* or toddler* or boy or boys or girl* or middle school* or pubescen* or jevenile* or teen* or youth* or high school* or adolesc* or pre-pubesc* or prepubesc*).mp.	population

Table 2. Complete list of search sources including databases, journals, conference proceedings, and grey literature

Literature Type	Sources
Databases:	- AMED - CINHAL - Education Source - Embase - ERIC - Linguistics and Language Behaviour Abstracts - Medline - PsycInfo - Scopus - Web of Science
Journals:	- American Journal of Speech-Language Pathology - Canadian Journal of Speech-Language Pathology - Child Development - Clinical Linguistics and Phonetics - Developmental Medicine and Child Neurology - Dysphagia - Gastroenterology - Infancy - International Journal of Behavioral Development - International Journal of Speech-Language Pathology - Journal of Child Language - Journal of Communication Disorders - Journal of Pediatric Gastroenterology and Nutrition - Journal of Pediatrics - Nature - The American Journal of Gastroenterology
Conference Proceedings	- ASHA Conference - Dysphagia Research Society - International Conference on Speech and Language Development - World pediatrics
Grey Literature:	- Networked Digital Library of Theses and Dissertations - Open Access Theses and Dissertations - Open Grey - Proquest Dissertations and Theses Global - Ontario Public Health Libraries Association - Grey Matters

Stage 3: selecting studies

We will compile and store all citations using Covidence[59] and Microsoft Excel. Following elimination of duplicates and citations without abstracts, we will review the remaining abstracts and articles in a two-step process. Two independent reviewers will code the abstracts for potential inclusion or exclusion (Table 3). Coding criteria are purposefully open-ended for abstract review to permit selection of all those potentially relevant for full article retrieval. Additionally, codes are hierarchical, such that if code 1 is relevant, and the abstract therefore deemed ineligible, the remaining codes are not applicable. Subsequently, the two abstract reviewers will discuss and resolve discrepancies by consensus, requesting input from a third reviewer for consensus deliberations. All abstracts not assigned an exclusion code will be accepted for full review.

The same process will apply to full article review to determine final articles for inclusion. That is, two reviewers, blind to each other's evaluations, will independently assess all full articles, determining eligibility for inclusion according to more stringent and hierarchically-coded criteria (Table 3). Any articles written in languages outside of those understood by the two reviewers will undergo translation (if possible) for key methodological content to enable coding. Coding criteria for the full article review will be more stringent than for the abstract review, since all pertinent information will be available and reviewers will make a final decision about article selection. Where discrepancies exist, the two reviewers engage in discussion to achieve consensus regarding inclusion or exclusion. In the event of difficult resolution, a third reviewer will assist in consensus deliberations. That is, all three reviewers will revisit the article in a

process of reiterative evaluation to determine final inclusion or exclusion of the article. All codes and final decisions for inclusion or exclusion from both abstract and full article reviews will be entered into the Excel datasheet.

Articles without exclusion codes will be accepted for the scoping review. Accepted articles that initially required translation will undergo a second review (if possible) by the same translator and/or a different translator to ensure that the appropriate content is available for data extraction and charting.

Table 3. Proposed coding categories for abstract and full article review

Step 1 - Exclude if abstract:	Step 2 – Exclude if full article:
1) is clearly a review, commentary, or opinion	1) is clearly a review, commentary, or opinion
2) clearly has only an adult sample (≥18 years of age)	2) has a sample exclusively outside desired age range (≥7 years of age)
3) swallowing/feeding context outside operational definition (i.e. relates exclusively to nutritional intake)	3) swallowing/feeding context outside operational definition (i.e. relates exclusively to nutritional intake)
4) outcomes relating to communication or other aspects of child development (motor, cognitive) clearly absent	4) outcomes relating to communication clearly absent
5) n/a	5) outcomes relating to swallowing/feeding and communication development clearly absent
6) clearly involves same data as another abstract	6) clearly involves same data as another article
Otherwise accept for full article retrieval	Otherwise accept for scoping review

Stage 4: charting the data

Multiple reviewers will be responsible for collecting data, each from a proportion of the articles, followed by independent verification of all data by research personnel. Data

collection will involve documenting key characteristics and variables of interest for each article (Table 4) and recording them in a database for storage and analysis. All reviewers collecting and charting data will be responsible for ongoing communication about emerging themes or domains of inquiry that could alter and enhance data collection procedures.

Table 4: Basic study characteristics for extraction from each accepted article.

