# AUGMENTATIVE AND ALTERNATIVE COMMUNICATION (AAC)


**HEALTH TECHNOLOGY ASSESSMENT SECTION**
**MEDICAL DEVELOPMENT DIVISION**
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## DISCLOSURE

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## EXECUTIVE SUMMARY

### Introduction

Augmentative and alternative communication (AAC) is an umbrella term that encompasses the communication methods used to supplement or replace speech or writing for those with impairments in the production or comprehension of spoken or written language. AAC is used by those with a wide range of speech and language impairments such as those with congenital disabilities and adults with acquired neurological conditions. AAC systems are diverse: unaided AAC systems are those that do not require an external tool which includes signing and body language, while aided AAC systems use external tools which ranges from pictures and communication boards (low-technology AAC) to speech generating devices (high-technology AAC). This technology review was conducted following a request from a Senior Principal Assistant Director, Medical Development Division, Ministry of Health (MOH) following a proposal from a company to introduce high-technology AAC system in government hospitals.

### Objective/aim

The objective of this systematic review was to assess the safety, efficacy / effectiveness, cost-effectiveness and organizational issues relating to the use of AAC systems to enhance communication among people with speech and language impairments in MOH hospitals.

### Results and conclusions

The search strategies yielded 18 articles related to AAC intervention for people with speech and language impairments.

### Safety

None of the studies retrieved reported on safety issues with regards to AAC intervention to enhance communication among people with speech and language impairments.

### Efficacy / effectiveness

#### Communication skills

- There was fair to good level of evidence to suggest that AAC intervention was associated with improvement in communication skills for individuals with developmental disabilities such as autism spectrum disorder, Down syndrome, cerebral palsy, mental retardation and patients with acquired neurological condition such as amyotrophic lateral sclerosis, traumatic brain injury, locked-in syndrome and aphasia.

- There was limited retrievable low level of evidence to suggest that AAC intervention has the potential to improve symptom communication for patients in the intensive care unit.

#### Speech production

There was limited retrievable but good level of evidence to suggest that AAC intervention do not impede speech production; instead studies reported an increase in speech production.

**Acceptance of AAC intervention**

- There was limited retrievable fair level of evidence to suggest that a high percentage of individuals with amyotrophic lateral sclerosis and traumatic brain injury accepted the AAC intervention as recommended by their speech language pathologist.

**Preferences of AAC options**

- There was limited retrievable fair level of evidence to suggest that individuals with speech and language disabilities have their own preference for the different AAC types.

- The type of AAC systems appropriate for an individual depends on several factors such as individual's motor, visual, cognitive, and language abilities which may be either unaided, low-technology or high-technology AAC systems.

**Training**

- There was limited retrievable evidence to suggest that pre-service programs / training (basic professional training) for speech language pathologist / speech therapist on AAC may not be adequate for them to provide comprehensive AAC services after graduation.

**Cost/Cost-effectiveness**

There was no retrievable evidence on the cost-effectiveness of AAC systems.

**Methods**

Electronic databases were searched through Ovid interface: Ovid MEDLINE, EBM Reviews-Cochrane Central Register of Controlled Trials, EBM Reviews - Cochrane database of systematic reviews, EBM Reviews - HTA, EBM Reviews - Database of Abstracts of Reviews, EBM Reviews- NHS Economic Evaluation database. Searches were also run in PubMed, Horizon Scanning databases, FDA website for published reports. There was no limit in the search. Relevant articles were critically appraised using Critical Appraisal Skills Programme (CASP) and graded according to US/Canadian preventive services task force.

# AUGMENTATIVE AND ALTERNATIVE COMMUNICATION (AAC)

## 1. INTRODUCTION

Augmentative and alternative communication (AAC) is an umbrella term that encompasses the communication methods used to supplement or replace speech or writing for those with impairments in the production or comprehension of spoken or written language.[1] AAC has two meanings - augmentative communication systems are used by people who already have some speech but are either unintelligible or have limited abilities to use their speech. In such cases, other modes of communication are used to support, or supplement what the person is able to say verbally. Alternative communication is the term used when a person has no speech and completely rely on another method to make all his ideas, wants, or needs known.[2]

AAC is used by those with a wide range of speech and language impairments. Congenital disabilities that impede the development of speech and language may include cerebral palsy, autism, dual sensory impairments, genetic syndromes, intellectual disability and multiple disabilities (including hearing impairment). Some children with this broad range of disabilities, may need to integrate AAC into their early development to augment natural vocal and speech skills so that they can successfully communicate with others and develop receptive and expressive language skills.[3] Adults with acquired neurological conditions such as amyotrophic lateral sclerosis (ALS), traumatic brain injury (TBI), brainstem dysfunction, severe, chronic aphasia and apraxia of speech, primary progressive aphasia (PPA), and dementia also rely on AAC systems to meet their communication needs.[4]

