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Assistive Technology Options for Individuals with Quadriplegia

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May 2019

This evidence project, submitted by

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has been approved and accepted
in partial fulfillment of the requirements for the degree of
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Key words: assistive technology, quadriplegia, spinal cord injury, tetraplegia

Abstract

This project was undertaken in collaboration with Sonia Nurkse, MOT, OTR/L and Bridget Tanner, MSOT, OTR/L, two occupational therapists working on the inpatient rehabilitation unit at MultiCare Good Samaritan Hospital in Puyallup, Washington. A systematic review of the literature was conducted to answer the question, "What are the most effective, up-to-date, and user-friendly assistive technology options to support individuals with quadriplegia in functional tasks?" Five databases were searched and through screening and careful review, 19 articles were selected for critical appraisal. Due to the wide variety of devices, some commercially available and other prototypes, we were unable to compare them and determine a superior device. Rather, the assistive technology (AT) devices were organized into three categories: devices that support computer and typing access, devices that support environmental control, and devices that restore function.

A binder was developed containing AT software and hardware for individuals with limited to no upper extremity use. The AT binder contains devices that are supported by research and those without evidence. An in-service was organized to present the finished product to collaborators and their OT/PT colleagues. Through this process, it has been determined that there is a need for increased outcome research on AT devices for individuals with quadriplegia. This research has also highlighted the unique role that occupational therapy practitioners have in supporting quadriplegic clients' independence. Due to the rapid rate of technological advances and developments, it is recommended that practitioners actively work to stay current on assistive technology devices and resources.

Executive Summary

The practice question that originated this systematic review was, "What are the most effective, up-to-date, and user-friendly assistive technology options to support individuals with quadriplegia in functional tasks?" A search of five databases identified 19 pertinent articles that were then detailed in the CAT table.

The devices included in the articles varied widely and were intended for a wide range of tasks. To organize them, we classified them into one of three categories: devices to support computer access, devices to restore function, and devices to support environmental control. Results from the studies varied greatly, with some technology options receiving positive feedback and others being rejected by the study participants. Two systematic reviews were included in the pool of chosen articles; the first focused on assistive technology's influence on quality of life measures for individuals with spinal cord injury (Baldassin et al., 2017), the second on the influence assistive technology has on communication abilities for individuals with cerebral palsy (Nerisanu et al., 2017). Both systematic reviews determined that devices and/or software that give the user the ability to perform functional tasks increased their quality of life, but neither focused on specific devices.

The significant range of complexity within the assistive technology market makes it difficult for clients who are generally unfamiliar with technology to determine which device would be best suited for their individual needs. Further, assistive technology can be cost prohibitive, as paying out of pocket is not an option for many individuals.

Consumers are reliant on therapists to have adequate understanding of the technology available and present the most appropriate options. Determining which technology would best suit a client depends on several factors, including client acceptance of assistive technology in the

first place, capacity to learn how to utilize it, financial resources, and consideration of any social

impact the technology may have for the individual. Options to keep up-to-date with recent

technological developments include continuing education courses or subscribing to publications

focused on assistive technology. It is the practitioner's responsibility to seek these opportunities

out and capitalize on them.

More research is needed in the realm of assistive technology for individuals with

quadriplegia. Due to the rapid nature of technological advances and updates or modifications to

existing technology, research quickly becomes outdated; for this reason it is essential that

ongoing research take place.

Two knowledge translation projects were undertaken to implement this research into

practice. An assistive technology binder was developed containing devices detailed in the

research as well as devices not yet backed by empirical research as a resource for the

rehabilitation team at Good Samaritan Hospital in Puyallup, WA to share with their patients who

are interested in exploring assistive technology options. In addition to the binder, an in-service

was held at this facility on April 5th, 2019 to introduce the binder to practitioners and address

any questions they may have.

A survey was distributed immediately after the in-service and eleven responses were

collected. Overall, the response to the in-service was positive. Two weeks after the in-service, an

online follow-up survey was distributed to the practitioners who had been present at the in-

service. Specific information regarding responses to survey questions can be found in the

evaluation of outcomes section of this paper.

Critically Appraised Topic

Focused Question

> What are the most effective, up-to-date, and user-friendly assistive technology options to support individuals with quadriplegia in functional tasks?

Prepared By

> Bri Brown, Natalie Geisler, Hannah Terranova

Date Review Completed

> 1/29/2019

Professional Practice Scenario

> Two rehabilitation occupational therapists working on the inpatient unit of a hospital that provides Level 1 Adult Trauma rehab services are interested in evidence regarding low/high technology options for individuals with high level SCI, specifically regarding feasibility and quality. The practitioners seek to know more about assistive technology options for clients affected by quadriplegia and want to be able to share information with these clients while they are actively receiving inpatient services, smoothing the transition from inpatient rehabilitation to the home setting.

Search Process
Procedures for the selection and appraisal of articles
Inclusion Criteria

> Our inclusion criteria were as follows:
> - Studies published in 2014 or more recently
> - Adult participants (≥ 18 years old)
> - Individuals with quadriplegia

Exclusion Criteria

> Our exclusion criteria were as follows:
> - Studies published in languages other than English and not yet translated
> - Studies with non-human participants

Search Strategy

Categories	Key Search Terms
Patient/Client Population	Individuals with: spinal cord injury, SCI, quadriplegia, tetraplegia, cerebral palsy, multiple sclerosis
Intervention (Assessment)	Assistive technology, AT, adaptive technology, rehabilitative technology
Outcomes	Increased level of independence and ability to perform functional tasks with use of assistive technology

Databases, Sites, and Sources Searched
CINAHL
Cochrane Library
Google Scholar
ProQuest Central
PubMed

Search Outcomes/Quality Control/Review Process

Our initial question included only the diagnosis of spinal cord injury, however after initial searches we decided to broaden our focus and include all individuals affected by quadriplegia in order to investigate assistive technology developed for a wider array of diagnoses resulting in quadriplegia.

To maximize efficiency and focus on the most relevant articles to our question, a search method was agreed upon. We searched our identified databases using key search terms and sorted results by relevance. We then evaluated the first ten pages of resulting articles for relevance to our question and screened them for inclusion in this analysis.

A search of the CINAHL database for articles published 2014 or more recently containing the search terms "assistive technology AND quadriplegia OR tetraplegia" resulted in 270 articles identified. To refine the search the term "exoskeleton" was excluded and the term "spinal cord injury" was included, resulting in 213 articles. The term "assistive technology" was specified as a title term, resulting in 190 articles identified. From this search, the first ten pages of results were evaluated (100 articles)

and ten articles were taken that seemed to align with our question. After further review, five were selected for inclusion.

An initial search of the PubMed database for articles published 2014 or more recently containing the search terms "assistive technology AND spinal cord injury OR SCI OR quadriplegia" resulted in 14,306 articles identified. To refine the search a filter was applied that excluded articles that focused on non-human subjects. This reduced the results to 5,361 articles sorted by highest relevance. Titles and/or abstracts of the first 10 pages (200 articles) were screened for eligibility, of which 68 were excluded based on irrelevance to our topic. After a full-text review of the remaining 32 articles, four were selected for inclusion. The remaining 28 articles were excluded because participants had higher levels of functioning in their upper extremities thus not meeting our 'individuals with quadriplegia' inclusion criteria.

A search of Google Scholar was conducted for articles published 2014 or more recently using the search terms "assistive technology OR AT AND quadriplegia" which resulted in 2,500 articles sorted by highest relevance. Titles and/or abstracts from the first ten pages (100 articles) were screened for eligibility, of which 12 articles were selected for full-text review. To further narrow the results "tongue" was added to the search which resulted in 365 articles. Titles and/or abstracts of the first 100 articles were again screened for eligibility and four additional articles were selected for full-review. Of the 16 articles reviewed, eight were selected for inclusion. The rest were excluded because participants were either not quadriplegic or were under the age of 18, thus not meeting the inclusion criteria.

An initial search of ProQuest Central for peer-reviewed articles published after 2014 using the search terms "quadriplegia AND assistive technology" identified 67 articles. Titles and/or abstracts were screened for relevance to our question and duplicates were removed. Two studies were selected for full-text review and included for critical appraisal.

A search of Cochrane Library was also conducted for systematic reviews published after 2014 using the search term "assistive technology" which resulted in 53 reviews. Titles of these results were screened for eligibility, but all 53 articles were excluded based on irrelevance to our topic.

Key contributors who guided our research are as follows: mentor and project chair George Tomlin, PhD, OTR/L, FAOTA, faculty member Renee Watling, PhD, OTR/L, FAOTA, University of Puget Sound library liaison Eli Gandour-Rood, MLIS, and collaborators Sonia Nurkse, MOT, OTR/L, and Bridget Tanner, MSOT, OTR/L.

Results of Search

Summary of Study Designs of Articles Selected for the CAT Table

Pyramid Side	Study Design/Methodology of Selected Articles	Number of Articles Selected
Experimental	___Meta-Analyses of Experimental Trials ___ Individual Blinded Randomized Controlled Trials _1_Controlled Clinical Trials _1_ Single Subject Studies	2
Outcome	___Meta-Analyses of Related Outcome Studies _1_Individual Quasi-Experimental Studies w/ Covariates _2_Case-Control or Pre-existing Groups Studies _2_One Group Pre-Post Studies	5

Qualitative	___Meta-Syntheses of Related Qualitative Studies
	 _1_Group Qualitative Studies w/ more Rigor
	    ___prolonged engagement with informants
	    _1_triangulation of data (multiple sources)
	    _1_confirmation (peer/member-checking; audit trail)
	    ___comparisons among individuals, w/i a person
	 _4_Group Qualitative Studies w/ less Rigor
	 ___Qualitative Study on a Single Person
		5

Descriptive	_2_Systematic Reviews of Related Descriptive Studies ___Association, Correlational Studies _1_Multiple Case Series, Normative Studies, Descriptive surveys _4_Individual Case Studies	7

AOTA Levels I- 3 II- 2 III- 3 IV- 3 V- 3 Comments: Five articles are qualitative studies, which are not rated according to the AOTA levels of evidence.	19

ENVIRONMENTAL CONTROL

Table Summarizing the *QUANTITATIVE* Evidence						
Author Year Journal Country	**Study Objectives**	**Study Design/Level of Evidence**	**Participants: Sample Size, Description Inclusion and Exclusion Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Etingen et al. 2018 *Disability and Rehab: Assistive Tech* USA	Describe inpatient perceptions of & experiences with ECU	Descriptive survey IV D3 1/3	*N*=150 total respondents; veterans w/ SCI/D *n*=70 inpt *n*=80 responses recntly discharged from inpt Incl: LOS ≥ 3 days Excl: discharge to LT care facility	I: Survey (inpt) & questionnaire (discharged) re: ECU use O:Type/frequency of use, method of interaction, features used, satisfaction, impact on independence, opportunities for improvement	Majority were satisfied, positive impact on independence (inpt 42%, dischrgd 50%) Most used ECU: AutonoMe followed by GWN w/ QuadJoy Most used fxns: cntrl envirnmnt & entertainment Areas for improvement=training, functionality, maintenance	Self-report surveys administered after discharge for 80 respondents may impact recall
Verikios et al. 2016 *Int J of Therapy & Rehab* Australia	Investigate the physical, psychosocial, and functional impact of the TAPit on an individual living with	Case study V D4 2/3	*N*=1; woman in her 50s w/ C4-lvl SCI; ID'd by purposeful sampling of clients attending trauma rehab srvs Incl/Excl not	I: TAPit tx w/ OT; amt of instruction/time w/ TAPit/ length of study not described O: PIADS, progress toward predetermined goals	PIADS results: TAPit was consistently rated as having a positive psychosocial impact on client's QoL (avg scores above +1.3); ⅔ functional goals met	Bias may be present due to the researchers having provided therapy to this client prior to the study and knowing her well

	SCI		addressed			
Yeung & Chau 2017 *Canadian Medical and Biological Engineering Society* Canada	Investigate useability of eyebrow switch and compare effectiveness of eyebrow switch to mechanical switches in order to independently change TV channel for indiv. w/ quadriplegia	Case Study IV D4 2/3	*N*=2; 20yo female w/ C1-C4 quadriplegia and 22yo AB male Incl/Excl not addressed	I: eyebrow switch device design, Tash Big Buddy Button, Tash Leaf Switch & Touch Switch. O: ability to successfully activate, activation speed, and eyebrow mvmt detection w/ & w/o environmental disturbances	Mechanical switches operated by hands were unsuccessful. Mechanical switches operated by chin restricted pt's ability to speak and access to tracheostomy site. System activated at rate of 45/min; pt = 26/min. Baseline data stat. dif. (p<0.001) compared to data w/ environmental disturbances.	Pt had no cognitive or speech deficits so results may not be generalizable to individ. w/ those deficits