Categories	Characteristics
1) Article details	Article details - year of publication - document type (peer-reviewed journal article, thesis, government document, conference proceeding or published abstract) - location of study (country)
2) Study details	Study details - design (cohort, case-series, RCT, case study, case series, qualitative) - time frame (cross-sectional, longitudinal) - setting (hospital, home) - population (children with typical communication development, children with disordered/atypical communication development)
3) Sample characteristics	Sample characteristics - sample size - groups - age range - sex/gender - ethnicity - language(s) used - etiology (if applicable) - comorbidities (if applicable) - hearing status
4) Study outcomes	Feeding/swallowing - physiology and behaviours - environment - modes Communication development

	- speech (early vocalizations, babbling, protowords, single word production, multiword production) - language (content, form, use) - gestural behaviours
5) Main findings of study	Trends Effects
6) Data analyses	Type Rigour
7) Themes/domains of study	Barriers to communication development Facilitators to communication development
8) Study limitations	Design Outcomes Generalizations
9) Pertinence[43]	Clinical practice Policy Research

Stage 5: collating, summarizing, and reporting the results

Data from stage 4 will be summarized to map the emergence and breadth of literature over time for the primary objective. Subsequently, we will stratify the findings according to healthy versus impaired development. Various forms of data presentation will include tables, line graphs (for chronological information), histograms, and/or pie charts. To illustrate, we will tabulate study characteristics according to design, population, setting, and pertinence for policy, clinical practice, or research. Similarly, we will visually represent information pertaining to swallowing-feeding functions and domains of communication development in charts. Where available, we will describe themes that arise from our review, including barriers and facilitators to the development of communicative functions in young children.

Our scoping review will therefore provide a first overview of trends and breadth for an emerging body of literature. Most important, we will identify gaps in the current

knowledge base and provide guidance for the prevention and treatment of potential communication impairments beginning in early infancy.

DISCUSSION (DISSEMINATION)

Following completion of all stages of scoping review, findings will be disseminated via local and international conference presentations and submission to a peer-reviewed journal. Knowledge translation activities will then include development of accessible materials for end-users, such as parents, infant caregivers, and clinicians from various fields of professional practice, so that they may understand and advocate best practice for communicative development in children. In addition, we will share our findings with policy-making organizations and other stakeholders, such as the Canadian Child and Youth Health Coalition and the Paediatric International Patient Safety and Quality Collaborative.

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Contributors: All co-authors provided meaningful and unique contributions to the development, preparation, and/or writing of the current scoping review protocol. HF formulated the topic and conceptualized the questions and theoretical framework. She also guided the research team at all stages of the review development and wrote the bulk of the protocol. DB contributed critical and novel insight for the research questions,

theoretical framework, and review components relative to communicative functions. SAS contributed critical and novel insight for the research questions and for operational definitions relative to swallowing functions. She also provided advice for scoping review methods and proposed analyses. ME provided conceptual input in the development of the search terms relating to communicative functions in collaboration with HF and in consultation from a research librarian. M-FP contributed to writing the introduction, especially with respect to epidemiology of communication impairments. SM contributed by drafting ideas related to the clinical relevance of the scoping review. All authors reviewed multiple renditions of the manuscript, providing suggestions and editing until all approved the appropriateness for submission.

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Swallowing behaviours and feeding environment in relation to communication development from early infancy to six years of age: A scoping review protocol

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ABSTRACT:

Introduction: Understanding the influences of early swallowing function and feeding environment on the development of communication will enhance prevention and intervention initiatives for young children. This scoping review will help elucidate key elements affecting the developmental trajectory of communicative systems, typically robust and well-developed by formal school entry. We aim to i) map the current state of the literature in a growing field of interest that has the potential to advance knowledge translation, ii) identify existing gaps, and iii) provide research direction for future investigations surrounding feeding-swallowing functions and environment that support or forestall communication development in young children.

Methods and analysis: We are proposing a scoping review to identify the breadth and depth of the existing literature regarding swallowing-feeding functions and environment relative to the onset and progression of communicative behaviours from infancy to six (<6;0) years of age. Our protocol delineates rigorous methods according to Arskey and O'Malley's framework and includes elaborations by Levac and colleagues. We will search the literature based on 10 databases 17 peer-reviewed journals, 4 conference proceedings, and 6 grey literature sources. Two authors will independently screen abstracts and review full articles, remaining blind to each other's results. A third author will contribute to resolving any discrepant results from both the abstract and article review. Subsequently, we will extract data and chart information from accepted articles using a pre-established data collection form. We will stratify results according to healthy versus impaired swallowing-feeding functions and communication development.

Ethics and dissemination: Our scoping review does not require ethical approval. We will disseminate our final study results through international and national conference presentations, publication in a peer-reviewed journal, and knowledge translation activities with stakeholders.