AAC systems are diverse: unaided AAC systems are those that do not require an external tool which includes signing and body language, while aided AAC systems use external tools which ranges from pictures and communication boards (low-technology AAC) to speech generating devices (high-technology AAC). An evaluation of an individual's abilities, limitations and communication needs is necessary to select appropriate AAC techniques. The purpose of the assessment is to identify potential AAC approaches that can bridge discrepancies between a user's current communication and their present and future communication needs. The evaluation of a user's abilities and requirement for AAC include the individual's motor, visual, cognitive, language and communication strengths and weaknesses. The evaluation requires the input from family members particularly for early intervention. Augmentative and alternative communication evaluations are often conducted by specialised teams which may include a speech language pathologist / speech therapist, occupational therapist, rehabilitation engineer, physiotherapist, social worker and a physician.[1] The aim of the evaluation is to match the AAC systems to the user's goal. The AAC systems which are considered the 'best' for a given individual depends on: the person's existing skills and abilities, the person's and family

preferences, the person's current and future communication needs, the environment in which the person live and the people with whom the person is likely to interact.[5] Speech language pathologist / speech therapist and occupational therapist are the major service providers for AAC intervention. The inability to communicate with others leads to frustration, isolation, fear and depression. AAC technology can enable a person to connect with others via email and internet thereby helping them to maintain relationships.[2]

AAC systems have been used in many countries such as the United States of America (U.S.A.), Ireland, Canada, Australia, United Kingdom, Finland and Hong Kong. In the U.S.A. the national program for funding medical care of persons with disability and retirees in the U.S.A. began funding selected AAC devices (dedicated speech generating system) in 2000. Currently, high-technology AAC system is not available in Ministry of Health government hospitals in Malaysia. However, the use of unaided and low-technology AAC system are increasing in the speech therapy clinic for assisting client with complex communication needs to achieve the most effective communication as they can.

This technology review was conducted following a request from a Senior Principal Assistant Director, Medical Development Division, Ministry of Health (MOH) following a proposal from a company to introduce high-technology AAC system in government hospitals.

## 2. OBJECTIVE / AIM

The objective of this systematic review was to assess the safety, efficacy / effectiveness, cost-effectiveness and organizational issues relating to the use of AAC systems to enhance communication among people with speech and language impairments in MOH hospitals.

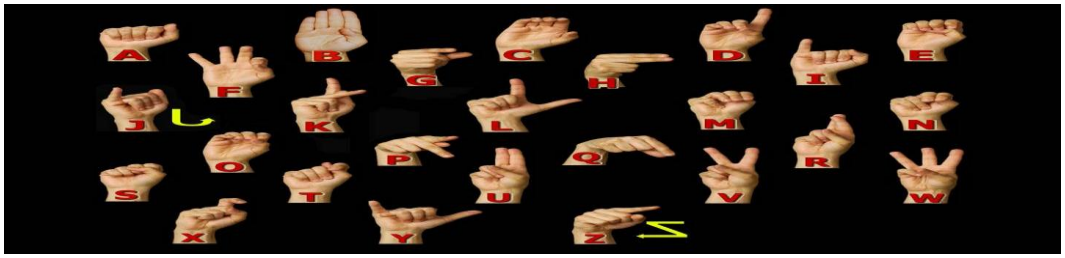
## 3. TECHNICAL FEATURES

### 3.1. Unaided AAC

Unaided AAC systems are those that do not require an external tool. It includes facial expression, vocalizations, gestures, and sign languages and systems. Informal vocalizations and gestures such as body language and facial expressions are part of natural communication, and such signals may be used by those with profound disabilities.[1,6] With no external aid, unaided AAC has advantages of portability and speed of message preparation as well as access to a potentially unlimited pool of messages.

However, unaided AAC also have some limitations. Signs requiring fine motor distinctions can be difficult to produce, and thus may not be the best option for all children. Furthermore, many if not most unaided AAC may have restricted set of potential listeners, as idiosyncratic gestures are understood only by familiar partners and signed languages only by those who have learned the language.

Unaided AAC system have been shown to support language learning in children with developmental disabilities that can be associated with intellectual disabilities like autism.[6]



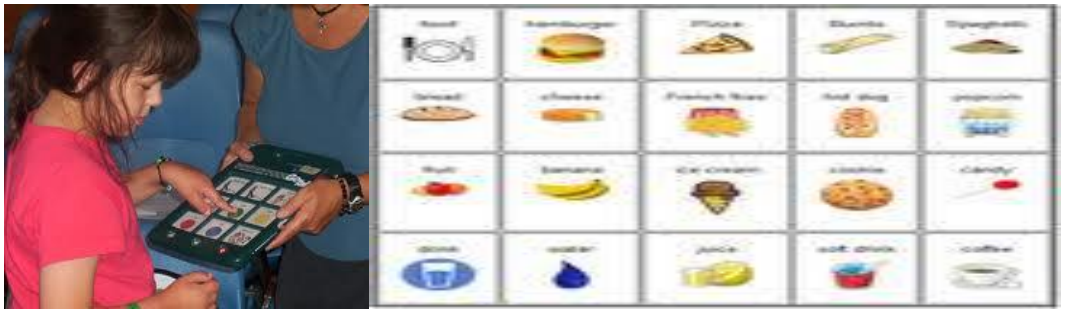
### 3.2. Aided AAC

An AAC aid is any device, either electronic or non-electronic, that is use to transmit or receive messages, such as aids from communication books to speech generating devices. Since the skills, areas of difficulty and communication needs of AAC users vary greatly, an equally diverse range of communication aids and devices are required.[1]

#### 3.2.1. Low-technology AAC

Low-technology communication aids are defined as those that do not need batteries, electricity or electronics. They are often very simple communication boards or books, and communication programs such as Picture Exchange Communication Program (PECS), from which the user selects letters, words, phrases, pictures or symbols to communicate message. Depending on physical abilities and limitations, users may indicate the appropriate message with a body part, light pointer, eye-gaze direction, or a head / mouth stick. Alternatively, they may indicate yes or no while a listener scans through possible options.[1]