ENVIRONMENTAL CONTROL

Table Summarizing *QUALITATIVE* Evidence						
Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence**	**Participants: Sample Size, Description Inclusion and Exclusion Criteria**	**Methods for enhancing rigor**	**Themes and Results**	**Study Limitations**
Kim et al. 2014 *J Rehab Res Dev.*	Describe lived experience w/ magnetic tongue piercing & use of TDS following high-level SCI	Phenomenol ogy NR Q3	*n*=11; 9 males, 2 females; 27-59 yo; SCI between C2-C6; 3.4-24.7 yrs post injury	Repeated surveying of participants throughout study Audit trail	All were satisfied with TDS performance & most said it enabled them to more effectively operate their PC's and PWC's	Small *N* Short duration of study

					than other AT	
USA						
Laumann et al. 2015 *Topics in Spinal cord Injury Rehab* USA	Develop/test medically supervised tongue piercing for those w/ tetraplegia; describe experience of piercing for TDS	Phenomenology NR Q3	*N*=11 w/ SCI C2-C6; 6 sip-n-puff users, 5 joystick users; 3-21 yrs post injry Incl: PWC users w/ limited UE strength Excl: predis. to infection/bleeding, inappropriate intraoral anatomy	Trial sessions to ensure phys/cog ability Each task (operate computer, PWC, phone, wght shift) repeated 3x Repeated yes/no surveying w/ option for explanation	Protocol = limited postpiercing pain, swelling, eating/speaking difficulties 11 satisfied, 10 said piercing comf/effective > current device 9 did not like appearance, 5 reported feeling tired	*n*=8 completed questionnaire immediately; *n=3* after interim sess = questionable accuracy of recall

RESTORING FUNCTION

Table Summarizing *QUANTITATIVE* Evidence						
Author Year Journal Country	**Study Objectives**	**Study Design/Level of Evidence**	**Participants: Sample Size, Description Inclusion and Exclusion Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Andreasen-Stujik et al. 2017	Proof of concept - use ITCS (intraoral interface &	Case control, pre-existing grps, non-randomized	*N*=2 Ctrl = 37yo AB female	I: ITCS to operate 14 assistive robotic arm mvmts; training & 10 fxnl trials	Indiv. w/ tetraplegia able to use intraoral control system to control robotic arm in fxnl tasks to pick up	Both participants had prev. experience w/ tongue control systems

J of Neuroengineering and Rehab Denmark	external unit) to control assistive robotic arm in fxnl activities for individuals w/ tetraplegia	II O3 3/6	Exp = 64yo female w/ C1-C2 SCI sustained 19 yrs prior to study	O:#/type/success of command, task completion time	object 5/10x, touch object 10/10x, pour water, handshake	Authors developed the ITCS = possibility of bias
Cappello et al. 2018 *J of Neuroengineerin and Rehab* USA	Effectiveness of fabric based, soft robotic glove for indiv w/ ↓ hand fxn 2° SCI	One group, pre-post study III O4 4/6	*N*=9; 20-68 yo; 8 males & 1 female Incl: C4-C7 SCI; 18-70yo, loss of hand fxn, MMSE score ≥ 23 Excl: not addressed	I: soft robotic glove O: TRI-HFT to assess grasp, pinch, manipulation. 3 trials= object manipulation, block strength, dynamometric msrmnts	Soft robotic glove ↑ hand fxn to manipulate ADL objects and ↓ variability of performance Sig ↑ for all participants across all TRI-HFT subtests, *M* score diff =2.34, $p < 0.01$	Did not report perceptions re: usability/comfort of glove
Dimbwadyo-Terrer et al. 2016 *BioMed Research International* Spain	Investigate effects of VR program (Toyra®) combined with CT on UE fxn for indiv w/ tetraplegia & study pt satisfaction of VR	Controlled clinical trial, 2 grp pre-test, post-test II E3	*N*=31; 22 males, 9 females, 19-65 yo, C5-C8 SCI w/ normal/or corrected to normal vision/hearing Ctrl grp; *n*=15; CT Exp grp: *n*=16; CT + VR Incl: +18 yo, < 12mo post SCI, A-B ASIA level Excl:pathlgy affecting UE mvmt,	Ctrl:CT=OT&physiothrpy; 1.5hr/day 5days/wk for 5 wks Exp:15 30m VR sess 3x/wk for 5wks, + CT O: UL fxn (MMT, FIM, SCIM-III self-care, BI, MI) & satisfaction (QUEST, satisfact. Survey)	No sig diff in imprvmnts btwn 2 grps for clinical/ fxnl measures, but MCID of both grps reported for SCIM self-care, BI, MI. Ctrl grp = stat sig ↑in MMT @follow up, *p*=0.043 QUEST total satisfy = 33.1 ±2.17 = grt satisfaction Overall satisfaction for Toyra, factors incl: ease of adjstmnt, enjoyable	Short duration/dosage of VR tx, 5 wks may not be long enough for skill transfer

			tech addiction, epilepsy, pregnant		actvties, lightweight, ↑motivation	
Shimizu et al. 2017 *J of Spinal Cord Med* Japan	Effect of HAL®-SJ to restore active elbow flex	Single case experimental design IV E4 3/7	*N=1*; 19yo male w/ complete C4 quadriplegia Incl/Excl not addressed	I:HAL®-SJ tx w/ OT/PT RUE = 10 sessions 2x/wk for 5 weeks LUE = 10 sessions 1x/1-2wks for 12 wks O:BI, FIM, ASIA, MMT	EMG: vol control of B biceps in elbow flex 4 mo. post tx completion BI & FIM unchanged, ASIA UE limb 0 → 2, MMT biceps & ISP 0 → 1	Brain activity not monitored (changes in CNS unknown)

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Table Summarizing *QUANTITATIVE* Evidence						
Author Year Journal Country	**Study Objectives**	**Study Design/Level of Evidence**	**Participants: Sample Size, Description Inclusion and Exclusion Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Andreasen-Stujik et al. 2017 *Dis & Rehab: AT* Denmark	To test an alternative computer interface that is embedded into the oral cavity that provides multiple control	Case control, 2 groups non-randomized II O3 4/6	*N=4*; all female (two w/ SCI & 2 able-bodied) age range 27-57 Incl/Excl not addressed	I: 1-day exp for sbjcts w/ tetraplegia & 2-day exp for subjects w/o SCI. Subjects were trained in use of ITCI by typing w/ Matlab© interface & Word© as well as games O: Amt of time req to type a correct character	For clients w/ tetraplegia, the mean time req to type a correct character was 7.3 sec. For able-bodied clients, the mean was 7.9 sec on day 1 & 4.3 sec on day 2, indicating sig learning	Because the authors developed the ITCI, they may have been biased in evaluating its effectiveness & ease of use. The small sample size does not make the study readily

	commands for people with quadriplegia					generalizable to others w/ tetraplegia
Pouplin et al. 2014 *JRRD* France	To carry out a preliminary eval of a dynamic on-screen keyboard & a word-prediction system on text input speed for pts w/ tetraplegia	Pre-existing groups w/ covariates III O2 5/6	*N*=10, 8 male & 2 female; mean=37.3yo Incl:18+yo, has funct tetraplegia, regularly uses on-screen static AZERTY keybrd, not reg users of dynamic keybrd or word prdctn Excl: cognitive/linguistic/ visual impairment preventing use of comp	I=1 hr. w/ each participant to explain function of the 4 modes (static & dynamic on-screen keybd, with & without word prediction); for 1 month all 4 modes available; month 2 clients chose which to use O=satisfaction using VAS, txt input speed, order of pref	No sig change in txt input speed across eval sessions (*p*=0.97); 9/10 preferred static keybd than dynamic; dynamic keybrd ↓ txt input speed; word prdcn didn't change input speed; static + word prdcn mode most popular; @ end of study 9/10 chose to keep their own on-screen keybd	Time spent by participants was not equal across modes; researchers did not collect data on use of word prdcn to see amt of use of prdcn list
Sigafoos et al. 2017 *Clinical Case Studies* New Zealand	Explore outcomes of a pt-directed support model to enable adult w/ CP to access internet	Case study V D4 1/3	*N*=1; 44yo male w/ spastic quadriplegia CP Intact cognition, total assist (FIM=13) for ADLs Incl/Excl not addressed	I: pt directed model to guide decisions re: goal setting & outcome measures during AT intervention; 45-60 min sess/wk for 12wks O: COPM, QUEST (satisfaction re: head pointer & iPad®)PRPS (participation), level of independence (scale 1-3)	COPM: perf & satis increased from 1 to 5 and 1 to 4. QUEST: head pointer *M*=4.6,iPad® *M*=4.2 PRPS: +6/6 11 sess, +4/6 1 sess Lev of ind: *M*=2.3 Pt directed model that incorporates self-determination = ↑ active participation & satisfaction	Pt had no deficits in communication/cognitive/psychological abilities, so this model may not be transferable to indiv w/ deficits in those areas
Taherian et al.	Investigate usability of	Case study	*N*=1; 21yo female with spastic	I: BCI training in private office @ school for 30	Training allowed pt to gain control over neural	Small *N* = difficult to generalize results

2016 *Disability and Rehab: Assistive Technology* UK	BCI as AT and describe how pt with CP trained to use BCI system to access her AAC software	V D4 1/3	quadriplegic CP Incl/Excl not addressed	min 3x/wk for 4wks w/ follow-up 6wks post-training O: performance scores and observations from each trial; ability to access AAC software using BCI	activity and motor imagery tasks. At 6wk follow-up pt able to control AAC software & type sentence using BCI, but much slower than head-wand & Dynavox for communication	No raw EEG data recorded or analyzed Training did not incl accessing AAC software, only follow up. Training sessions only occured in morning so results may not account for fatigue Training occured in isolated office so results don't account for distractions of normal environments. # of trials in each session varied making results inconsistent
Van Middendorp et al. 2015 *Spinal Cord* UK	To determine preliminary benefits of using ETCSs among pts with tetraplegia & feasibility of conducting a RCT	One group pre-post study III O4 2/6	*N*=6 51-72yo, all males Incl: present w/ tetraplegia, expected LOS>10wks Excl: no comorbidities	I=Part. used ETCS 2x/wk for 10 wks. 1-hr training sessions provided to part. for 2-4 wks; after training part. used ETCS for 2 2-hr sessions/wk O=3 questionnaires admin before/after ETCS sessions: ADAPSS, HADS, & ATD-PA	ADAPSS showed no stat sig differences b/w 6 subscales; ATD-PA showed a small ↑ in funct abilities	All participants aged 51+; study not generalizable to younger individuals. Medical complications unrelated to the study limited ETCSs use; technical difficulties limited use of ETCS

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Table Summarizing the *Meta-Analyses/Meta-Syntheses/Systematic Review* Evidence						
Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence**	**Number of Papers Included, Incl/Excl Criteria**	**Interventions & Outcome Measures**	**Summary of Results**	**Study Limitations**
Baldassin et al. 2018 *Quality of Life Research* Brazil	Assess available evidence re: influence of AT for use in computers & QoL for indiv w/ SCI	Systematic Review D1, Q1 4 Cross sectional, 1grounded theory, 1phenomenology, 1thematic analysis, 2narrative review, 1descrip-exploratory Lev of evidence assigned using Oxford Centre for Evidence-Based Med; 5D-3A	*N*=79 reviewed, *N*=10 selected; no date restriction; PubMed, PEDro, LILACS,PsycINFO,SCIELO Keytrm: SCI, tetraplegia,quadriplegia, AT, self-help device, computer system, QoL Incl: sample >18yo w/ SCI, QoL outcome measure Excl: lang ≠ Eng/Span/Ital/Portug/French, AT ≠ computer interfaces	I: AT for computer access O: QoL, satisfaction, psychosocl well-being, fxnl abilities, usability of AT, factors related to self-perception of participation, explore experiences	For indiv w/ SCI, AT can ↑ QoL for users > non-users AT has + impact on self-esteem/perceptn of competence; computer access = crucial for participation/communication Dissatisf. post-SCI due to social disadvantages	Heterogeneity in multiple study factors restrict ability to draw conclusions Only 3 studies detailed specific types of AT used Outcomes restricted to USA, Canada, Australia = need for multicultural perceptions of QoL
Nerisanu et al. 2017 *AMT*	Describe how technology such as eye-tracking can create communication	Systematic Review D1 Levels of evidence sought by authors	"Over 30" articles reviewed; span of publication years unidentified; 12 databases listed as resources; incl/excl not addressed	I: Implementation of communicative devices for those with CP O: Usability of eye-gaze tech with infared, AAC, text-to-speech, communication ability	Several studies showed improvement in eye-gaze & AAC performance, ↑ communicative ability for individuals w/ CP; a limitation of this technology is the high	The authors of the review neglect to identify levels of evidence of their reviewed studies and do not include incl/excl criteria.