STRENGTHS AND LIMITATIONS OF THE STUDY:

- A key strength includes a first and comprehensive literature mapping for research on the influence of early swallowing-feeding behaviours and environment on communication development
- A second strength includes a rigorous search design involving multiple sources, such as databases, journals, conference proceedings, and the grey literature
- An inherent limitation of our scoping review is that we will not conduct quality appraisal for individual articles given anticipated breadth of results and research designs
- A second limitation is that we did not include nutritional factors alongside feeding as potential mediators of optimal development of communicative behaviours. The breadth of the review protocol is extensive and cannot feasibly accommodate infant or maternal nutritional inquiry

BACKGROUND:

There has been growing interest in the effects of swallowing and feeding functions on the development of communicative systems in young children. Research is necessary to understand the complexity of influences that may foster optimal development and conversely forestall delays, especially in the wake of increasingly prevalent communication disorders. Whether or not children incur communication disorders via elusive causes or predisposing conditions, a high proportion of newborn babies will develop a communication disorder. They often remain vulnerable from birth through to school entry (generally before the age of six), especially if diagnosis is delayed or early interventions are lacking.[1] Various prenatal, perinatal, or postnatal congenital abnormalities or conditions, including syndromes, cerebral palsy, and premature birth, may predispose children to impaired communication development. Currently, congenital syndromes affect about four percent of Canadian babies.[2] In particular, the birth prevalence of Down syndrome is 0.16 percent[3] and orofacial clefts are evidenced in 0.13 percent of live births.[4] Even more prevalent, cerebral palsy ranges from 0.31 to 0.36 percent of eight year old children in the USA.[5] Far exceeding the prevalence of other conditions, prematurity is currently estimated at 8 percent of all births,[6] and ensuing difficulties may persist throughout childhood.

In fact, eight percent of American children aged three to 17 years has a speech, language, voice, or swallowing disorder.[7] More specifically, a recent population study demonstrated a frequency of language disorders by entry to mainstream schooling in 10 percent of children.[8] Close to one-third of the sample had a language disorder of unknown cause,[8] which is often attributable to specific language impairment.[9]

Similarly, the prevalence of language impairment in Canadian kindergarteners is about eight percent.[10] Concerning speech acquisition, approximately 15 percent of three-year old and four percent of six-year old children have a speech sound disorder.[11] Speech and/or language impairments often co-occur, affecting over 10 percent of kindergarten children.[10] They may be also present in children with social communication impairments, such as autism spectrum disorder, which affects one and a half percent of Canadian children currently.[12]

Despite good epidemiological information and a long history of research on speech and language development in the preschool years,[13-17] a significant gap exists concerning knowledge of the earliest precursors to communication.[13] There is, however, emerging evidence for synchrony and congruence between maternal vocalisations and fetal behaviours.[18] In particular, the fetus is preferentially sensitive to particular types of maternal linguistic input and may even mirror associated gestural oral behaviours (such as mouth opening).[19] Early after birth, synchronous mother-infant vocal behaviours continue to manifest.[20] Vocalizations of the newborn infant include cries, vegetative sounds, and comfort sounds such as cooing, as described in Stark and her colleague's (1978)[21] seminal study, all occurring well before the onset of reduplicated babbling.[13] Of note, a recent study underscored differences in maternal response to early speech-like vocalizations (protophones) compared to infant cries.[20] That is, mothers more frequently engaged in verbal turn-taking when infants produced protophones compared to cries.[20] Cooing is an early speech-like behaviour, occurring as early as one month of age,[21] and it may well be a hallmark indicator to the healthy

progression of higher order speech and communicative systems because of its association with positive affect and relational interactions.[22]

A body of evidence suggests that early positive attachment and interactive experiences between mothers and babies facilitate affective, cognitive, and communication development.[23] Over the long term, children demonstrate improved social-emotional[24,25] and cognitive[26] development when their mothers are emotionally available,[24,26] provide skin-to-skin contact,[25] and/or provide verbal stimulation[26] in early infancy. Likewise, intact early infant neuroregulation, particularly attention (a precursor to interactive engagement), predicts good social communication outcomes by school entry.[27]

Notwithstanding, the nature and potential range of early facilitators and associated trajectory of infant responses that converge for the healthy or optimal development of communication, particularly the onset of joint attention,[28] remain elusive. Given the highly responsive and largely reflexive behaviours in the neonatal period, young infants are difficult to evaluate and monitor in a natural setting. Consequently, there remains a paucity of literature on very early onset of vocalizations and progression toward the development of symbolic communication despite evidence for early maternal verbal contingencies following infant vocalizations[20,29] and interactive cues such as eye-gaze patterns.[29] An ideal naturalistic early context for understanding communication development includes physiologically-driven periods when infants are alert, most notably prior to and during feeding sequences. For example, early vocalizations of contentment may be inextricably linked to the feeding context.[30] Interestingly, infants remain by and large dependent for feeding, until just about the time when symbolic communication

and joint attention emerge (8 to 12 months).[31] Consequently, the feeding environment can promote optimal linguistic exposure and interactions, facilitating development of the auditory system and various basic motor functions of the vocal tract.[32]