Low-technology options do not provide voice output and typically require communication partners to speak the words and phrases that the person selects. For communication to be successful either the AAC user must elaborate somehow or the communication partner must guess various options.[6]



#### 3.2.2. High-technology AAC

High-tech AAC aids permits the storage and retrieval of electronic messages, with most allowing the user to communicate using speech output. Such devices

are known as speech generating devices (SGD) or voice output communication aids (VOCA). A device's speech output may be digitised and / or synthesised: digitised systems play recorded words or phrases and are generally more intelligible while synthesised speech uses text-to-speech software that can be harder to understand but that permits the user to spell words and speak novel messages.[1]

High-technology systems may be dedicated devices developed solely for AAC, or non-dedicated devices such as computers, including tablets and other mobile devices that run additional software to allow them to function as AAC devices. They may be static or dynamic in form. Static communication device have symbols in fixed positions on paper overlays, which are changed manually. To increase the vocabulary available, some static devices have multiple levels, with different words appearing on different levels. On dynamic AAC devices, the user can change the symbols available using page links to navigate to the appropriate pages of vocabulary and messages.[1]

High-technology devices vary in the amount of information that can be stored, as well as size, weight and thus portability. Access methods depend on the abilities of the user, and may include the use of direct selection of symbols on the screen or keyboard with a body part, pointer, adapted mice or joysticks, or indirect selection using switches and scanning. Devices with voice output offer its user the advantage of more communicative power, including the ability to initiate conversation with communication partners who are at a distance. However, they typically require programming.[1] Although the high technology devices are more appealing to many users they may not always be the mode of choice for a specific situation or individual. Electronic devices are more vulnerable to damage than low-technology device.[6]

Examples of high-technology AAC systems include SpringBoard Lite, Vantage Lite, Easy Talk, DynaVox M3, Tango, Allora, Dubby and Freedom 2000:[7,8]

### a. SpringBoard Lite[7]

SpringBoard™ Lite is a portable Prentke Romich Company (PRC) product using the powerful Unity® language system. It includes display configurations of 4-, 8-, 15-, and 36 locations. It is claimed that SpringBoard™ Lite is most easy-to-use device, yet its communication capacity can grow along the user's capabilities. Schools and AAC centres appreciate the easy-to-change access options when serving various skill levels of multiple device users. It features a simplified Toolbox as well as the standard Toolbox feature in its predecessor, SpringBoard Plus.

**Technical features:**

- Unique, built-in handle offers maximum portability
- "Exploration Wizard" for exploring targeting, picture recognition, associations, and vocabulary options

- Built-in media player for playing MP3, VMA, and VAC files in stereo
- Basic serial output to allow some computer access options
- Infrared environmental control functions to control common IR devices, i.e., lights and TV / DVD
- Integrated Bluetooth® connectivity
- New PRC Application and Support software (PASS™)
- Five integrated versions of pre-stored vocabulary using 4-, 8-, 15-, and 36-location options with special emphasis on the core words that power most speech
- Pre-loaded male and female recorded voices
- Introductory set of therapy exercises
- PRC Language Activity monitoring (LAM) software
- Vocabulary can be saved and transferred into more advanced PRC devices as skills expand
- Access methods include, direct selection-or-dual-switch scanning; USB connectivity allows use of head pointing systems, mouse, USB joystick and mouse emulation access products
- Standard and custom keyguard are available

**Device specifications**;
- Weight: 2 lbs. 8 oz
- Dimensions: 7.3 inch width x 7.3 inch height x 1.8 inch diameter
- Speech memory: more than 500 minutes of digitised speech capacity
- Battery life; 6-8 hours (normal operation)

Bilingual - English / Spanish


**b. Vantage Lite**[7]

The manufacturer claimed that Vantage Lite is portable, lightweight and easy to learn. It has a strong core vocabulary featuring the powerful Unity® language system in multiple display configuration settings. Vantage Lite provides an excellent starting point for the child or adult just beginning augmentative communication and those ready for the next step.

**Technical features:**

- Vocabulary Builder assists the person one step at a time as the person introduce small sets of vocabulary within the sequenced Unity® language system
- Unique, integrated carrying handle ideal for users on the go
- Recessed and covered ports and connections stand up to rough use
- Heavy-duty case design protects against bumps and drops
- “Exploration Wizard” for exploring targeting, picture recognition, associations, and vocabulary options
- Built-in player allows user to import WAV files and play MP3 / WMA files in stereo
- Compact flash card slot for future expandability
- Import icons or digital photographs
- Infrared environmental control functions to control common IR devices, i.e., lights and TV / DVD
- Integrated Bluetooth® connectivity
- Notebook capability for creating or storing text
- Presets to support implementation of LAMP therapy strategies
- Special vocabulary sets for adults with acquired language disorders
- Spelling and Word Prediction software
- PRC Application and Support Software (PASS™)
- Access methods include;
    - Direct selecting
    - Single-or-dual-switch scanning
    - USB connectivity allows use of headpointing systems, mouse, joystick and mouse emulation success products.
- Voices
    - Acapela Text-to-speech
    - Fonix-DECtalk Text-to-Speech software
    - Real/Speak Text-to-Speech

**Device specifications**;

- Weight: 3 lbs. 6 oz
- Dimensions: 8.7 inch width x 9.2 inch height x 1.6 inch diameter
- Speech memory: more than 60 minutes of digitised speech capacity
- Battery life; 5-7 hours (normal operation)
- Language Activity Monitoring (LAM)
- Mini USB-B port
- Secure Digital (SD) card slot

This device permitted the use of all three language representation methods which includes the alphabet system, single-meaning pictures and the Semantic Compaction System (multi-meaning icon). However, currently it is only available in English and Spanish. Both devices have no accessibility to Malay, Mandarin or Tamil language as spoken by most of the Malaysian population.