| România | opportunities for individ w/ CP | not identified | | | price | |

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Table Summarizing the *QUALITATIVE* Evidence						
Author Year Journal Country	**Study Objectives**	**Study Design/ Level of Evidence**	**Participants: Sample Size, Description Inclusion and Exclusion Criteria**	**Methods for enhancing rigor**	**Themes and Results**	**Study Limitations**
Feng et al. 2018 *Journal of Human-Computer Interaction* USA	Explores the evolving use of AT by people with quadriplegia.	Phenomenology NR Q2	*N*=15; 5 females, 10 males; 28-67 yo; varying degenerative neurological diseases Incl/Excl not addressed	Code-recode of data collected until theoretical saturation achieved Triangulation of data	advt: ↓ control efforts, customizable/dynamic interfaces disadvantages: efficiency and accuracy, control precision, fatigue caused from AT use, dep on others AT abandoned when it does not accommodate pts symptoms Current AT does not meet efficient text-entry and comm needs	Small *n* Short duration - only 1 30-60 min interview conducted w/ each pt.
Folan et al. 2015	Gain understanding of experiences	Phenomenology NR	*N*=7; 3 outpt, 4 inpt Incl: 18+yo, dx of	Member checking, data triangulation	Themes identified: getting back into life, assisting in adjusting	Recruitment of participants only from 1 rehab center, limited

Dis & Rehab: Assist Tech Australia	of clients w/ tetraplegia trialing AT for computer access	Q2	tetraplegia w/ UE impairment, beyond acute stage of rec, inpt @ VSCS or d/c w/i last 18mo., exposure to AT in past		to injury, and learning new skills. These can all relate to returning to work after SCI. Early intro to AT ID'd as important to learning new skill	experience of lead researcher w/ pts with SCI
Huggins et al. 2015 *Archives of Phys Med and Rehab* USA	Explore SCI survivors' interest in & perceptions of BCI	Phenomenology NR Q3	*N*=40 total; 30 via SCI registry & 10 via BCI study *n*=24, FIM <40 & SCI C2-C4/5 *n*=16, FIM>40 & SCI below C4	Caregiver responses included Survey based on instrument from similar study & modified after analysis & input from indiv w/ phys impairments	Indiv w/ high level SCI = strongest interest Current abilities of BCI ≠ sufficient to meet low func abilities; need ↑speed, ↓set up time, fxns that supplement or are > than other AT	No respondents used BCI; perceptions based on imagined performance NOT actual experience

Abbreviations Key

AAC - augmentative & alternative technology

AB - able bodied

ADAPSS - Appraisals of Disability: Primary and Secondary Scale questionnaire

AT - assistive technology

ATD-PA - Assistive Technology Device Predisposition Assessment questionnaire

ASIA - American Spinal Injury Association

BCI - brain-computer interface

BI - Barthel Index

COPM - Canadian Occupational Performance Measure

CP - cerebral palsy

CT - conventional therapy

ECU - environmental control unit

ETCS - Eye-Tracking Computer Systems

FIM - Functional Independence Measure

HADS - Hospital Anxiety and Depression Scale

HAL®-SJ - Hybrid Assistive Limb Single Joint

ISP - infraspinatus

ITCI - inductive tongue computer interface

ITCS - inductive tongue control system

MCID - minimal clinically important difference

MI - Motricity Index

MMSE - Mini Mental State Examination

MMT - Manual Muscle Test

PC - personal computer

PIADS - Psychosocial Impact of Assistive Devices Scale

PRPS - Pittsburgh Rehabilitation Participation Scale

PWC - powered wheelchair

QUEST - Quebec User Evaluation of Satisfaction with Assistive Technology

rmANOVA - repeated measures analysis of variance

SCI - spinal cord injury

SCI/D - spinal cord injury/disorder

SCIM III - Spinal Cord Independence Measure III

TAPit - Touch Accessible Platform for Interactive Technology

TDS - Tongue Drive System

TRI - tongue-robot interface

TRI-HFT - Toronto Rehabilitation Institute Hand Function Test

VAS - visual analog scale

VR - virtual reality

VSCS - Victorian Spinal Cord Service

Summary of Key Findings.

Summary of Experimental Studies

Two experimental studies, levels E2 and E4, met our criteria and were selected for
critical appraisal. Both studies recruited participants with high level spinal cord injuries
to examine the use of technology during the intervention process as a means to increase
upper extremity function.

The randomized control trial investigating conventional therapy supplemented with a
virtual reality program did not result in statistically significant findings (Dimbwadyo-
Terrer et al., 2016). However, minimal clinically important differences in several
outcome measures were noted, which can be more meaningful for clients and
practitioners alike. Moreover, the addition of the VR system resulted in satisfaction,
increased motivation, and interest in patients. The findings from the single case
experimental design study indicated that functional recovery of bilateral biceps muscles
in an individual with C4 quadriplegia was possible after training with a robotic arm
(Shimizu et al., 2017).

Summary of Outcome Studies

The five outcome studies included for critical appraisal included participants with
quadriplegia and explored the effect of various assistive technologies and interfaces.

Two studies used tongue-based systems to control other devices - a keyboard and an
assistive robotic arm, and found that participants were able to use the oral systems almost
as efficiently and accurately as able-bodied persons in functional activities (Andreasen-
Struijk et al., 2017). Another study with promising findings explored the use of a soft
robotic glove; results indicated the glove increased object manipulation skills and hand
function in ADLs in participants with cervical level spinal cord injuries (Cappello et al.,
2018).

Another study investigated the preferences of individuals with functional tetraplegia in
the use of four keyboard designs: static and dynamic on-screen keyboards both with and
without word-prediction. Findings failed to support the hypothesis that these technologies
would increase text input speed. Nine out of the ten participants chose to return to using
the keyboards they had used prior to beginning the study over any of the proposed
models (Pouplin et al., 2014).

A study conducted to determine the benefits of an eye-tracking computer system for
individuals with tetraplegia did not find significant improvements in outcomes related to
psychological state, disability, or independence (Van Middendorp et al., 2015). They
described the difficulties of conducting a study investigating use of assistive technology
in an inpatient rehabilitation setting citing medical complications and dissatisfaction of
the participants with the technology. Further, Van Middendorp et al. (2015) indicated the
introduction of assistive technology may be more appropriate "...once recovery of arm

and hand function has reached a plateau phase" (p. 224) in order to more accurately assess the potential benefits of assistive technology such as the ETCS for individual clients.

Summary of Qualitative Studies

The five qualitative studies included for critical appraisal explored the lived experiences of individuals with quadriplegia and their experiences with different types of assistive technology.

One article gave a general overview of the types of assistive technology available for individuals with quadriplegia and completed a study on what individuals use computers for, the types of assistive technology participants have tried and currently use, the advantages and disadvantages of the assistive technologies they have tried and currently use, how participants learned about and chose assistive technologies, why assistive technologies they had tried or previously used were abandoned, and their wishes for and opinions about the assistive technologies they were currently using (Feng et al., 2018). The primary findings from the study were that individuals with quadriplegia are not satisfied with the assistive technologies currently available and have a need for more efficient text-entry and communication technology.

Two studies looked at tongue-based systems. The first explored the experiences of individuals with quadriplegia using a tongue drive system for the first time. They compared the use of the TDS for accessing the computer and operating their power wheelchairs with the assistive technology they currently have. The second study examined the experience of piercing the tongue for use of a tongue drive system with the intent of developing a protocol for the procedure. Both studies had positive outcomes. The participants in the first study found that the TDS enabled them to more effectively operate both their computers and wheelchairs than other assistive technologies (Kim et al., 2014). In the second study all participants were satisfied with the tongue piercing and the piercing procedure was successful with limited side effects (Laumann et al., 2015).

Similar to the TDS for accessing a computer and wheelchair, another study explored the experiences of clients trialing assistive technology for computer access. The study found that assistive technology for accessing computers allowed participants to get back into life, adjust to their injury, and learn new skills (Folan et al., 2015).

The final qualitative study explored the interest in a brain computer interface for individuals who had a spinal cord injury. They found individuals with high level spinal cord injuries had the highest interest in the technology, but that current brain computer interfaces were not sufficient for this population (Huggins et al., 2015).

Summary of Descriptive Studies

Overall, the seven descriptive studies selected provided information related to several types of assistive technology, their impact on quality of life and communication abilities, and identified limitations in devices or barriers to success.

A case study (Yeung & Chau, 2017) on various types of switches found that an eyebrow switch device was more successful and less restrictive than either a hand operated or chin operated switch device, suggesting it may be an effective means for a controlling aspects of one's environment.

TAPit, an interactive learning station that allows users to access the internet among other resources, was determined to have high potential as an assistive device for individuals with SCI. The study showed that this user friendly device positively influenced psychosocial components of quality of life in addition to increasing independence in functional tasks by enabling the individual with C4 SCI to meet ⅔ of her long-held functional goals (Verikios et al., 2016).

Survey and questionnaire data from current or recently discharged veterans with SCI revealed that a majority were introduced to some form of an environmental control unit that had a positive impact on their independence during their inpatient stay (Etingen et al., 2018). Despite high levels of satisfaction, respondents indicated that there are several areas for improvement: opportunities for training to learn how to operate the device and its features, regular maintenance to prevent malfunctioning or technical errors, and physical properties of the equipment (wires, cables, fragile arms).

Two articles included participants with spastic quadriplegic cerebral palsy. One study found that training with a BCI for a client with spastic quadriplegic cerebral palsy was possible and allowed her to access alternative and augmentative communication devices (Taherian et al., 2016). However, time to complete the tasks was longer than with other assistive technologies (head-wand, Dynavox) and further development and research with BCIs is necessary. The second article detailed the effects of using a patient-guided model during an intervention using a head-wand to access preferred internet content. Findings suggested that active participation of the client lead to increased satisfaction, performance, and increased self-determination. (Sigafoos et al., 2017).

Two systematic-reviews were selected. The first was on computer AT's influence on quality of life for individuals with SCI. The authors found that assistive technology with computer interfaces can increase aspects of quality of life by increasing self-esteem and perception of competence, and enabling communication for social participation (Baldassin et al., 2017). Methodological limitations and the heterogeneous nature of the selected studies prevented authors from further analyzing the results. The second systematic review was interested in the influence AT, such as eye-tracking, has on communication abilities for individuals with cerebral palsy. Information gathered indicated that participants' can operate eye-gaze technology/augmentative & alternative

communication for increased communication, however, the high cost of the equipment is a significant barrier (Nerisanu et al., 2017).

Implications for Consumers

A wide variety of devices engineered to assist individuals with quadriplegia in functional tasks are on the market and continue to be developed at a rapid rate. This means it may be difficult to keep up with recent advances. Because the initial introduction to this type of technology typically happens in an inpatient rehabilitation setting, clients are reliant on therapists and physicians to present them with options that best fit their individual needs. Clients often are unable to conduct research independently to find devices that align with their needs and desires, and the opportunity to try different technologies is limited so it is difficult to know what kinds of assistive technology would be most appropriate. Additionally, the cost of these devices may be prohibitive, further limiting an individual's choice in assistive technology.

Although assistive technology can be cost prohibitive, difficult to research, and is typically presented by practitioners in a limited way, the development of assistive technology has shown to be invaluable to individuals who require it to be independent. Several articles included in this literature review detail the positive results assistive technology has provided to individuals with quadriplegia, such as: the ability to access the internet for entertainment and communication, control aspects of their environment to change the television channel and turn on lights, and restore function to further support their independence in daily life. There is a significant range of complexity within the assistive technology market; ease of use was addressed in several articles, indicating accessibility is a genuine concern for researchers.

Implications for Practitioners

Clients are reliant on practitioners to know the available technology and be able to present different options to them that coincide with their needs and functional abilities. If a client is matched with a device that is too complicated for them to use independently, they may relinquish the technology and be discouraged from trying other devices. This was evident with the client who ultimately found success with the TAPit device (Verikios et al., 2016). Continuing education courses and subscribing to tech websites may help mitigate the gap between the technology available in practice and what is currently being developed. By keeping up with the technology available to those with quadriplegia, therapists can be more confident they are providing the best possible care to their clients and providing opportunities for them to become as independent as possible. Findings concerning specific devices are detailed in the table following this implication section.

Implications for Researchers

There is a need for outcome research on assistive technology for individuals with quadriplegia. Multiple articles identified in this document detail the difficulties present in attempting to conduct research in an inpatient rehabilitation setting. Individuals shortly after suffering from a SCI or TBI may be more focused on regaining function and motor ability by way of natural recovery than exploring what assistive technology is available to them to compensate for their deficit. It seems the most appropriate time to begin introducing assistive technology to these clients is once they have hit a plateau with regaining function several months post-lesion; this will inevitably occur after discharge from inpatient rehabilitation.

Due to the rapid rate of technological advances and development of assistive technology there is a shortage of research on the current most up-to-date assistive technology and the available research will soon become outdated. Therefore, it is important that researchers continue to investigate assistive technology. Many therapists will want research to back up a device before they suggest it to their clients and many consumers will want research backing up a device before they spend the money for it, as many are not covered by insurance.

Bottom Line for Occupational Therapy Practice/Recommendations for Best Practice

The broad range of types of assistive technology devices with their varying levels of complexity makes it difficult to objectively compare their usability and value to those living with quadriplegia. The results of our research confirmed this, indicating every individual has specific needs related to their desires and level of function so it is impossible to say one type of device is best suited for all individuals. Practitioners must actively seek out information regarding new technology options and be prepared to share that information with their clients. The table below details several of the assistive devices used in the research studies we selected.