Various theoretical premises exist regarding the development of communication: i) one revolving around the tightly-coordinated and integrative physiological development of the respiratory and vocal/articulatory systems,[33,34] ii) another particularly centered on intrinsic innate developmental stages for speech and language acquisition,[35,36] and iii) a third pertaining to a connectionist framework for speech production and/or processing alongside learning demands,[37] dependent on capacity for resource allocation.[38] By extension, a connectionist model could intuitively include physiological integrity as necessary for higher-level resource allocation, whereby excessive demands or dysfunction would preclude optimal activation of complex behaviours and cognitive processing. Conversely, physiological integrity coupled with environmental facilitators would permit the necessary resource allocation for the optimal development of integrated networks for communicative systems, ensuring appropriate stage to stage developmental progression.

To illustrate, from a physiological standpoint, both respiration and swallowing are primordial life-sustaining functions, and they are inextricably linked and tightly coordinated behaviours.[39-41] Consequently, integrity of swallowing depends upon adequate respiratory functions and together they provide the physiological and neurological basis for developing voice and speech functions.[33,34] Physiological integrity of swallowing coupled with a facilitative feeding environment[32] may well optimize connections and prime the development of neural networks for communication.

Conversely, detriment to swallowing functions can incur disease and grossly compromise physiological integrity of the respiratory and auditory systems. Examples include increased risk of secondary respiratory infections[42] and otitis media.[43,44].There is a need to collect additional knowledge about swallowing/feeding and speech/language relationships, including mediation by the auditory system[45] to help us improve our current understanding of healthy versus disordered development of communication. Specifically, we want to improve the processes of early detection, evaluation, and intervention for swallowing/feeding and associated communicative functions in an integrated manner.

Rationale:

Identifying relationships between early physiological functions (such as feeding and swallowing) and communication (from speech-like behaviours such as cooing to phonological development for meaningful word production and language use in discourse) will help us improve our understanding of the development of communication. We need to consider these relationships starting in early infancy because the feeding context has great potential as a facilitative environment for social interactions. Nevertheless, problems with swallowing function and/or suboptimal feeding environment may have a grossly prohibitive effect on optimal and healthy development of communicative systems. We still need a comprehensive understanding of precursors and determinants longitudinally from birth to the age of six, when most children begin formal schooling.

Objectives:

The primary objective of our scoping review is to provide an overview of the literature considering the association between swallowing physiology and feeding environment and the development of communicative functions, whether healthy or disordered. The specific objectives include: 1) identifying the number and design of articles over time, 2) mapping sample characteristics and study themes in the existing literature, and 3) identifying gaps in knowledge pertaining to the contribution of swallowing function and feeding environment to the development of communicative systems in infants and young children.

METHODS AND ANALYSIS

Operational Definitions

We have defined swallowing to include oropharyngeal and/or esophageal stages[46] involving anatomical, neurological (e.g. coordinated respiratory/swallowing behaviours), and/or physiological functions. Pediatric feeding includes i) interest in feeding[47] and consequent environmental engagement, ii) behavioural manifestations of dietary preferences, and/or iii) progression through developmentally appropriate food and/or liquid consistencies and type.[48] As such, feeding does not include nutritional aspects of intake and/or diet, such as adequacy of macro or micronutrients. Hereafter, the term "environment" will refer to external stimuli linked to the feeding process and related context. Consequently, elements could include feeding mode, accompanying auditory or visual stimuli, location (e.g., intensive care unit, home, an incubator), and social interactions (e.g., verbal and tactile).

Communication refers to the exchange of information, ideas, needs, and desires between at least two persons.[31] It involves both linguistic and paralinguistic codes,[31] whereby methods of transmission include speech, intonation, gestures, and body language.[31] Examples of earliest behavioural manifestations may include first words or manual signs, presenting in children as young as 8 months,[31] rapidly increasing in complexity.[49] For the purpose of this scoping review, the definition of communication encapsulates the entire developmental progression from earliest precursors in the newborn infant to the use of near adult-like constructs by school entry.[31]

Therefore, we need to appreciate factors involving swallowing physiology and feeding relative to the onset of pre-linguistic vocalisations and progression towards a highly complex communicative system. Such an understanding will help identify early facilitators or prognostic indicators of delay in the development of communication, whether speech, language, or social communication (or a combination therein). A recent shift in culture in health-care settings has already manifested, whereby early infant behaviours (such as vocalizations) are understood to be cues that communicate a need and warrant a social interactive response.[50,51] Hence, recommended feeding practices follow from observing infant cues for readiness,[52,53] rather than from assessing oral motor abilities (such as non-nutritive sucking) or from documenting quantity of ingested feeds.[53] Accordingly, there has been a recent increase in attention to pediatric feeding-swallowing disorders and their relationship to communication development.[54-59] Research investigations involving swallowing behaviours and feeding are badly needed to guide preventative and clinical treatment initiatives to promote the healthy development of communication from infancy to school entry.