## 4. METHODS

### 4.1. Searching

Electronic databases were searched through the Ovid interface: Ovid MEDLINE® In-process and other Non-indexed citations and Ovid MEDLINE® 1948 to present, EBM Reviews - Cochrane Central Register of Controlled Trials - June 2012, EBM Reviews - Cochrane Database of Systematic Reviews - 2005 to June 2012, EBM Reviews - Health Technology Assessment - 3rd Quarter 2012, EBM Reviews – Database of Abstracts of Review of Effects (2nd Quarter 2012), EBM Reviews-NHS Economic Evaluation Database – 2nd Quarter 2012. Searches were also run in PubMed, Horizon Scanning database (National Horizon Scanning Unit, Australia and New Zealand Horizon Scanning Network), ASERNIP-S, and FDA website for published literature. Google was used to search for additional web-based materials and information. There was no limit in the search. Additional articles were identified from reviewing the references of retrieved articles. Last search was conducted on 19 July 2012.

Appendix 1 showed the detailed search strategies.

### 4.2. Selection

A reviewer screened the titles and abstracts against the inclusion and exclusion criteria and then evaluated the selected full-text articles for final article selection.

The inclusion and exclusion criteria were:

Inclusion criteria

| | |
|---|---|
| Population | People with speech and language impairments |
| Interventions | Augmentative and alternative communication (AAC) systems – unaided, low-technology and high-technology |
| Comparators | No comparator or usual treatment or therapy |
| Outcomes | Speech production, literacy skills, communication skills, quality of life, adverse events, cost, cost-effectiveness, AAC preferences, training |
| Study design | Health Technology Assessment, Systematic Reviews, |

| | |
|---|---|
| | Randomised Controlled Trial, Non Randomised Controlled Trial, Pre and post-intervention studies, Cohort studies, cross-sectional studies, case series, economic evaluation studies |
| | English full text articles |

Exclusion criteria

| | |
|---|---|
| Study design | Studies conducted in animals and narrative reviews |
| | Non English full text articles |

Relevant articles were critically appraised using Critical Appraisal Skills Programme (CASP) graded according to US/Canadian preventive services task force (Appendix 2). Data were extracted and summarised in evidence table as in Appendix 3.

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## 5. RESULTS AND DISCUSSION

The search strategies yielded 18 articles related to AAC intervention for people with speech and language impairments. There were no health technology assessment report or cost-effectiveness studies. The studies included consist of six systematic reviews, seven pre and post-intervention studies, four cross-sectional studies and one case series.

### 5.1. SAFETY

None of the studies retrieved reported on safety issues with regards to AAC intervention to enhance communication among people with speech and language impairments. Speech Generating Devices are classified as Class II devices by United States Food and Drug Administration (U. S. FDA) and are exempt from the premarket notification procedures. The U.S. FDA has described these devices as: “system, communication, powered” devices. The U.S. FDA identifies them as, “A powered communication system is an AC-or battery-powered device intended for medical purposes that is used to transmit or receive information. It is used by persons unable to use normal communication methods because of physical impairment.” [8]

### 5.2. EEFICACY/EFFECTIVENESS

Twelve articles related to the efficacy / effectiveness of AAC intervention to enhance communication among people with speech and language impairments were included in this review.

#### 5.2.1. Communication skills

**AAC intervention in individual with developmental disabilities**

Branson D and Demchak M conducted a systematic review to determine the evidence of AAC use in infants and toddlers with disabilities. The systematic review included studies conducted from 1982 to 2007. Based on the inclusion and exclusion criteria, seven single-subject studies involving a total of 32 participants and five group design studies involving a total of 158 participants were included in the review. The participants were 36 months of age or younger. Most of the participants (52.11%) had either unspecified developmental delays or one of the wide varieties of identified aetiologies (agenesis of the corpus callosum, Trisomy 8, mitochondrial disorder),16.84% had Down syndrome, 14.74% had multiple disabilities (cerebral palsy plus sensory impairments),13.68% had an autism spectrum disorder, and 2.63% had cerebral palsy. The types of AAC used included manual signs, line drawings, photographs, VOCA, gestures, eye gaze shift from referent to communication partners, vocalizations and body movements. The majority of the studies investigated the unaided AAC methods, with 42% of the studies also included aided AAC methods. [9] level I

In-depth analyses of study methodology indicated that only seven of the 12 studies (58.33%) including five single-subject case designs and two group designs provided conclusive evidence (the design provided experimental control, the dependent variable was reliable and treatment integrity was solid). They reported that AAC use in infants and toddlers resulted in improved communication for 71% of these participants. The included studies also reported that communication partners were successfully taught to create more communicative opportunities for their child and a variety of AAC systems were used successfully with children 36 months of age and younger. [9] level I