Summary of Devices and Efficacy of Each by Level of Injury or Diagnosis:

Spinal Cord Injury					
Name of Device	**Purpose**	**Findings**	**Level(s) of SCI or other Dx**	**Author**	**Notes**
Eyebrow Switch	To develop an eyebrow controlled switch to increase independence in more severely disabled individuals.	The system shows promise. They found that there are distinguishable accelerometer signals from eyebrow movement, but further studies need to be done to assess its effectiveness with disabled individuals.	C1-C4 SCI (but primarily tested on an able-bodied individual)	Yeung, M., & Chau, T. (2017)	They have a preliminary device design but it is not available for purchase.
The Tongue Drive System (TDS)	Used to access a personal computer and drive a powered wheelchair	Participants preferred devices that were the least noticeable (retainer over headset and injection over tongue piercing) About 50% of participants said TDS was easy to access. 50% of participants found TDS to be more effective than sip-and-puff and other current AT.	C2 - C6 SCI	Kim et al. (2014)	TDS is a functional prototype, but not currently available for purchase.
Tobii Eyegaze C15 System	ETCS for computer access and communication ability	Although the ETCS was easy to use, there were no substantial improvements in independence for clients	C2-C5 SCI	Van Middendorp et al. (2015)	Tobii Dynavox no longer sells the C-series
HAL®-SJ	Restore active elbow flexion	Able to contract both biceps voluntarily	C4 SCI (complete)	Shimizu et al. (2017)	Commercially available, but pricing & additional info only available for medical institutions/welfare organizations
TAPit	Internet use for access to information and communication	The TAPit allows individuals with quadriplegia to perform meaningful tasks	C4 SCI (incomplete)	Verikios et al. (2015)	Cost starting at $16,995.00 ("The TAPit," n.d.)

		such as reading online, independently making Skype calls, and operating the television			
QuadJoy	Mouth-operated joystick (sip & puff) computer mouse	Provides independence in online access & communication via the internet	C4 SCI (complete) C4/5 SCI (complete)	Folan et al. (2015)	Cost starting at $1,398.60 ("QuadJoy Package," n.d.)`]
Dragon Voice Activation	Internet Use, Typing Letters	Increase in typing speed, independence with computer use and composing messages	C4 SCI (complete) C4 SCI (incomplete) C5 SCI (complete) C5 SCI (incomplete)	Folan et al. (2015)	Cost starting at $150 ("Dragon Home," 2018)
Fabric-based soft robotic glove	Manipulate objects	Improved manipulation in ADL tasks	C4-C7 SCI	Cappello et al. (2018).	Updated design; not commercially available
Toyra® Virtual Reality System	Increase arm function, satisfaction with VR system	High satisfaction reported by all participants; upper limb function results were similar to conventional-therapy-only group	C5-C8 complete SCI	Dimbwadyo-Terrer et al. (2016)	Sales model is adapted to each individual's needs; price varies based on services required ("Toyra Sales Model," n.d.)
Custom Virtual Keyboard	Dynamic on-screen keyboard	The dynamic keyboard reduced text-input speed by 37%	Cervical-level SCI; Myopathy; Locked-in Syndrome; Tetraplegia	Pouplin et al. (2014)	The custom virtual keyboard used in this study was developed by the research team and is available free of charge
Sibylle	Word-prediction system	The addition of word prediction had no effect on text input speed	Cervical-level SCI; Myopathy; Locked-in Syndrome; Tetraplegia	Pouplin et al. (2014)	Purchasing information unavailable
Other or Unknown Diagnoses					
EMOTIVE EPOC+	Investigate usability of BCI as AT and use of BCI to access AAC software after 4 weeks of BCI training.	The participant in this study was able to control her AAC device using the BCI, but it took much more time than when she uses her head wand.	Spastic quadriplegic cerebral palsy	Taherian et al. (2016)	Emotive EPOC is a brain computer interface (BCI). It is a commercially available 14-channel headset. It costs $799.99 ("EMOTIV EPOC+ 14 Channel Mobile EEG," n.d.)

ITCI	Typing, computer use, game accessibility	Individuals with tetraplegia were able to perform typing with the ITCI; design of the system aesthetically desirable as it is fully intraoral and discreet	Individuals with tetraplegia	Andreasen-Struijk, Lontis, et al. (2017)	Unavailable to consumers
ITCS	Control assistive robotic arm for ADLs	Individual with tetraplegia was able to use tongue interface to control robotic arm without long-term training or personal assistance.	Tetraplegia	Andreasen-Struijk, Egsgaard-Lindhardt, et al. (2017)	Tongue interface used in study unavailable.Similar models (iTongue) commercially available; purchasing information not found.

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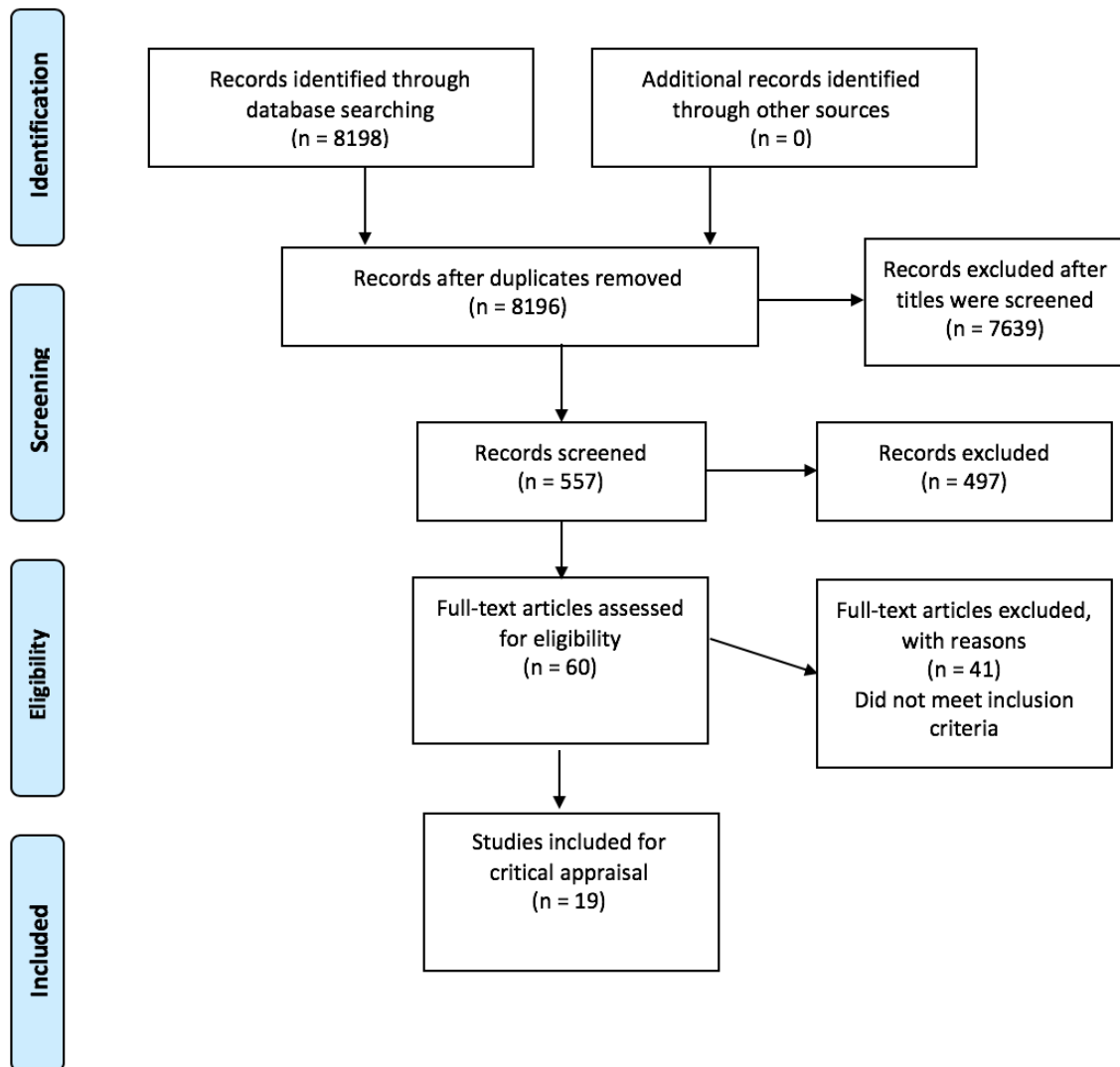
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PRISMA 2009 Flow Diagram

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┌─────────────────────────────┐      ┌─────────────────────────────┐
│ Records identified through  │      │ Additional records identified│
│    database searching       │      │    through other sources    │
│        (n = 8198)           │      │         (n = 0)             │
└─────────────────────────────┘      └─────────────────────────────┘
              │                                    │
              ▼                                    ▼
       ┌──────────────────────────────────┐       ┌─────────────────────────┐
       │ Records after duplicates removed │──────▶│ Records excluded after  │
       │          (n = 8196)              │       │   titles were screened  │
       └──────────────────────────────────┘       │       (n = 7639)        │
              │                                    └─────────────────────────┘
              ▼
       ┌──────────────────────┐       ┌─────────────────────────┐
       │  Records screened    │──────▶│    Records excluded     │
       │     (n = 557)        │       │       (n = 497)         │
       └──────────────────────┘       └─────────────────────────┘
              │
              ▼
       ┌──────────────────────┐       ┌─────────────────────────┐
       │ Full-text articles   │       │ Full-text articles      │
       │ assessed for         │──────▶│ excluded, with reasons  │
       │ eligibility          │       │      (n = 41)           │
       │    (n = 60)          │       │ Did not meet inclusion  │
       └──────────────────────┘       │      criteria           │
              │                       └─────────────────────────┘
              ▼
       ┌──────────────────────┐
       │ Studies included for │
       │  critical appraisal  │
       │      (n = 19)        │
       └──────────────────────┘
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Identification | Screening | Eligibility | Included

Involvement Plan

Introduction

On February 15th, 2019, a meeting was conducted with our group's collaborators in order to present the final CAT table and discuss options that would allow us to help them utilize the information within. Due to the nature of this research project and the collaborators' desire to share this information with as many of their patients as possible, it was decided that a binder detailing the devices included in the CAT would be most useful. Included in the binder was the name, photo, purpose, cost, and purchasing information for the devices. Many devices in our CAT are not commercially available so they were not included in the binder; however, a master list of manufacturers serves as a resource for staying current on devices that are updated, outdated, or up and coming. The intended audience is clinicians in addition to clients with high level spinal cord injuries and their families.

Due to the rapid, ever-changing nature of technology, there were a number of commercially available devices that did not have research demonstrating their effectiveness. Our collaborating practitioners requested devices without evidence backing also be included in the binder. The binder was divided into three sections: devices that support environmental control, devices that support computer access, and safety. There is also a restoring function section in the CAT. However, it was decided that devices of these nature, such as passive range of motion machines, would not be included in the binder because these devices are designed to restore function and are typically used as a treatment method in a therapy setting rather than by the individual in their home.

In addition to the binder, an in-service was held for the rehabilitation practitioners at the facility, including occupational and physical therapists. This session provided us an opportunity

to present the binder to the practitioners, explain how and why they might use it, and allowed them time to ask questions.

Context

Prior to implementation, it was considered that knowledge translation could be affected by several different types of contextual factors. On the organizational level, it would have been difficult to collaborate with each and every department due to the large size of the facility. Due to the nature of this research project, we collaborated with the rehabilitation department specifically.

On the departmental level, we considered knowledge integration regarding the assistive technology (AT) binder throughout the entire rehabilitation department. We attempted to mitigate this by holding an in-service as a means to introduce the binder's contents as well as present background information such as our research question and a brief summary of the research process. The in-service was held during the facility's lunch hour, however, the schedule of the practitioners was a deciding factor in scheduling the date of the in-service and not every practitioner was able to attend.

On an individual level, we could not be sure of the AT binder's applicability to each discipline in the rehabilitation department. Occupational therapy practitioners knew it would be a valuable tool for patient education, however, it depended on the personal preference of the individual occupational therapist as to whether they chose to present this resource to their clients. It is not clear if other disciplines on the rehabilitation team, such as physical and speech therapy practitioners, have utilized the AT binder in their work. However, because they were invited to the in-service, they may now know about the binder as a resource.

Additionally, the contents of the binder were primarily intended for individuals with high level spinal cord injuries. Due to their injury, these clients may not be able to independently turn the pages of the binder without assistance from another individual. This may be a barrier that prevents this resource from reaching a large part of its intended audience - the clients and consumers themselves. However, in order to make the information accessible to as many clients and family members as possible, the binder was designed with the widespread levels of cognition and health literacy knowledge in mind. This was done by using patient-friendly language at approximately a sixth-grade reading level, with large font, and a clean and consistent format. Assistive technology is complex. By organizing and condensing the information into a binder, we made the information easier to access and more digestible.