Framework

Given the breath of our topic, we chose to conduct a scoping review of the literature that will guide knowledge translation, identify gaps in the literature, and inform future research investigations from an emerging evidence base.[60] Our scoping review follows Arskey and O'Malley's framework involving six stages,[61] including elaborations, such a clearly articulated reason and scope of inquiry as well as a transparent and replicable approach to study selection.[62] We have applied the PRISMA-P reporting checklist[63,64] as a guide for the process of literature appraisal and for reporting results (Supplementary Table 1).

Patient and Public Involvement

Neither patients nor the public was involved in the development of the current scoping review protocol.

Stage 1: identifying the research questions

We have developed a single broad research question to inform our search strategy and to derive key domains for our results. We seek to understand the foundational underpinnings of the early development of communication in relation to its inherent physiological and environmental precursors surrounding early swallowing and feeding behaviours. The overarching broad question that our review addresses is:

"What early feeding/swallowing factors are associated with communication development from birth to six (<6;0) years of age?"

Our line of inquiry includes early child development in both health and congenital or acquired diseases/disorders. Consequently, our review will facilitate an appreciation of swallowing-feeding factors that relate to the development of communication within an epidemiological framework. Underlying secondary questions relate to swallowing physiology and the feeding environment more specifically. The development of our secondary questions results from an iterative process, whereby reformulations of the questions posed *a priori* (i.e, those identified herein) may result and/or new questions may arise. Our secondary questions currently include:

i. What underlying congenital problems (e.g., cerebral palsy, cardiac/respiratory/gastrointestinal anatomical defects, neurological syndromes, prematurity, transient birth-related distress) impact swallowing-feeding integrity and the development of communicative functions?

ii. What swallowing-related impairments (e.g., poor respiratory function, reflux, weak neonatal latch/sucking behaviours, otitis media) compromise or delay the onset of communicative functions?

iii. How do feeding environments alter the onset and course of development of communicative functions?

   a. feeding mode (breast, bottle, combination feeding, enteral feeding)

   b. setting (neonatal intensive care unit stay, hospital stay, interventions such as incubation for phototherapy)

   c. interactive constructs (quality and quantity of feeding-related caregiver verbal and/or tactile interactions)

Stage 2: identifying relevant studies

The search strategy for Medline was developed in three steps by the first (HF) and third authors (ME) with input by the final author (SAS) through ongoing consultation with a research librarian. First, we undertook a consultative process, whereby we analysed and reviewed all MeSH terms associated with communicative functions and feeding/swallowing behaviours multiple times to maximize specificity while retaining the necessary scope of inquiry. Subsequently, the first and third authors chose MeSH terms for explosion if all subordinate terms were truly relevant to the content area and research questions. Second, review of other relevant systematic or scoping reviews revealed additional possibilities for MeSH terms and context-dependent terms (e.g., title, abstract, and key words) in the areas of swallowing-feeding[65-68] and communication[69-72]. The two authors (HF and ME) developing the search strategy selected terms for a pediatric population from a published filter,[73] identified by the research librarian, rather than limit the search within Medline. Finally, we developed additional context-dependent terms that we felt were not be captured from the previous two steps based on our expert knowledge of the fields of swallowing and communicative sciences. The research librarian then confirmed the integrity of the terms and search strategy (Table 1) and provided consultation for additional databases to search.

We selected nine additional databases to search based on adaptations of the Medline search terms (Table 2). We did not include PubMed as part of the search, given the possibility of its referencing predatory journals.[74] We consider our set of selected databases sufficient to capture potentially-relevant PubMed citations. We will not apply date or language limits on the searches to the extent possible. That is, we will

accommodate languages that we can read (including at least English, French, German, Italian, Persian, and Spanish) and seek translations for other languages (if possible) from colleagues and contacts within our scientific communities. All study designs are of interest, including case reports, case series, qualitative, cohort, case-control, and quasi-experimental studies, as well as randomised controlled trials.

Further, we identified additional sources most relevant to the content of the scoping review and based on feasibility of search conduct. We will apply the same article inclusion criteria and determine search terms accordingly. Selections include 17 journals, 4 conference proceedings, and 6 grey literature sources (Table 2). The research librarian assisted with determining grey literature sources. We will search all sources electronically from the first date of their online availability. Finally, we will review the reference lists and citations of selected articles through Google Scholar using a process of forward and backward chaining.[75] Our intent is to complete all searches within six months of the publication of the current scoping review protocol.