**Down syndrome**

Foreman P and Crews G reported the use of two forms of AAC with young children with Down syndrome; a program using signing (Makaton), and the COMPIC system of computerised pictographs in the University of Newcastle, Australia. The study involved 19 children with Down syndrome, aged between two and four years. The study utilised a simple repeated measure technique. All children who participated were encouraged to learn to communicate 12 single words: three via verbal instruction alone, three via the symbol (COMPIC) method, three via the sign (Makaton) method and three via the multimodal method (verbal + sign + symbol). The four treatments (verbal, symbol, sign and multimodal) were administered successively over four days. Each of the treatments consisted of three teaching sessions: the initial teaching session, a post-teaching session 15 minutes later, and a follow-up teaching session 24 hours later. Learning in the study was assessed according to the relearning (or savings) strategy. Apart from allowing participants performance to be scored, the relearning strategy also allowed participants score to be plotted over time. They found that the sign method of instruction evoked significantly higher scores than the symbol method of instruction [$F(1, 18) = 9.362$, $p = 0.01$]. Scores obtained for the multimodal method of instruction, although significantly higher than symbol method of

instruction, were not significantly higher than those scores for sign instruction [F (1, 118 = 0.607, p = 0.446].[10 level II-2]

**Autism spectrum disorders (ASD)**

Ganz JB *et al.* conducted a systematic review with meta-analysis to investigate the effectiveness of aided AAC systems with individuals with autism spectrum disorders (ASD). On-line databases were searched for literature published between 1980 and first six months of 2008. Twenty four single-case studies were analysed via an effect size measure, the Improvement rate difference. Improvement rate difference (IRD) is the difference or change in percent of high scores from baseline to intervention phase. The effectiveness measure for single-subject data that is the percentage of Non-overlapping Data (PND) was calculated for each comparison as well.[11] The percentage of PND is calculated by identifying the highest data point in baseline and determining the percentage of data points during intervention that exceed this point. The PND scores of < 50% reflect ineffective treatment, PND 50% to 70% reflect questionable effectiveness, PND 70% to 90% reflect fairly effective treatment and PND > 90% reflect a highly effective treatment.[9]

Overall, 58 individuals participated in the studies. Twenty seven (46.55%) of the participants were preschool-aged (up to five years), 18 (31.03%) were elementary-aged (six to 10 years), seven (12.07%) were secondary-school aged (11 to 15 years) and six (10.35%) were young adults (over age of 15 years). The interventions included three categories of aided AAC systems: (a) PECS (37.5%), (b) picture-based systems other than PECS (29.17%), and (c) SGDs (33.33%).[11 level I]

They reported that the IRD calculated for the overall effects of AAC was 0.99, which indicated large effects. Overall percentage of PND calculations ranged from 0% to 100%, with a median of 76%, which indicated that aided AAC was an effective treatment. The IRD for communication skills (0.99) was significantly higher than that for social skills (IRD = 0.90), for challenging behaviours (IRD = 0.80) and for academic skills (IRD = 0.79). Improvement rate difference calculations for the use of PECS and for the use of SGDs indicated large effects (IRD = 0.99 for each). However, IRD for other picture-based AAC was 0.61 (indicated only moderate effects).[11 level I]

**Cerebral palsy**

Lund SK and Light J evaluated the long-term outcomes of individuals with cerebral palsy who had use AAC intervention. The study involved seven young men with cerebral palsy aged between 19 years old to 23 years old who had use AAC systems for at least 15 years and were part of the first generation to have received AAC services since they were in preschool. Outcomes were measured for the following domains: (a) receptive language, (b) reading comprehension, (c) communicative interaction, (d) linguistic complexity, (e) functional communication, (f) educational and vocational achievement, (g) self-

determination, and (h) quality of life. They reported that the outcomes for the group were diverse, with individual variations across all measurement. Two of the seven young men performed below average group performance in all the domains. Three of the young men performed above average group for communication sharing, educational placement, vocational goals and quality of life. The authors mentioned that outcomes for the individuals may have been related to certain intrinsic factors such as cognition, motor impairments and personal characteristics of the individuals and factors extrinsic to the individuals which included environmental factors, familial support and educational placement.[12] level II-2

The same authors reported the communicative interaction skills of the seven young men who had used AAC systems for at least 15 years. Turn-taking patterns, use of communicative functions, and linguistic complexity were analysed. Current performance was compared to the participant's skills when they were preschoolers and participated in another study of interaction skills. They reported that the turn distribution between partners was more equitable than it had been when the participants were preschoolers. During interaction with their caregivers, the participants fulfilled most of their obligatory turns and more than half of their non-obligatory turns. The communicative functions used most frequently by the participants were confirmations / denials and provisions of information. Three of the participants demonstrated the ability to use complete and complex syntax and committed few errors in grammar, while the other four participants demonstrated many syntactic errors.[13] level II-2

**Amyotrophic Lateral Sclerosis (ALS)**

Ball LJ, Beukelman DR, Pattee GL evaluated the acceptance of dedicated and multifunctional high-technology AAC by persons with Amyotrophic Lateral Sclerosis (ALS). The study included 50 participants (28 males and 22 females). Seventeen of the participants (34.00%) were diagnosed as primarily bulbar, 22 participants (44.00%) were diagnosed as primarily spinal, and 11 participants (22.00%) were diagnosed as primarily mixed ALS. The participants ranged from 36 years to 78 years (mean = 60.16 years).Participants were presented with a variety of high-technology AAC devices during the evaluation process, including both dedicated and multipurpose devices. AAC acceptance, rejection, and discontinuance were monitored for each participant until the time of his or her death [mean = 43.8 months, range four to 181 months, standard deviation (SD) = 37.54 months]. In general, a high level of acceptance was observed, with 90% demonstrating immediate acceptance and another 6% demonstrating delayed acceptance. Only 4% of the participants in this study completely rejected AAC technology whereby cognitive limitations were identified as the primary reason for rejection. They reported that none of the participants discontinued use of their AAC technology. All of the participants used AAC technology as their primary means of communication.[14] level II-2