Monitoring Outcomes

Our intended outcome was to provide rehabilitation therapists and clients with high level spinal cord injury with a means to access information about potential assistive technology devices that can support them in functional tasks. To evaluate the outcome of the AT binder, we administered two surveys to the practitioners. The initial survey was given after we presented the background of our research study and the AT binder at the in-service presentation. The first survey was interested in the value of the information we provided and how likely they are to use the binder with current and future clients. We sent a follow-up survey on 4/22/19 to gather information and feedback regarding how often and in which manner the practitioners have used the AT binder with their clients.

Tasks/Products and Target Dates

Task/Product	Deadline	Steps with Dates to Achieve Final Outcome
Binder of AT devices with photo, what the device is, its purpose, the cost, and where to find more information.	3/24/19	1. Locate devices to be included (3/10) 2. Divide up devices amount group members (3/11) 3. Create table of contents/index (3/23) 4. Assemble binder (3/24)
In-service to introduce the AT binder to practitioners	4/5/19	1. Put together PowerPoint presentation (3/31) 2. Create initial paper survey to monitor outcomes (3/28)
Develop follow-up survey to evaluate outcomes	4/19/19	1. Create and send online follow up survey to attendees

Knowledge Translation

We conducted two knowledge translation activities that involved the creation of an assistive technology binder as a resource for the facility, and an in-service to present and introduce the binder to our collaborators and their colleagues at Good Samaritan Hospital in Puyallup, Washington.

Assistive Technology Binder

It was decided with our collaborators that a binder of available assistive technology would be the most useful way for them to access and share our research with their clients and other members of the rehabilitation team. Because our systematic review identified a limited number of hardware/software options, some did not have positive outcomes, and not all were commercially available, our collaborating practitioners requested that we also include commercially available assistive technology that did not have evidence to back it. They also requested that we exclude the devices categorized as restoring function because these devices would typically be used in a clinic setting rather than by the individual in their home. At this meeting, we provided a sample page of what a page in the binder could look like to get feedback from the collaborators. After viewing the sample page, it was decided that each page would feature the following items in this order: the product logo, a photo of the product, a description of what the product is, its purpose, the cost, and a web link to find additional information. The font would be at least size 18 with a reading level of 6th grade or lower to make it useable by a greater number of individuals. Each page would be single sided and placed in a page protector to allow for easy removal to photocopy or replace if technology becomes outdated or updated.

Internet searches were conducted in order to find additional assistive hardware/software not previously identified in our research to aid individuals with quadriplegia in functional tasks.

This resulted in the final binder including a total of 49 assistive technology options. The binder was divided into three main sections: devices that support environmental control, devices that support computer access, and safety. The section on devices that support environmental control contains 29 assistive devices and is further subdivided into 10 subcategories: environmental control units and smart hubs, smart speakers, communication devices, door locks and video doorbells, fans and heaters, garage door openers, lights, smart home product manufacturers, thermostats, and window coverings. The section on devices that support computer access contains 19 assistive devices and is further divided into 7 subcategories: hands-free computer access and dictation, hands-free mice, smartphone/tablet access, hands-free video game controllers, mouth sticks, on-screen keyboards, and accessible computers. The safety section contains one device, so it was not further divided into subcategories.

In order to make it easier to compare similar devices, a table is presented at the beginning of each subcategory listing the names, a short description, manufacturer name, and price of each device included in that subcategory. Following the safety section of the binder is a table that lists a portion of the many devices compatible with the top three smart speakers - Amazon Echo, Google Home, and Apple Home Kit. The table includes the name of the product or app, how voice control works with it, and a weblink to find more information. As we searched for additional technology to include in this binder, we found that a great number of the apps/devices were compatible with smart speakers, so we decided it was important to include this table. Due to the rise in popularity and everyday use of voice-controlled smart speakers, the number of devices and apps compatible with them has grown at a rapid rate and continues to do so.

Next, is a product manufacturer list for all products included in the binder with a link to each manufacturer's website. This feature was included to assist with keeping the binder up to date. By having all manufacturers in one central location it makes checking manufacturers websites for updates on products in the binder and identifying new products to add to the binder faster and easier.

The final feature in the binder is a resource section. It includes both local and online resources for a variety of information needs such as selecting appropriate assistive technology, funding for assistive technology, programs that assist with trialing devices, home modifications, resources for setting up already existing accessibility features on smartphones and computers, along with a variety of other things. We understand that there is a significant amount of effort and decision making involved in acquiring assistive technology, more than simply having a desire to use it. Therefore, we felt it was important to provide additional resources that individuals may find as a helpful starting point.

Throughout the process of creating this binder we encountered some difficulties. Since we were including devices that were not backed by the evidence it was challenging to know when to stop searching for technology to add to the binder. We also found that with the rise in popularity of smart homes and smart technology there is a larger number of manufacturers of similar smart products than in the past. Ultimately, we stopped adding additional technology once we were unable to locate additional devices or had a few of a similar type of device included. While we know we do not have an exhaustive list of all assistive technology available to support individuals with quadriplegia in functional tasks, we do feel that it is a very good starting point to demonstrate to client's and their family what is available.

Another difficulty encountered was locating information about purchasing or downloading information for devices and software included in the systematic review. For example, one article (Pouplin et al., 2014), looked at custom virtual keyboards and stated they were available free of charge, but there was no information provided about how to access them. Other devices included in the systematic review were prototypes, not commercially available, no longer sold, or only available for purchase from medical institutions. This limited the number of devices from our systematic review that we were able to include in the binder to four.

In-Service Presentation

Following the creation of the binder, our group developed a PowerPoint presentation to present to our collaborators and other individuals on the rehabilitation team who chose to attend our in-service. In order to prepare for this in-service, we reviewed the latest version of our CAT paper to pull out the most noteworthy elements of our research to briefly highlight at the beginning before delving into the specifics of the binder. We then introduced the binder and covered relevant features of the binder as well as our thoughts on the potential use and impact it could have. We introduced the three main sections, two of which were divided further into subcategories, and provided an example of a device page and a summary table page. Next, we discussed the table on devices compatible with smart speakers and why we felt this was an important section to include. Last, we reviewed the resource section and discussed some of the local options we had included in this list to ensure practitioners were aware of these local resources available to their clients. At the end of the in-service a survey was handed out to assess attendees' opinions on potential usefulness of this binder as resource for their clients.

Outline of scheduled dates of completion

Task/Product	Deadline Date	Steps with Dates to achieve the final outcome	Deadlines Met?(Y/N)
Create binder of AT devices with photo of device, what the device is, its purpose, the cost, and where to find more information.	3/24/19	1. Meeting with collaborators to discuss knowledge translation - 2/16 2. Meeting with Dr. Tomlin re: knowledge translation - 2/5 3. Locate devices to be included in binder - 3/10 4. Divide up devices among group members - 3/11 5. Create table of contents/index - 3/23 6. Send draft of binder to Dr. Tomlin for feedback - 3/25 7. Assemble binder - 4/3	Y
Inservice to introduce the AT binder to practitioners	4/5/19	1. Contact collaborators to set date for in-service 2. Put together PowerPoint presentation - 3/31 3. Send draft of PowerPoint to Dr. Tomlin for feedback - 4/30 4. Create survey to monitor outcomes, send to Dr. Tomlin for feedback - 3/28 5. Present binder at in-service - 4/5	Y
Develop follow-up survey to evaluate outcomes	4/19/19	1. Create and send follow up survey to Dr. Tomlin for feedback - 4/19 2. Create follow up survey - 4/22 3. Send follow-up survey reminder to attendees - 4/24	Y

Statement of Outcome Monitoring

In order to monitor the outcome and effectiveness of the assistive technology binder at Good Samaritan Hospital we conducted two surveys. The first was given immediately after the in-service, where we also collected the names and email addresses of the attendees. The follow-up survey was sent out via email 17 days later, using an online survey tool. A follow-up reminder email was sent 2 days after the initial email was sent. A thank you email was also sent to respondents of the online survey.

The initial survey focused on the value of the in-service, likelihood of potential use of the binder, and whether the practitioner had a current or past client that could benefit from its use. Refer to Appendix C to view initial survey. The follow-up survey focused on whether the practitioner had looked at/used the binder, how useful it has been for them, and their reasoning if they had not used it. There was also room for qualitative feedback at the end. Refer to Appendix D to view follow-up survey.

Evaluation of Outcomes

A survey was distributed immediately after the in-service on April 5, 2019 at Good Samaritan Hospital in Puyallup, Washington. Eleven rehabilitation practitioners attended the in-service: five occupational therapists, five certified occupational therapy assistants, and one physical therapist. Eleven completed surveys were returned.

The survey sought to evaluate the perceived value of the in-service and assistive technology binder, whether practitioners currently had a client who would benefit from the binder or have had a past client who would benefit, and the likelihood of binder utilization in the future. Overall, feedback was positive. On a scale from one to ten, one being not valuable at all and ten being highly valuable, responses averaged 8.2 to the question of whether the in-service provided valuable information.

Seven of the eleven respondents indicated they currently had a client who would benefit from the assistive technology binder. Every respondent indicated they have had a client in the past who would have benefited from the binder.

On a scale from one to five, one being not likely at all and five being very likely, responses averaged 4.9 to the question of, "How likely is it that you will have a client in the future who would benefit from the assistive technology binder?" Using the same scale, the question "How likely are you to use the assistive technology binder as a resource with future clients?" received an average response of 4.6.

An online follow up survey was distributed about two weeks later via email to the ten practitioners who had been present at the in-service and had provided their email on the check-in form. The email invitation to the survey was sent out on April 22, 2019 and an email reminder to complete the survey sent on April 25, 2019. The follow up survey sought to identify whether the

assistive technology binder had been used in practice, whether it was perceived as a useful resource, and the likelihood of the practitioner giving it to a future client.

Despite our sending an email reminder to complete the survey, response to the survey was limited, with only three responses being submitted out of the ten email requests. For this reason it is impossible to generalize the data as being true for all practitioners who were present at the in-service.

Results of the online survey were mixed; two of the three respondents reported they had had time to look at the binder, however none of the respondents indicated they had presented the binder to a client. Two reported they had not had a client with quadriplegia since receiving the binder at the in-service, and one respondent indicated the client with quadriplegia they provided services to was not interested in exploring assistive technology options. All three respondents answered "Yes" to the question of whether they predicted they would have a future client who would benefit from the binder.

It would be beneficial to develop a second online follow up survey to gauge utilization of the assistive technology binder to determine if it is a useful tool for practitioners in this setting. Additional email reminders and phone contact may increase the likelihood of higher response rates. However, due to time constraints, this will not be possible.

Analysis of Overall Project Process

We had opportunity to collaborate with practitioners in the community, Sonia Nurkse, OTR/L and Bridget Tanner, OTR/L, with the support and guidance of our chair and mentor, George Tomlin, PhD, OTR/L, FAOTA. The yearlong process involved: identifying search terms and inclusion/exclusion criteria to conduct a review of the literature, carefully screening articles for relevance and eligibility, critical analysis of selected articles to determine implications and conclusions, collaborating with our practitioners and chair to create and deliver a meaningful knowledge translation product, and measuring the outcome of our product.

Throughout this endeavor we encountered a few challenges due to the rapid and ever evolving nature of our topic on technology. The first task was determining a cutoff date for including articles. We decided to exclude articles published before 2014, with the hope that this would limit the inclusion of technology that is now out of date.

The second challenge was due to the vast array of available devices. This made it difficult to conclude that any single device is the most effective, considering each client presents with unique needs, abilities, and preferences. After meeting with George, it was decided the most practical way to present these findings was to develop a summary table highlighting the features of the devices. To do so, we organized the findings into 3 categories: devices that support computer access/typing, devices that support environmental control, and devices that restore function.

The third challenge we encountered had to do with the knowledge translation portion of this project and creating a product that would be of use, despite our limited findings. Our discussions with George, Sonia, and Bridget led us to the decision that we would create a compilation of assistive technology devices that are both backed by research and those that are

not. During the creation of this binder we had to problem-solve how to design it so that the

information is easily understood, shareable, and updated. To address these considerations, we

ensured the binder had 1) a consistent layout 2) summary tables for cross-referencing 3) plastic

sheet coverings so pages could be easily removed for photocopying or removed for updating, and

4) a master list of manufacturers and resources.

We presented the binder at an in-service and delivered two follow-up surveys, two weeks

apart, to measure outcomes. The first survey, delivered immediately after the in-service, had a

100% response rate. However, the second survey was sent via email to the attendees and despite

reminder emails, we had a low response rate.

Overall, the process taken to address this question was time consuming and yet

rewarding, knowing our findings would potentially have an impact on the services provided by

practitioners at Good Samaritan Hospital and the quality of life of their clients. Although the

topic we were assigned to address was not initially of interest to any us, it was enlightening to

see how we each gradually became more invested in this subject area. The process of conducting

this research project has been a valuable learning experience that has led to a growth in both our

understanding of and appreciation for evidence-based practice. This project also allowed us the

opportunity to practice and understand the importance of open communication, individual

accountability, and group decision making. These skills will support our success as effective

team members in each of the settings we end up in as future occupational therapists.