Table 1. Medline search strategy

Item	Term Set	Area
1	exp Deglutition/	swallowing
2	exp Gastroesophageal Reflux/	swallowing
3	Deglutition disorders/	swallowing
4	"Feeding and Eating Disorders of Childhood"/	swallowing
5	Breast feeding/	swallowing
6	Bottle Feeding/	swallowing
7	Feeding Methods/	swallowing
8	Enteral Nutrition/	swallowing
9	Parenteral Nutrition/	swallowing
10	Kangaroo-Mother Care Method/	swallowing
11	Pacifiers/	swallowing
12	sucking behaviors/	swallowing

13	((enteral or tube or gastric) adj (feed$)).ti,ab,kw.	swallowing
14	((deglut$ or feed$ or swallow$ or feed$-swallow$) adj3 (difficult$ or disorder$ or abnormal$ or delay$ or dysfunction$ or impair$ or problem$ or disabil$ or disabl$ or deficit$)) .ti,ab,kw.	swallowing
15	((deglut$ or feed$ or swallow$ or feed$-swallow$) adj3 (behavior or develop$ or neurodevelop$ or matur$ or function$)) .ti,ab,kw.	swallowing
16	(dysphag$).ti,ab,kw.	swallowing
17	((bottle fe$) or (bottlefe$) or (breast fe$) or (breastfe$) or (feeding mode) or (feeding methods)).ti,ab,kw.	swallowing
18	((gastroesophageal or gastro-esophageal or infantile or gastric) adj3 (reflux or regurgitat$)).ti,ab,kw.	swallowing
19	exp Speech/	comm
20	exp Speech disorders/	comm
21	exp Language development disorders/	comm
22	exp Child language/	comm
23	Speech sound disorder/	comm
24	Verbal behavior/	comm
25	Manual communication/	comm
26	Communication disorders/	comm
27	Social communication disorder/	comm
28	Autism Spectrum Disorder/	comm
29	Language disorders/	comm
30	Language Development/	comm
31	((speech or oromotor or "oral motor" or verbal$ or oro-motor or orofacial or oro-facial or "oral facial") adj3 (aprax$ or dysprax$ or prax$)).ti,ab,kw.	comm
32	((speech or speak$ or oral or language or verbal$ or communication or voice or vocal$ or babbl$ or coo$ or "oral motor" or oromotor or oro-motor or orofacial or oro-facial or "oral facial" or oralfacial or articulat$ or phonetic$ or phonologic$ or phonemic$ or pre-linguistic or prelinguistic) adj3 (difficult$ or disorder$ or abnormal$ or delay$ or dysfunction$ or impair$ or problem$ or disabil$ or disabl$ or deficit$)) .ti,ab,kw.	comm
33	((speech or speak$ or oral or language or verbal$ or communication or voice or vocal$ or babbl$ or coo$ or "oral motor" or oromotor or oro-motor or orofacial or oro-facial or "oral facial" or oralfacial or articulat$ or phonetic$ or phonologic$ or phonemic$ or pre-linguistic or prelinguistic) adj3 (behavior or develop$ or neurodevelop$ or matur$ or acqui$)) .ti,ab,kw.	comm
34	exp child/	population
35	exp infant/	population
36	adolescent/	population

37	(pediatric* or paediatric* or child* or newborn* or infan* or baby or babies or neonat* or pre-term or preterm* or premature birth* or NICU or preschool* or pre-school* or kindergarten* or kindergarden* or elementary school* or nursery school* or schoolchild* or toddler* or boy or boys or girl* or middle school* or pubescen* or jevenile* or teen* or youth* or high school* or adolesc* or pre-pubesc* or prepubesc*).mp.	population

Table 2. Complete list of search sources including databases, journals, conference proceedings, and grey literature

Literature Type	Sources
Databases:	- AMED - CINHAL - Education Source - Embase - ERIC - Linguistics and Language Behaviour Abstracts - Medline - PsycInfo - Scopus - Web of Science
Journals:	- American Journal of Speech-Language Pathology - Canadian Journal of Speech-Language Pathology - Child Development - Clinical Linguistics and Phonetics - Developmental Medicine and Child Neurology - Dysphagia - Gastroenterology - Infancy - International Journal of Behavioral Development - International Journal of Speech-Language Pathology - Journal of Child Language - Journal of Communication Disorders - Journal of Pediatric Gastroenterology and Nutrition - Journal of Pediatrics - Journal of Speech, Language, and Hearing Research - Nature - The American Journal of Gastroenterology
Conference Proceedings	- ASHA Conference - Dysphagia Research Society

	- International Conference on Speech and Language Development - World pediatrics
Grey Literature:	- Networked Digital Library of Theses and Dissertations - Open Access Theses and Dissertations - Open Grey - Proquest Dissertations and Theses Global - Ontario Public Health Libraries Association - Grey Matters

Stage 3: selecting studies

We will compile and store all citations using Covidence[76] and Microsoft Excel. Following elimination of duplicates and citations without abstracts, we will review the remaining abstracts and articles in a two-step process. Two independent reviewers will code the abstracts for potential inclusion or exclusion (Table 3). Coding criteria are purposefully open-ended for abstract review to permit selection of all those potentially relevant for full article retrieval. Additionally, codes are hierarchical, such that if code 1 is relevant, and the abstract therefore deemed ineligible, the remaining codes are not applicable. Subsequently, the two abstract reviewers will discuss and resolve discrepancies by consensus, requesting input from a third reviewer for consensus deliberations. All abstracts not assigned an exclusion code will be accepted for full review.