**Traumatic brain injury**

In another study, Fager *et al*. reported the acceptance and use patterns of either high-or low-technology AAC devices or strategies in 25 adults with traumatic brain injury (TBI) at some point during their recovery. Information was gathered via questionnaire that was completed by three Speech Language Pathologists (SLPs) who provided services to individuals with TBI as well as comprehensive AAC evaluation and treatment programs. The questionnaire was developed by the research team and was designed to capture information related to AAC use among individuals with TBI. In seventeen of the 25 individuals (68.00%), the assessment outcome included a recommendation for using a high-technology AAC device whereby 16 of the 17 individuals (94.22%) accepted the recommendation. Of the 16 who accepted the recommendation, 15 actually received a high-technology device. However, funding issues prevented one individual from receiving a device. Two of the device recipients (13.33%) discontinued use due to lack of ongoing facilitator support. The range of communicative functions people with high-technology AAC devices used throughout the day include relaying stories, writing, in-depth information, telephone, communicate quick needs, communicate detailed needs and for conversation.[15] level II-2

All eight (100%) of individuals who received a low-technology recommendation accepted the recommendation. Three of the eight individuals (37.50%) regained functional natural speech and later discontinued AAC use, while the five continued to use low-technology AAC. Due to the nature of low-technology AAC, individuals with TBI who relied on such systems could not participate in some communicative functions (example: telephone use without the aid of an interpreter). They used the low-technology AAC systems to communicate quick needs, relaying stories, conveying in-depth information, communicating detailed needs and participating in conversational exchanges. The majority (86%) of the individuals in this study who used high-or low-technology AAC devices utilised letter-by-letter spelling as their primary method of message formulation.[15] level II-2

**Locked-In Syndrome (LIS)**

Soderholm S, Meinander M, Alaranta H reported on the augmentative skills and alternative communication methods based on clinical follow-up of 17 patients with locked-in syndrome (LIS) rehabilitated in Kapyla Rehabilitation Centre, in Helsinki, Finland between 1979 to 2000. Locked-in syndrome is a neurological condition due to a brain disease or injury affecting the brain stem whereby vertical eye movements are the only commonly remaining voluntary motor function. The multidisciplinary rehabilitation team developed an individual alternative communication method for all patients and trained them to use it by minor movements of the thumb, chin or head. They authors reported that the average rehabilitation period took three to four months and during the follow-up, patients have learned to use an individually designed alternative communication method or a computer based communication method or both. Nine of the follow-up patients used their computers daily as a communication method and keep up contacts through e-mail. They also used the internet for shopping, findings new contacts and reading daily newspaper.[16] level II-2

**Aphasia**

Koul R, Corwin M, Hayes S from Texas Tech University Health Sciences Centre, evaluated the efficacy of a computer-based AAC intervention to either replace or augment the spoken language of individuals with global aphasia or Broca's aphasia. The study employed a single-subject multiple-baseline design across behaviours to examine the ability of nine individuals with severe Broca's aphasia or global aphasia to produce graphic symbol sentences of varying syntactical complexity using a software program that turns a computer into a speech output communication device. The sentences ranged in complexity from simple two-word phrases to those with morphological inflections, transformations, and relative clauses. They found that individuals with aphasia were able to access, manipulate, and combine graphic symbols to produce phrases and sentences of varying degree of syntactical complexity.[17] level II-2

**AAC intervention in patients in the Intensive Care Unit (ICU)**

Radtke JV *et al*. illustrated the application of AAC strategies across different levels of illness severity and communication impairment for three non speaking patients in ICU. The cases included; a 32 years old female patient with fluctuating cognitive and impaired motor function, a 28 years old female patient with fluctuating cognitive and moderately compromised motor function and a 39 years old female with intact cognitive and motor function. Both high-technology communication devices with voice out-put and low-technology options were used for each patient according to their motor and cognitive abilities. To accommodate fluctuations in patient status and communication needs, multiple AAC strategies were integrated into the communication repertoire and tailored for each case. They reported that medical personnel involved in these three cases attributed enhanced communication efficiency, improved ventilator weaning trials, and increased patient engagement to the AAC techniques. The authors concluded that this approach has the potential to improve symptom communication and to ease suffering for seriously ill ICU patients with speech limitations. No. 1-2012 [18] level II-3

### 5.2.2. Speech production

The impact of AAC intervention on the speech production of individuals with developmental disabilities was systematically reviewed by Millar DC, Light JC, Schlosser RW. A comprehensive search of literature published between 1975 to 2003 which included data on speech production before, during, and after AAC intervention was conducted using a combination of electronic and hand searches. The systematic review indentified 23 studies that met the inclusion criteria. However, 17 of the 23 studies did not established experimental control with respect to the relationship between AAC intervention and natural speech production making it difficult to draw reliable conclusions about the relationship. According to the certainty of evidence coding scale, these studies were considered inconclusive. Hence, the evidence reported was based on six studies involving 27 cases, which had sufficient methodological rigor for the "best

evidence analysis". Most of the participants (aged two to 60 years) had mental retardation or autism. Five of the six studies investigated the effects of unaided AAC interventions and the remaining study considered the effects of aided AAC systems without speech out-put. An increase in speech production were observed in 24 of the 27 cases (88.89%) and in the remaining three cases (11.11%), there was no change in speech production. [19] level I