Recommendations for Feasible Follow-On Future Projects

Recent research on commercially available assistive technology to support individuals with quadriplegia in functional tasks was limited. Future research should focus on exploring the effectiveness and levels of satisfaction with commercially available assistive technology. All technology included in our systematic review was unfamiliar to us, as a majority of it was either a prototype created specifically for the study or not commercially available. It could also be beneficial for future research to explore commonly used and well known devices such as Amazon Echo or Philips Hue, as they are used by a wider variety of individuals, more readily available and therefore may be more likely to be purchased.

When conducting searches for assistive technology to include in our assistive technology binder we found many manufacturers creating devices that do the same things. For example, there are five hands-free computer mice included in the binder. Each works slightly differently, but they all allow individuals with quadriplegia to access the computer. Because there are so many devices that all complete similar tasks and functions, it could be beneficial for future research to compare devices in order to assist individuals in selecting a device that best fits their needs.

Many of the devices included in the assistive technology binder are smart home devices. Because smart homes are currently so popular amongst all individuals, able bodied and disabled, the number of manufacturers and compatible products available is increasing rapidly. If conducting research to compare these devices, it would be imperative to conduct it with individuals with quadriplegia and differing levels of abilities, in order to ensure the findings are applicable to a broad range of individuals.

When conducting our review, we contacted assistive technology product manufacturers in hopes that they would be able to provide us with outcome research related to their products. Unfortunately, none of the manufacturers contacted provided us with any relevant research. One manufacturer was interested in contacting our collaborating practitioners to arrange for a trial of the device in the hospital. If assistive technology product manufacturers are willing to do this in the future, a future project could be to trial specific assistive devices with clients being seen in the hospital to gather data on effectiveness of the technology, ease of use and satisfaction. If trialing multiple devices used for similar purposes, devices could also be compared.

Appendix A

Assistive Technology

Prepared for Multicare Good Samaritan Hospital

Created by Bri Brown, OTS, Natalie Geisler, OTS, and Hannah Terranova, OTS

University of Puget Sound, School of Occupational Therapy

Table of Contents

Devices that Support Environmental Control

Environmental Control Units & Smart Hubs

Device Name	Description	Manufacturer	Cost (as of April 2019)
autonoME Residential Package	Environmental Control Unit	Accessibility Services, Inc.	unknown
Insteon (Comfort Home Automation Starter Kit)	Device connects to smartphone/tablet to control smart devices in home	Insteon	$119-199
MEDIAssistant MM115	Control of electrical & electronic devices	Convergence Concepts	$5,995
Relax IR Remote	Switch accessible TV remote	Ablenet	$425.00
SmartThings Hub	A hub that wirelessly connects to a range of smart home technology	Samsung	$69.99
Tecla-e	Connect and control up to 8 devices by activating a switch	Tecla	$499
Wink Hub 2	A hub that wirelessly connects to a range of smart home technology	Wink	$99

autonoME ECU/SGD tablet   All in One microphone/
                                     sip and puff system

Floorstand   autonoME
                                  command center

What is it? An environmental control unit that enables individuals with physical disabilities greater independence.

Purpose: The autonoME residential package allows individuals to control their environment using either voice, switch, eye, touch or mouse access. Some of the things this device enables users to do include send text messages, access the internet, turn lights on/off, operate the TV, open door, and adjust blinds. Accessibility Services, Inc. technician comes to purchaser's home to assist with set-up and training with new device.

Cost: Price is not listed. Website offers option to request a quote.
More Information: https://asi-autonome.com/product/autonome-residential-package/

What is it? Insteon hub device that connects to compatible devices (sold separately). Insteon Comfort Home Automation Starter Kit includes hub, two dimmer modules, & thermostat.

Purpose: Connects to smartphone/tablet to allow user to control aspects of environment - thermostat, light switches, garage door, outlets, etc.

- Compatible with Android, iOS, Amazon Alexa & Google Assistant for voice control

Cost: Starter kit $119-199, Insteon hub $79.99

More Information: https://www.insteon.com/insteon-hub

What is it? Portable environmental control unit / electronic aid to daily living

Purpose: This device can be mounted various ways to allow the user to control electrical and electronic devices throughout the home or office - TVs, DVD players, cable/satellite boxes, lights, fans, door openers, and thermostats. It can be operated via touch, voice, switches, or head tracking & connected to larger monitor via HDMI. Users can also access the internet, play computer games, and send/receive emails - all hands free if necessary.

Cost: $5,995.00

More Information:
http://www.convergenceconcepts.com/pdfs/MEDIAssistant%20Mobile%20Brochure.pdf

Relax

What is it? Infrared accessible learning remote

Purpose: Uses light touch or connected with a switch device to provide simplified control of up to 8 functions on almost any infrared device. It is easily programmable and mountable.

- Compatible with most infrared devices

Cost: $425.00

More Information: https://www.ablenetinc.com/technology/connected-home/relax#Description

What is it? A hub that a wide range of smart devices can be connected to.

Purpose: By connecting a variety of smart devices to one hub it allows the devices to work together. User can control connected smart devices using the SmartThings smartphone app or using voice control on a compatible device.

- Compatible with Amazon Alexa, Google Assistant, and a variety of smart devices (lights, switches, outlets, sensors, cameras, doorbells, door locks, thermostats, speakers, etc. - refer to website below for specifics).

Cost: $69.99

More Information: https://www.smartthings.com/gb/

What is it? tecla-e is an assistive device that allows individuals with upper extremity impairments and limitations to access technology and smart devices.

Purpose: Control up to 8 devices by activating a switch. Some of the things tecla-e allows users to do include send/receive emails and text messages, browse the internet, watch videos, use apps, read, turn on TV, control thermostat, turn lights on/off, and make calls.

- Compatible iPad, iPod Touch, iPhone and Android phones, Mac and Windows computers, Apple TV and with all adaptive switches.

Cost: $499.00

More Information: https://gettecla.com/products/tecla-e

What is it? A hub that a wide range of smart devices can be connected to.

Purpose: By connecting a variety of smart devices to one hub it allows the devices to work together. User can control connected smart devices using the Wink smartphone app or using voice control on a compatible device.

- Compatible with an Amazon Alexa, Google Assistant, and a variety of smart devices (lights, switches, outlets, sensors, cameras, doorbells, door locks, thermostats, speakers, etc. - refer to website below for specifics on compatible devices).

Cost: $99.00

More Information: https://www.wink.com/products/

Smart Speakers

Device Name	Description	Manufacturer	Cost
Amazon Echo	Smart Speaker	Amazon	$49.99 - 299.99
Apple HomeKit	App that allows user to control all HomeKit accessories.	Apple	App: free HomePod: $349 (not req)
Google Home	Smart Speaker	Google	$49 - 399

What is it? A voice controlled smart speaker. There are four versions: Echo Dot, Echo, Echo Plus and Echo Show.

Purpose: This smart speaker, using Amazon Alexa, can be used to complete a wide variety of tasks and is compatible with many devices and apps (see page 69 for more information on compatible devices and applications). Some uses include playing music, making calls, sending messages, setting timers/alarms, setting reminders, making lists, and controlling smart home devices.

Cost: $49.99 - $229.99

More Information: https://www.amazon.com/all-new-amazon-echo-speaker-with-wifi-alexa-dark-charcoal/dp/B06XCM9LJ4

Doorbell Cam Pro

What is it? A Smart doorbell with video monitoring

Purpose: With live streaming through the app, users can use this device to see and speak with guests at the front door through their smartphone. A motion detection feature sends instant notifications, replay feature shows you visitors you may have missed, and floodlight feature to light up the video at night. Can be synced with August Smart Lock for additional benefits. Requires Wi-Fi signal.

- Compatible with Android & iOS smartphones

Cost: $199.00

More Information: visit
https://august.com/products/august-doorbell-cam-pro

Smart Lock

What is it? A Smart Lock device that attaches to an existing deadbolt & syncs with app for smartphone use

Purpose: Through the smartphone app, users can lock/unlock their door, create virtual keys for guests, and monitor who comes & goes. Auto feature automatically locks and unlocks the door as you enter / exit your door.

- Compatible with Android & iOS smartphones

Cost: $149.00

More Information: visit https://august.com/products/august-smart-lock-connect

What is it? A Wi-Fi enabled doorbell; several models are available - pictured is the basic model.

Purpose: Lives audio & video stream of doorstep to allow users to see & speak with visitors through free smartphone app. It can also detect motion, monitor with infrared night vision, and send notifications to your device for security purposes. Works on any home, with or without existing doorbell wires.

- Compatible with Amazon Alexa, Android, iOS, Mac & Windows 10

Cost: $99.00

More Information: https://shop.ring.com/pages/doorbells

Fans & Heaters

Device Name	Description	Manufacturer	Cost
Dyson pure hot + cool	Air purifier + fan + heater	Dyson	$649.99
Hunter Ceiling Fans with SIMPLEconnect Wi-Fi	Control light, turn fan on/off, and adjust speed using voice.	Hunter Fan	$249.99 - 349.99

What is it? An air purifying fan and heater. Choose to either heat or cool a room while also purifying the air.

Purpose: Heat/Cool/Purify areas of the home. Using the Dyson Link smartphone app air quality can be monitored and fan can be turned on/off.

- Compatible with Amazon Alexa allowing for voice control operation of device.

Cost: $649.99

More Information: https://www.dyson.com/purifiers/dyson-pure-hot-cool-hp04-white-silver.html

What is it? A Wi-Fi connected ceiling fan.

Purpose: The Hunter SIMPLEconnect Wi-Fi collection allows users to control their ceiling fans using an integrated remote control or using voice control on a compatible device.

- Compatible with Amazon Alexa, Google Assistant and Apple HomeKit allowing for voice control operation of device.

Cost: $299.99 - $349.99

More Information: https://www.hunterfan.com/ceiling-fan-smart-home

Garage Door Openers

Device Name	Description	Manufacturer	Cost
LiftMaster myQ Garage Door Openers	Control garage door & monitor activity status via smartphone	LiftMaster	$250+
myQ Chamberlain Smart Garage Door Opener	Control garage door & monitor activity status via smartphone	Chamberlain	$179-338

What is it? A Wi-Fi enabled garage door system. Many models are available.

Purpose: Used with myQ smartphone app to open/close, monitor, turn on lights, and receive activity alerts from anywhere.

- Compatible with Google Assistant, Apple HomeKit, and IFTTT allowing hands-free voice control of garage door and lights.

Cost: $250+

More Information: https://www.liftmaster.com/myq/myq-smart-home

CHAMBERLAIN.

myQ Smart Garage Door Opener

What is it? A Wi-FI enabled garage door system. There various models available, pictured is the lowest cost option, the C450 Durable Chain Drive Wi-FI Garage Door Opener.

Purpose: Used with myQ smartphone app to open/close, monitor, turn on lights, and receive activity alerts from anywhere. Can be synced with other smart devices and platforms.

Cost: $179-338.00

More Information: https://www.chamberlain.com/garage-door-openers/c/smart-garage-door-openers?q=%3A%3Acategory%3Asmart-garage-door-openers

Lights

Device Name	Description	Manufacturer	Cost
Philips Hue	Smart light bulbs	Philips	$14.99+
Vocca Pro Smart Light	Voice activated light bulb	Vocca	$78.77

What is it? Smart light bulbs, light strips and light fixtures

Purpose: Download the Philips Hue app and control lights and set up schedules from the app or use voice control with Amazon Alexa, Google Assistant, or Apple HomeKit to control Philips Hue smart lights throughout the home.

- Compatible with Amazon Alexa, Google Assistant and Apple HomeKit.

Cost: Bulbs start at $14.99; Bridge is $59.99

More Information: https://www2.meethue.com/en-us

What is it? A smart light bulb adapter

Purpose: Once any light bulb is screwed in & adapter is connected to a light socket, the user can use their voice to activate and control the light. With a smartphone app, set your voice trigger & schedule on/off times. Easy installation & set up, does not require Wi-Fi.

- Compatible with most light bulbs

Cost: $78.77

More Information: https://www.amazon.com/Vocca-Pro-Light-Activated-Triggers/dp/B018QS3P68

Smart Home Product Manufacturers

Device Name	Description	Manufacturer	Cost
Kasa Smart Products	Smart home products - video doorbell, lights, light switches, security cameras, and smart plugs.	TP-Link	$15 - 130
WEMO Smart Home Products	Smart Plugs and light switches	Belkin	$34.99-79.99

What is it? Smart home products. Products include a video doorbell (coming soon), cameras, lights, light switches, and smart plugs.

Purpose: Control lights and appliances and monitor home from the Kasa Smart smartphone app or using voice control on a compatible device.

- Compatible with Amazon Alexa and Google Assistant

Cost: $15 - $130

More Information: https://www.kasasmart.com/us/products

What is it? Smart home products: smart plugs, light switches, and dimmers.