The same process will apply to full article review to determine final articles for inclusion. That is, two reviewers, blind to each other's evaluations, will independently assess all full articles, determining eligibility for inclusion according to more stringent and hierarchically-coded criteria (Table 3). Any articles written in languages outside of

those understood by the two reviewers will undergo translation (if possible) for key methodological content to enable coding. Coding criteria for the full article review will be more stringent than for the abstract review, since all pertinent information will be available and reviewers will make a final decision about article selection. Where discrepancies exist, the two reviewers engage in discussion to achieve consensus regarding inclusion or exclusion. In the event of difficult resolution, a third reviewer will assist in consensus deliberations. That is, all three reviewers will revisit the article in a process of reiterative evaluation to determine final inclusion or exclusion of the article. All codes and final decisions for inclusion or exclusion from both abstract and full article reviews will be entered into the Excel datasheet.

Articles without exclusion codes will be accepted for the scoping review. Accepted articles that initially required translation will undergo a second review (if possible) by the same translator and/or a different translator to ensure that the appropriate content is available for data extraction and charting.

Table 3. Proposed coding categories for abstract and full article review

Step 1 - Exclude if abstract:	Step 2 – Exclude if full article:
1) is clearly a review, commentary, or opinion	1) is clearly a review, commentary, or opinion
2) clearly has only an adult sample (≥18 years of age)	2) has a sample exclusively outside desired age range (≥6 years of age)
3) swallowing/feeding context outside operational definition (i.e. relates exclusively to nutritional intake)	3) swallowing/feeding context outside operational definition (i.e. relates exclusively to nutritional intake)
4) outcomes relating to communication or other aspects of child development (motor, cognitive) clearly absent	4) outcomes relating to communication clearly absent

5) n/a	5) outcomes relating to swallowing/feeding and communication development clearly absent
6) clearly involves same data as another abstract	6) clearly involves same data as another article
Otherwise accept for full article retrieval	Otherwise accept for scoping review

Stage 4: charting the data

Multiple reviewers will be responsible for collecting data, each from a proportion of the articles, followed by independent verification of all data by research personnel. Data collection will involve documenting key characteristics and variables of interest for each article (Table 4) and recording them in a database for storage and analysis. All reviewers collecting and charting data will be responsible for ongoing communication about emerging themes or domains of inquiry that could alter and enhance data collection procedures.

Table 4: Basic study characteristics for extraction from each accepted article.

Categories	Characteristics
1) Article details	Article details - year of publication - document type (peer-reviewed journal article, thesis, government document, conference proceeding or published abstract) - location of study (country)
2) Study details	Study details - design (cohort, case-series, RCT, case study, case series, qualitative) - time frame (cross-sectional, longitudinal) - setting (hospital, home) - population (children with typical communication development, children with disordered/atypical communication development)
3) Sample characteristics	Sample characteristics - sample size

	- groups - age range - sex/gender - ethnicity - language(s) used - etiology (if applicable) - comorbidities (if applicable) - hearing status
4) Feeding/Swallowing variables	Feeding/swallowing - physiology and behaviours - environment - modes
5) Communication outcomes	Communication development - speech (early vocalizations, babbling, protowords, single word production, multiword production) - language (content, form, use) - gestural behaviours
5) Main findings of study	Trends Effects
6) Data analyses	Type Rigour
7) Themes/domains of study	Barriers to communication development Facilitators to communication development
8) Study limitations	Design Outcomes Generalizations
9) Pertinence[43]	Clinical practice Policy Research

Stage 5: collating, summarizing, and reporting the results

Data from stage 4 will be summarized to map the emergence and breadth of literature over time for the primary objective. Subsequently, we will stratify the findings according to healthy versus impaired development. Various forms of data presentation will include tables, line graphs (for chronological information), histograms, and/or pie charts. To illustrate, we will tabulate study characteristics according to design, population, setting,

and pertinence for policy, clinical practice, or research. Similarly, we will visually represent information pertaining to swallowing-feeding functions and domains of communication development in charts. Where available, we will describe themes that arise from our review, including barriers and facilitators to the development of communicative functions in young children. We will not include quality or rigour of specific analyses in the scoping review, because the intent is to obtain a sense of the extent of the literature in the area rather than appraise individual articles.