The effects of speech production in children with autism or pervasive developmental disorder-not otherwise specified (PDD-NOS) on AAC intervention was evaluated by Schlosser RW and Wendt O. They conducted a systematic review involving studies written between 1975 and May 2007. Based on the inclusion criteria, nine single-subject experimental design studies involving 27 participants and two group studies involving 98 participants were included in the review. For single-subject studies, most of the studies evaluated the effectiveness of the PECS by itself or in comparison to manual signing. Three studies involved SGD as part of their intervention, one study examined the effects of enhanced milieu teaching to teach requesting with SGD, whereas, two studies were sorting the effects of speech output when using SGD. For the group design studies: one study compared three different methods for introducing manual signs and the other study compared PECS with Responsive Education and Prelinguistic Milieu Teaching. They reported that AAC interventions do not impede speech production. In fact, most studies reported an increase in speech production. However, in-depth analyses revealed that the gains were rather modest.[20] level i

### 5.2.3. Preferences for AAC options

Meer *et al.* conducted a systematic review to assess individual preferences for AAC options in communication interventions for individuals with developmental disabilities. Studies were identified via systematic searches of electronic databases, journals and reference lists up to May 2010. Based on inclusion and exclusion criteria, seven studies involving 12 individuals were included in the review. In these studies, individuals were taught to use SGD or PECS and /or manual signs. Assessments to identify preferences for using each AAC option were conducted in each study. In the review, a communication option was classified as highly preferred if it was selected on at least 70% of the provided opportunities, moderately preferred if it was selected on 55% to 70% of opportunities, and non-preferred if it was selected on less than 55% of the opportunities. They reported that eight of twelve individuals (66.67%) demonstrated some degree of preference (≥ 55%) for using SGD. In contrast, 4 individuals (33.33%) demonstrated some degree of preference (≥ 55%) for using PECS. The authors concluded that incorporating an assessment of such preferences might therefore enable individuals to exert some degree of self-determination with respect to AAC intervention. [21] level I

The views of young people using AAC towards the organization of speech and language therapy, the role of speech and language therapist in school and issues

directly concerned with the AAC systems they use were evaluated by Clarke M *et al.* Six young adults and 17 children from London education authorities were interviewed on a one-to-one basis and in focus groups. Eleven of 17 children (64.71%) indicated that their AAC system was useful to them. Further analysis of these opinions revealed that negative attitudes towards AAC systems were primarily associated with operational issues and issues of self image / identity and to some degree with a lack of perceived benefit in interaction. In contrast to therapist preferred models of working, children and young people identified a preference for therapy organized on a one-to-one basis targeting linguistic and operational skills. [22] level II-3

### 5.2.4. Training

The success of an AAC application relies heavily on the prescriber professional competence in AAC, the appropriateness of the AAC device and the understanding and support provided by communication partners such as parents of people with complex communication needs. Individuals with complex communication needs are at risk for receiving inadequate services if speech language pathologists / speech therapist, special education teachers (SETs) and occupational therapist (OTs) are not prepared with basic AAC competencies upon graduating from pre-service programs.[23]

Costigan FA and Light J conducted a systematic review to investigate the adequacy and effectiveness of pre-service AAC training for SLPs, SETs and OTs in the U.S.A. They found that many pre-service programs offered minimal AAC training, faculty members have minimal expertise in AAC, and the effectiveness of pre-service programs in equipping professionals for entry-level AAC practice was unclear. Speech-language pathologist, SETs and OTs may thus be at risk of graduating with minimal to no exposure to AAC, with little knowledge or skill in AAC service provision, and may be unprepared for entry-level practice.[24] levei I Similarly, a survey of AAC service provision in Hong Kong by Siu E *et al.* reported that 72% of respondents were dissatisfied with the training in AAC that they received during their basic professional preparation. [23] level II-3

Similarly in Malaysia, only minimal training on AAC was included in the undergraduate program for speech therapist and it does not include training on high-technology AAC systems. (via verbal communication with speech therapist)

### 5.2.5. Expertise of Service Provider on AAC

Hustard KC *et al.* conducted a cross-sectional study to evaluate the types of technology used in AAC interventions for preschool-aged children provided by AAC experts and general speech language pathologist / speech therapist who were not AAC experts. A retrospective analysis of clinic records of young children who received AAC services through two AAC specialty programs in the Midwestern region of the United States between 1999 and 2004 was carried out. They found that interventions provided to the children by general speech language pathologists / speech therapist who were not AAC experts tend to be

broader in scope focusing on reducing underlying impairments while the interventions provided by AAC experts tend to focus on improving activities and participation and were oriented toward improving functional communication. The most commonly used AAC intervention tools by AAC experts were low-technology and simple digitized devices.[25 level II-3]

## 5.3. COST/COST-EFFECTIVENESS

There was no retrievable evidence on the cost-effectiveness of AAC systems. However, the cost for high-technology AAC system such as SpringBoard Lite was [redacted] and for Vantage Lite was [redacted].[26-27]