Purpose: Control lights and small appliances like lamps, fans, heaters, humidifiers, Christmas lights, coffee pots, etc. from WEMO smartphone app or using voice control with compatible devices.

- Compatible with Amazon Alexa, Google Assistant, IFTTT and Apple HomeKit (Bridge - $39.99 - is required for use with Apple HomeKit)

Cost: $34.99 - $79.99

More Information: https://www.wemo.com/products/

Thermostats

Device Name	Description	Manufacturer	Cost
ecobee4	Smart Thermostat + Alexa	ecobee	$249
Honeywell T5+ Smart Thermostat	Smart Thermostat	Honeywell	$149.99
Nest Learning Thermostat	Smart thermostat	Nest	$249

What is it? A smart thermostat with built in Amazon Alexa and a room sensor.

Purpose: ecobee4 helps individuals save energy by heating and cooling the home based on the schedules of the individuals living in the home. Temperature can be monitored in different area than thermostat with room sensor. Change temperature remotely using the smartphone app. Built in Alexa adds additional voice-controlled features such as setting timers, making lists, playing music, finding recipes, etc.

- Compatible with Amazon Alexa, Google Assistant, Apple HomeKit, SmartThings and IFTTT.

Cost: $249

More Information: https://www.ecobee.com/ecobee4/

What is it? A smart thermostat that learns and adapts to the individual or family's routines or can be programmed with a schedule.

Purpose: Helps individuals save energy by heating and cooling the home based on the schedules of the individuals living in the home. Temperature can be monitored and changed remotely using the smartphone app.

- Compatible with Amazon Alexa, Google Assistant, Apple HomeKit and SmartThings allowing for voice control of thermostat.

Cost: $149.99

More Information: https://www.honeywellhome.com/T5-Smart-Thermostat-RCHT8612WF

What is it? A smart thermostat that learns and adapts to the individual or family's routines and can be operated using the Nest smartphone app.

Purpose: The Nest Learning Thermostat helps individuals save energy by heating and cooling the home based on the schedules of the individuals living in the home. Temperature can be monitored and changed remotely using the smartphone app.

- Compatible with Amazon Alexa and Google Assistant allowing for voice control of thermostat.

Cost: $249

More Information: https://nest.com/thermostats/nest-learning-thermostat/overview/

Window Coverings

Device Name	Description	Manufacturer	Cost
MySmartBlinds Blinds	Horizontal blinds with automated tilt feature	MySmartBlinds	$270 (+ $89 for bridge for voice control)
MySmartBlinds Automation Kit	A device that can be installed on existing horizontal blinds to enable automated tilting of blinds	MySmartBlinds	$149 (+ $89 for bridge for voice control)
Serena Shades	Control window shades from smartphone app or using voice control w/ compatible device	Lutron	$400 - 1350

What is it? Horizontal blinds with automated tilt feature.

Purpose: Open and close blinds manually, using MySmartBlinds app, or with voice control using Amazon Echo or Google Home (MySmartBlinds bridge required for voice control).

- Compatible with Amazon Alexa and Google Assistant

Cost: $270; MySmartBlinds bridge $89

More Information: https://www.mysmartblinds.com/products/horizontal-blinds

What is it? A device that can be installed on existing horizontal blinds to enable automated tilting of blinds.

Purpose: Open and close blinds manually, using MySmartBlinds app, or with voice control using Amazon Echo or Google Home (MySmartBlinds bridge required for voice control).

- Compatible with Amazon Alexa and Google Assistant

Cost: $149; MySmartBlinds bridge $89

More Information: https://www.mysmartblinds.com/products/automation-kit

What is it? Customizable window shades that can be operated using smartphone app.

Purpose: Control window shades from anywhere with Lutron smartphone app or using voice control on compatible device.

- Compatible with Amazon Alexa, Google Assistant, Apple HomeKit, SmartThings, Wink, and IFTTT.

Cost: $400 - $1350. Lutron Smart Bridge($79.95) required in order to operate blinds from smartphone app or using voice control technology.

More Information:

https://www.serenashades.com/serenaadvantage/connected-home

Devices to Support Computer Access

Hands-Free Computer Access & Dictation

Device Name	Description	Manufacturer	Cost
Dragon NaturallySpeaking	Dictation, computer access using voice	Nuance	$150.00 +
EMOTIV EPOC+	Headset that senses brain waves, sending signals to computer for operation.	EMOTIV	$799
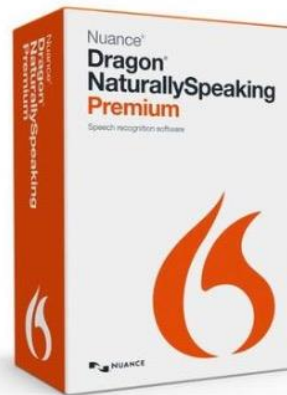
What is it? A speech recognition software package that also allows the user to edit and format text, click/drag/position the mouse by voice commands, and full text control within Chrome, Firefox, or Internet Explorer browsers

Purpose: Voice recognition in dictation, recognition of spoken commands, and text-to-speech

- Version 15 is compatible with Windows 7, 8, & 10
- For MacOS the software is called *Dragon for Mac*

Cost: Starts at $150.00

More Information: https://www.nuance.com/dragon.html

What is it? A headset with 14 sensors that rest on the user's head in order to send signals to a computer or smartphone.

Purpose: Allows individuals to operate a computer or smartphone using thoughts, emotions or facial expressions.

- compatible with Windows, Mac, iOS, and Android

Cost: $799

More Information: https://www.emotiv.com/product/emotiv-epoc-14-channel-mobile-eeg/

Hands-Free Mice

Device Name	Description	Manufacturer	Cost
GlassOuse V1.2	Glasses provide access to TV, smartphones & computers	GlassOuse	$499.00
QuadJoy	Sip & Puff Joystick Computer Mouse	QuadJoy	$1,368.60
SmartNav 4	Hands-free computer mouse controlled via head movements	Natural Point	$499
TetraMouse	Lip, chin, tongue operated mouse	TetraLite Products	$349.00
TrackerPro	Hands-free computer mouse controlled via head movements	AbleNet	$995.00

What is it? Wearable head mouse

Purpose: Slight head movements control cursor for access to smartphones, TV, computers, tablets via Bluetooth
- Compatible with Windows, macOS, Linux, Android, Chrome

Cost: $499.00

More Information: https://glassouse.com/

What is it? A Sip & Puff operated joystick computer mouse.

Purpose: Allows individuals without limb function to operate a computer using a mouth operated joystick.

- Compatible with Windows computers, Mac computers, and Android phones and tablets

Cost: Starting at $1398.60

More Information: https://quadjoy.io

What is it? SmartNav 4 is a hands-free computer mouse that uses an infrared camera to track head movements.

Purpose: Allows individuals with limited to no arm/hand use to independently operate a computer using head movements. The device also comes with a free on-screen keyboard. The system requirements for this device are a 500 MHz processor, a USB 1.1 or 2.0 port and a CD-ROM drive.

Cost: $499

More Information: http://www.naturalpoint.com/smartnav/products/4-at/
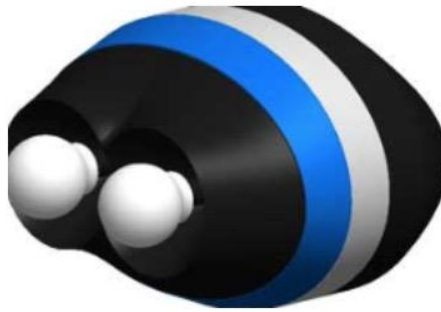
What is it? A hands free, high precision, full function mouth operated computer mouse.

Purpose: This mouse features dual joysticks and can be mounted to allow the user to access their computer with 5-8 button functions, scroll, and drag & drop functions. It can be operated by the lip, chin, tongue, fingers, or toes and comes in many color combinations.

- Compatible with any computer and operating system that supports a standard USB mouse

Cost: $349.00

More Information: https://tetramouse.com/tmxs.html

What is it? TrackerPro is a hands-free mouse that uses a camera and small reflective dot placed on the users head to track head movements.

Purpose: Enables individuals with little to no use of their hands to access a computer using small head movements and either two switches or dwell selection software. Both the switches and the software are sold separately.

Cost: $995.00

More Information: https://www.ablenetinc.com/technology/computer-tablet-access/trackerpro

Smartphone/Tablet Access

| Device Name	Description	Manufacturer	Cost
iOS Switch Control	Accessibility feature on iPhones supports access using a switch	Apple	Free
Open Sesame!	Hands free smartphone app for Androids	Sesame Enable	$19.99/mo
QwikList Voice	Voice controlled smartphone app for Androids	Shah Lab	$0.99

iOS Switch Control

What is it? Accessibility feature on iOS7+ smartphones

Purpose: Switches cannot be plugged directly into iOS devices, however the "Switch Control" feature acts as a hub, allowing users to use their switch to access nearly all aspects of their iPhone. It requires a switch & a Bluetooth Switch Interface, such as the Tecla Shield or Blue2.

- iPhone smartphones *only*; compatible with single and dual/multiple switches, joystick inputs, sip & puff.

Cost: Free; but must have a switch & Bluetooth Switch Interface

More Information: https://gettecla.com/blogs/news/15118049-siri-vs-ios-switch-control-for-hands-free-iphone-access
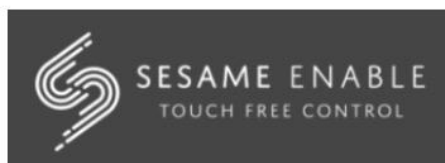
Open Sesame!

Android App

What is it? Hands-free Android app

Purpose: This app turns your Android phone or tablet into a touch free device, while still allowing for full control of the device by using head movements or voice commands.

- Android smartphones and tablets *only*

Cost: $19.99/month

More Information: https://sesame-enable.com/support/#vc_text_separator_2

QwikList Voice

Android App

What is it? Voice controlled Android app

Purpose: With this home screen app, you can add items to a list and events to your Google calendar, send texts, create reminders, scan items to a list using a barcode, and more - all with your voice.

using head movements or voice commands.

- Android smartphones *only*

Cost: $0.99

More Information:

http://www.androidzoom.com/android_applications/productivity/qwiklist-voice_crea.html

Hands-Free Video Game Controller

Device Name	Description	Manufacturer	Cost
QuadStick	Sip & Puff Joystick game controller, keyboard, mouse for video games	QuadStick	$449-549.00

Pictured: FPS Quadstick

What is it? Sip & Puff operated joystick - available in 3 models: original QuadStick, Singleton, and QuadStick FPS.

Purpose: Game controller, keyboard, and/or mouse to allow individuals without limb function to operate computers and play video games.

- Compatible with PS3, PS4, Nintendo Switch, Windows PC, Mac. Requires USB adapter for compatibility with Xbox 360/Xbox One.

Cost: $449-549.00 depending on model

More Information: http://www.quadstick.com/

Mouth Sticks

Device Name	Description	Manufacturer	Cost
Bendable Telescopic Mouth Stick	Pointer for keyboard or page turning or holder for pen, pencil, or paint brush.	Performance Health	$60.60 - 70.70
Faraday Mouth Stick Stylus	Computer control via mouth stylus	Faraday Stylus	$25-$30

What is it? A mouthstick with options for a page turner end or an implement holder end.

Purpose: For individuals with limited to no upper extremity use. The page turner mouthstick can be used for turning pages in a book or for typing on a keyboard. The implement holder mouthstick can be used for writing, drawing or painting. Angle and length of mouthstick are both adjustable.

Cost: $60.60 - $70.70

More Information: https://www.performancehealth.com/bendable-telescopic-mouth-sticks

Faraday Stylus

The Handmade Stylus with the Unique Fabric Tip

What is it? A mouth-held stylus to support computer access via touchscreen. Stylus is available in multiple lengths to meet the user's needs, from 9'' - 18''.

Purpose: Supports computer access for individuals who don't have functional use of their upper extremities.

- Compatible with any touch screen

Cost: $25 - $30

More Information: http://fd-stylus.com/product/mouth-stick-stylus/

On-Screen Keyboards

Device Name	Description	Manufacturer	Cost
Comfort On-Screen Keyboard Pro	Fully customizable on-screen keyboard software	Comfort Software	$19.95
Mac On-Screen Accessibility Keyboard	On-screen keyboard that can be turned on in computer settings.	Apple	Free
Windows On-Screen Keyboard	On-screen keyboard that can be turned on in computer settings.	Windows	Free

What is it? A universal on-screen keyboard that responds to a computer

mouse, touch screen, pen, or stylus for typing. Fully customizable including

language, layout, position, size, number of keys, and large selection of

templates.

Purpose:

- Compatible with Windows 10/8.1/8/7/Vista/XP and Microsoft Servers

  2012/2012 R2/2008/2008 R2/2003

Cost: $19.95

More Information: https://www.comfort-software.com/on-screen-keyboard/

What is it? An on-screen keyboard that can be turned on in the setting section of a mac computer.