Our scoping review will therefore provide a first overview of trends and breadth for an emerging body of literature. Most important, we will identify gaps in the current knowledge base and provide guidance for the prevention and treatment of potential communication impairments beginning in early infancy.

Stage 6: optional consultation exercise

We intend to seek input and consultation from caregivers and practitioners once we have compiled and mapped the results of our full scoping review. We hope that such consultation may elucidate gaps that were otherwise not salient to us and subsequently render our knowledge translation endeavours more feasible and accessible to stakeholders.

ETHICS AND DISSEMINATION

Following completion of all stages of scoping review, findings will be disseminated via local and international conference presentations and submission to a peer-reviewed journal. Knowledge translation activities will then include development of accessible materials for end-users, such as parents, infant caregivers, and clinicians from various

fields of professional practice, so that they may understand and advocate best practice for communicative development in children. In addition, we will share our findings with policy-making organizations and other stakeholders, such as the Canadian Child and Youth Health Coalition and the Paediatric International Patient Safety and Quality Collaborative.

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Contributors: All co-authors provided meaningful and unique contributions to the development, preparation, and/or writing of the current scoping review protocol. HF formulated the topic and conceptualized the questions and theoretical framework. She also guided the research team at all stages of the review development and wrote the bulk of the protocol. DB contributed critical and novel insight for the research questions, theoretical framework, and review components relative to communicative functions. SAS contributed critical and novel insight for the research questions and for operational definitions relative to swallowing functions. She also provided advice for scoping review methods and proposed analyses. ME provided conceptual input in the development of the search terms relating to communicative functions in collaboration with HF and in consultation from a research librarian. M-FP contributed to writing the introduction, especially with respect to epidemiology of communication impairments. SM contributed by drafting ideas related to the clinical relevance of the scoping review. All authors

reviewed multiple renditions of the manuscript, providing suggestions and editing until all approved the appropriateness for submission.

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Supplementary Table 1. PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol*

Section and topic	Item No	Checklist item	Page #s
ADMINISTRATIVE INFORMATION			
Title:			
Identification	1a	Identify the report as a protocol of a systematic review	1
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	n/a
Registration	2	If registered, provide the name of the registry (such as PROSPERO) and registration number	n/a
Authors:			
Contact	3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author	1
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	21-22
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	n/a
Support:			
Sources	5a	Indicate sources of financial or other support for the review	22
Sponsor	5b	Provide name for the review funder and/or sponsor	22
Role of sponsor or funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol	22
INTRODUCTION			
Rationale	6	Describe the rationale for the review in the context of what is already known	3-7
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	10-11
METHODS			
Eligibility criteria	8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review	17-18

Information sources	9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage	12-15
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	13-15
Study records:			
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	16-18
Selection process	11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)	16-18
Data collection process	11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	16-18
Data items	12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications	18-20
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	7-11
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	n/a
Data synthesis	15a	Describe criteria under which study data will be quantitatively synthesised	18-20
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I^2, Kendall's τ)	n/a
	15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)	n/a
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	18-20
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)	n/a

Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (such as GRADE)	n/a

* It is strongly recommended that this checklist be read in conjunction with the PRISMA-P Explanation and Elaboration (cite when available) for important clarification on the items. Amendments to a review protocol should be tracked and dated. The copyright for PRISMA-P (including checklist) is held by the PRISMA-P Group and is distributed under a Creative Commons Attribution Licence 4.0.
n/a = not applicable

From: Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart L, PRISMA-P Group. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ. 2015 Jan 2;349(jan02 1):g7647.

Supplementary Table 1. PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol*

Section and topic	Item No	Checklist item	Page #s
ADMINISTRATIVE INFORMATION			
Title:			
Identification	1a	Identify the report as a protocol of a systematic review	1
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	n/a
Registration	2	If registered, provide the name of the registry (such as PROSPERO) and registration number	n/a
Authors:			
Contact	3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author	1
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	21-22
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	n/a
Support:			
Sources	5a	Indicate sources of financial or other support for the review	22
Sponsor	5b	Provide name for the review funder and/or sponsor	22
Role of sponsor or funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol	22
INTRODUCTION			
Rationale	6	Describe the rationale for the review in the context of what is already known	3-7
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	10-11
METHODS			
Eligibility criteria	8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review	17-18

Information sources	9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage	12-15
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	13-15
Study records:			
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	16-18
Selection process	11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)	16-18
Data collection process	11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	16-18
Data items	12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications	18-20
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	7-11
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	n/a
Data synthesis	15a	Describe criteria under which study data will be quantitatively synthesised	18-20
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I^2, Kendall's τ)	n/a
	15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)	n/a
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	18-20
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)	n/a

Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (such as GRADE)	n/a

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