### 5.3.1. Maintenance cost of Speech Generating Devices (SGD)

People who use AAC and their families have indicated that reliability of AAC devices is of outmost importance. Shepherd TA *et al.* conducted a study to assess the reliability of new SGDs. The study was conducted at the Centralized Equipment Pool (CEP), a leasing program for communication aids in Ontario, Canada. The CEP purchases devices with government funding and leases them to individuals in Ontario. The time period covered by the study was from 1 April 2002 to 1 April 2007, which constituted five years of data on SGD repairs. They found that the mean time to the first failure was 41.7 weeks, (SD = 41.3, range = 0.1 to 222.1 weeks) and at least 40% required repairs within the first year of life. The components that most frequently broke down were touch screens, wiring, main boards, batteries, memory cards, and AC adaptors. The mean cost of the first repair was Canadian $142.60 (SD = 184.70). Out of the 484 devices that experienced a first breakdown, 321 (66.3%) of them failed the second time during the study period. The mean time to second failure from the first failure time was 73.8 weeks (SD = 52.2, range = 3.3 to 252.0 weeks). The mean cost of second repair for devices that broke a second time was Canadian $ 152.81 (SD = $ 216.87).The authors highlighted the need to include the cost of repairs when attempting to acquire funding for AAC systems.[28 level II-3]

## 5.4. LIMITATIONS

This technology review has several limitations. The selection of studies was done by one reviewer. Although there was no restriction in language during the search but only English full text articles were included in this report. Some of the pre and post-intervention studies included small sample size. There was no economic evaluation study retrieved.

# 6. CONCLUSION

## 6.1. SAFETY

- There was no retrievable evidence on safety issues with regards to AAC intervention to enhance communication among people with speech and language impairments.

## 6.2. EFFICACY/EFFECTIVENESS

### 6.2.1 Communication skills

- There was fair to good level of evidence to suggest that AAC intervention was associated with improvement in communication skills for individuals with developmental disabilities such as autism spectrum disorder, Down syndrome, cerebral palsy, mental retardation and patients with acquired neurological condition such as amyotrophic lateral sclerosis, traumatic brain injury, locked-in syndrome and aphasia.

- There was limited retrievable low level of evidence to suggest that AAC intervention has the potential to improve symptom communication for patients in the intensive care unit.

### 6.2.2. Speech production

- There was limited retrievable but good level of evidence to suggest that AAC intervention do not impede speech production; instead studies reported an increase in speech production.

### 6.2.3. Acceptance of AAC intervention

- There was limited retrievable fair level of evidence to suggest a high percentage of individuals with amyotrophic lateral sclerosis and traumatic brain injury accepted the AAC intervention as recommended by their speech language pathologist.

### 6.2.4. Preferences for AAC options

- There was limited retrievable evidence to suggest that individuals with speech and language disabilities have their own preference for the different AAC types.
- The type of AAC systems appropriate for an individual depends on several factors such as individual's motor, visual, cognitive, and language abilities which may be either unaided, low-technology or high-technology AAC systems.

### 6.2.5. Training

- There was limited retrievable evidence to suggest that pre-service programs / training (basic professional training) for speech language pathologist (speech therapist) on AAC may not be adequate for them to provide comprehensive AAC services after graduation. Differences were found in a study on the

scope of interventions provided by speech language pathologist / speech therapist who are AAC expert and who are not AAC expert.

## 6.3. COST/COST-EFFECTIVENESS

There was no retrievable evidence on the cost-effectiveness of AAC systems.

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# 8. APPENDIX

## 8.1. Appendix 1: LITERATURE SEARCH STRATEGY

**Ovid MEDLINE® In-process & other Non-Indexed citations and OvidMEDLINE® 1948 to present**

1. Speech/
2. (public adj1 speaking).tw.
3. Speech.tw.
4. speech.mp.
5. Speech Disorders/
6. dysglossia$.tw.
7. cluttering$.tw.
8. dyslalias$.tw.
9. rhinoladias$.tw.
10. aprosodia$.tw.
11. (speech adj1 aprosodic).tw.
12. Verbal fluency disorder$.tw.
13. Speech disorder$.tw.
14. Language/
15. Language$.tw.
16. Language.mp.
17. Language Disorders/
18. Language disorder$.tw.
19. (Language disorder$ adj1 acquired).tw.
20. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19
21. Augmentative.mp. and alternative communication.tw. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
22. AAC.tw.
23. High-technology Augmentative.mp. and alternative communication devices.tw. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
24. SpringBoard Lite.tw.

25. Vantage Lite.tw.
26. High-technology augmentative.mp. and alternative communication.tw. [mp=title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
27. 21 or 22 or 23 or 24 or 25 or 26
28. 20 and 27

| **OTHER DATABASES** | |
|---|---|
| EBM Reviews - Cochrane Central Register of Controlled Trials | Same MeSH, keywords, limits used as per MEDLINE search |
| EBM Reviews - Database of Abstracts of Review of Effects | |
| EBM Reviews - Cochrane database of systematic reviews | |
| EBM Reviews - Health Technology Assessment | |
| PubMed | |
| NHS economic evaluation database | |
| National Horizon Scanning unit | Augmentative and alternative Communication |
| Australia and New Zealand Horizon Scanning Network | Augmentative and alternative Communication |
| INAHTA | Augmentative and alternative Communication |
| FDA | Augmentative and alternative Communication |

## 8.2. Appendix 2

**DESIGNATION OF LEVELS OF EVIDENCE**

I Evidence obtained from at least one properly designed randomized controlled trial.

II-I Evidence obtained from well-designed controlled trials without randomization.

II-2 Evidence obtained from well-designed cohort or case-control analytic studies, preferably from more than one centre or research group.

II-3 Evidence obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments (such as the results of the introduction of penicillin treatment in the 1940s) could also be regarded as this type of evidence.

III Opinions or respected authorities, based on clinical experience; descriptive studies and case reports; or reports of expert committees.

***SOURCE: US/CANADIAN PREVENTIVE SERVICES TASK FORCE (Harris S2001)***