Purpose: Allows users with limited arm and hand movement to operate a computer without the use of a physical keyboard.

To turn on: on your Mac, choose Apple menu > System Preferences, click Accessibility, click Keyboard, click Accessibility Keyboard, then select Enable Accessibility Keyboard.

- Compatible with Dwell, allowing for eye or head-tracking use.

Cost: Free

More Information:

https://help.apple.com/accessibility/mac/control/10.14/#/mchlc74c1c9f

What is it? An on-screen keyboard that can be turned on in the setting section of a Windows computer.

Purpose: Allows users with limited arm and hand movement to operate a computer without the use of a physical keyboard.

To turn on: Go to Start , then select Settings > Ease of Access > Keyboard, and turn on the toggle under Use the On-Screen Keyboard

Cost: Free

More Information: https://support.microsoft.com/en-us/help/10762/windows-use-on-screen-keyboard

Accessible Computers

Device Name	Description	Manufacturer	Cost
TAPit	Touch-accessible interactive & highly customizable learning platform	TeachSmart	$19,999.00

What is it? An interactive-touch platform that works with educational and assistive software programs, providing accessibility to individuals of all ages and abilities. It responds to a variety of styluses including mouth sticks, head pointers, on-screen keyboards, and switches.

Purpose: Originally developed as a device to support classroom learning, the TAPit has been found to be useful in supporting individuals with multiple diagnoses, such as developmental delays, hearing and vision impairments, and fine motor delays.

- Compatible with Windows, Apple, and Linux software by utilization of TAPit Platform Drivers

Cost: $19,999.00

More Information: https://www.teachsmart.org/

Devices to Support Safety

Transfer Aids

Device Name	Description	Manufacturer	Cost
Comfort Carrier	Safely, comfortably and securely transfer individuals to and from wheelchair.	Broadened Horizons	$365

What is it? A transfer sling

Purpose: Allows individuals to be safely and comfortably transferred to/from wheelchair. Sling has handles for 2-5 people to assist with transfer while maintaining secure grip on sling. Available in small, medium and large. Size is based on height of individual.

Cost: $365.00

More Information: https://www.broadenedhorizons.com/comfort-carrier

Products and Applications Compatible with Amazon Echo, Google Home, and Apple HomeKit

This is a list of some of the many products and applications compatible with Amazon Echo, Google Home, and Apple HomeKit. For more information and additional apps and products please visit:

Amazon Echo: https://www.amazon.com/b/ref=ods_aucc_dp_sh_rd?node=6563140011

Google Home: https://assistant.google.com/explore/c/19/

Apple HomeKit: https://www.apple.com/ios/home/accessories/

Control Lighting - use voice control to turn lights on/off, brighten/dim, change color of lights and find out if lights in a room are on/off. These smart light bulbs can also be controlled using an app downloaded to the user's phone.	
Product	**More Information**
Ilumi*	https://ilumi.co
LIFX	https://www.lifx.com
Philips Hue	https://www2.meethue.com/en-us
Sengled*	https://us.sengled.com
Yeelight*	https://www.yeelight.com/home
Control Outlets with Smart Plugs – Smart plugs connect to the user's home Wi-Fi allowing them to control lights and small appliances plugged into smart outlet using voice with Amazon Echo, Google Home, or Apple HomeKit.	
Product	**More Information**
Gosund Smart Plugs*	https://www.gosund.store/collections/smart-plug-1
Kasa Smart Wi-Fi Plugs and Power Strips*	https://www.kasasmart.com/us/products/smart-plugs
Koogeek Smart Plugs and Power Strips	https://www.koogeek.com/smart-home-2418/

VOCOlinc Smart Plugs and Power Strips		https://www.vocolinc.com/pages/products
Wemo Mini Smart Plug		https://www.belkin.com/us/p/P-F7C063/
Control Temperature and Air		
Product	**What can voice control operate?**	**More Information**
Ecobee Thermostats	Turn thermostat on/off or adjust temperature with voice.	https://www.ecobee.com
GE Connected Window Room Air Conditioners	Turn AC on/off and control temperature using voice.	https://www.geappliances.com/ge/connected-appliances/air-conditioners.htm
Honeywell T5+ Smart Thermostat	Turn thermostat on/off or adjust temperature with voice.	https://www.honeywellhome.com/T5-Smart-Thermostat-RCHT8612W
Hunter Ceiling Fans with SIMPLEconnect Wi-Fi	Control light, turn fan on/off, and adjust speed using voice.	https://www.hunterfan.com/ceiling-fan-smart-home
Nest Thermostats*	Turn thermostat on/off or adjust temperature with voice.	https://nest.com
Control Home Security		
Product	**What can voice control operate?**	**More Information**

ADT Pulse SmartHome*	Works with a variety of ADT smart home products including home security systems, lights, door locks, cameras, garage door openers, and thermostats.	https://www.adt.com/home-automation
August Home	Smart Security devices such as door locks and video doorbells.	https://august.com
Honeywell Lyric Security and Home Control System	Home security system. Systems can include smoke detectors, door/window sensors, motion detectors, glass break detectors, a siren, and two-way wireless keys.	https://www.honeywellhome.com/en/products/security-alarm-solutions/lyric-security-and-home-control-system
Logitech Circle 2 Home Surveillance Camera	Security camera. Voice control allows user to start/stop recording or pull up live stream on device.	https://www.logitech.com/en-us/product/circle-2-home-security-camera
Schlage Sense Smart Deadbolt	Smart deadbolt that allows user to lock/unlock deadbolt and find out if door is locked using voice.	https://www.schlage.com/en/home/smart-locks/sense.html
Control Home Electronics/Entertainment		
Product	**What can voice control operate?**	**More Information**

The Bond*	Small device that links to home WIFI and already existing ceiling fan, turning ceiling fan into smart ceiling fan. Turn fan on/off, adjust speed, and turn on/off lights with voice control. Company have plans to also support window AC units, motorized shades, and garage doors in the future.	https://bondhome.io
Denon Home Theater Receivers	Stream music, switch between inputs, adjust volume, pause, mute and skip using voice control.	https://usa.denon.com/us/product/hometheater/receivers
iRobot Wi-Fi Connected Roomba Vacuums*	Use voice control to start/stop/pause/resume cleaning, find out status or location of Roomba, schedule or remove scheduled cleaning job, and find out when Roomba is scheduled to clean.	https://store.irobot.com/default/robot-vacuum-roomba/
LG SmartThinQ*	Control LG smart appliances (refrigerator, dishwasher, stove, washer/dryer, heater, AC, vacuum, etc.) with voice control.	https://www.lg.com/us/discover/smartthinq/thinq
LG Smart TVs*	Fully operate TV using voice control.	https://www.lg.com/us/smart-tvs
MySmartBlinds*	User can either purchase smart blinds or a Smart Window Automation Kit which can be	https://www.mysmartblinds.com

	added to existing horizontal blinds and MySmartBlinds Smart Bridge to control tilt of blinds with voice.	
Sony Smart TVs*	Fully operate TV using voice control.	https://www.sony.com/electronics/tv/t/televisions?type=smart_tv

Hubs – Control a Variety of Smart Home Devices in one location		
Product	**What can voice control operate?**	**More Information**
1Home	All smart home devices in one place. Allowing user to interact with one interface to automate and manage all smart devices. Membership required. Options range from 1 year to lifetime. Free trial available.	https://www.1home.io
Harmony Hub*	Turn TV on/off, change channel, control volume, control gaming console, lights, thermostat, blinds, etc. by adding smart devices to Harmony Hub.	https://www.logitech.com/en-us/product/harmony-hub?crid=60
openHAB	Integrates all smart home devices allowing different devices to communicate and work together. Recommends set up be completed by tech-savvy individual as it can be complicated.	https://www.openhab.org

Samsung SmartThings Hub*	Connects a variety of smart devices allowing them to work together.	https://www.samsung.com/us/smart-home/smartthings/hubs/samsung-smartthings-hub--2018--gp-u999sjvlgda/?CID=afl-ecomm-cjn-cha-092118-52057&cjevent=2e53d2964c1711e98343000f0a1c0e11
Smart We Link	Allows users to control different brands and types of smart devices using Google Home voice control.	http://www.ewelink.cc/en/
TP – Link Kasa*	Control all TP-Link Kasa Smart Home Products – light bulbs, light switches, range extenders, using voice control.	https://www.tp-link.com/us/

* Not compatible with Apple HomeKit

Master List of Manufacturers & Resources

Manufacturers

- August
  - https://august.com/
- Ablenet
  - https://www.ablenetinc.com/
- Accessibility Services, Inc.
  - https://asi-autonome.com/
- Amazon
  - https://www.amazon.com/
- Android
  - https://www.android.com/
- Apple
  - https://www.apple.com/
- Belkin
  - https://www.belkin.com/us/
- Broadened Horizons
  - https://www.broadenedhorizons.com/
- Chamberlain
  - https://www.chamberlain.com/
- Comfort Software
  - https://www.comfort-software.com/
- Convergence Concepts
  - http://www.convergenceconcepts.com/
- Dyson
  - https://www.dyson.com/en.html
- ecobee
  - https://www.ecobee.com/
- EMOTIV
  - https://www.emotiv.com/
- Faraday Stylus
  - http://fd-stylus.com/
- GlassOuse
  - https://glassouse.com/
- Google
  - https://www.google.com/
- Honeywell
  - https://www.honeywell.com/
- Hunter Fan
  - https://www.hunterfan.com/
- Insteon
  - https://www.insteon.com/

- LiftMaster
  - https://www.liftmaster.com/
- Lutron
  - http://www.lutron.com/en-US/Pages/default.aspx
- Microsoft
  - https://www.microsoft.com/en-us/
- MySmartBlinds
  - https://www.mysmartblinds.com/
- Natural Point
  - https://www.naturalpoint.com/
- Nest
  - https://nest.com/
- Nuance
  - https://www.nuance.com/index.html
- Performance Health
  - https://www.performancehealth.com/
- Philips Hue
  - https://www2.meethue.com/en-us
- QuadJoy
  - https://quadjoy.io/
- QuadStick
  - http://www.quadstick.com/
- Ring
  - https://ring.com/
- Samsung
  - https://www.samsung.com/us/
- Sesame Enable
  - https://sesame-enable.com/
- TeachSmart
  - https://www.teachsmart.org/
- Tecla
  - https://gettecla.com/
- TetraLite Products
  - https://tetramouse.com/
- TP-Link
  - https://www.tp-link.com/us/
- Vocca
  - https://www.vocca.shop/
- Wink
  - https://www.wink.com/products/

Resources

- **Washington Assistive Technology Act Program (WATAP):** Provides comprehensive continuum of services & resources to Washingtonians with disabilities and their family members, employers, educators, health care providers, social service providers, and others to make informed decisions about AT. Connect with local resources for consultation, demonstrations, training, and information re: funding options. For more info, visit: http://watap.org/
- **Evergreen Reuse Coalition:** An statewide coalition through WATAP that sees to collecting, refurbishing, and redistributing used assistive devices. For more info, visit: http://watap.org/device-reuse
- **Assistive Technology Acquisition System:** Program through National Assistive Technology Act Data System (NATADS) that allows users to loan devices for a 5-week trial period prior to purchasing, have access to a back-up system while theirs is being repaired/delivered. For more info, visit: https://www.myatprogram.org/Default.aspx
- **AbleData:** An online database for objective, comprehensive information regarding available assistive technology, solutions, and resources. To learn more, visit https://abledata.acl.gov/
- **UW Center for Technology and Disability Studies:** Interdisciplinary program interested in research, education, advocacy, and information regarding disabilities and assistive technology. For more information, visit http://uwctds.washington.edu/
- **Assistive Technology Selection Checklist:** A guide to selecting the right AT device provided by the Northwest Access Fund, includes things to consider and questions to ask. To view, visit: http://www.nwaccessfund.org/asistive-technology-selection-checklist/
- **Computer Accessibility Features:** Windows and Mac computers have accessibility features built into their products that may support use, including sticky keys or on-screen keyboard options. To learn more, visit: https://www.microsoft.com/en-us/accessibility/ or https://www.apple.com/accessibility/mac/
- **Smartphone Accessibility Features:** Android and Apple smartphones have accessibility features built into their products that may support use. To learn more, visit https://www.androidcentral.com/basic-accessibility-settings-android or https://www.apple.com/accessibility/iphone/physical-and-motor-skills/
- **Spinal Cord Injury Resource Library:** A comprehensive, online library offered through Craig Hospital that provides information and resources on a wide variety of topics related to spinal cord injury - including educational transfer videos, airline travel, asthma, advocating for self, spirituality, and more. New resources are added regularly. To explore, visit: https://craighospital.org/spinal-cord-injury-resource-library
- **The Empower Project:** Program through the UW Department of Rehabilitation Medicine that aims to address healthy aging and quality of life after SCI. Includes a discharge care guide, 23 printable health guides covering important SCI health topics, 30 short videos about various SCI topics such as wheelchair skills and leg-wrapping techniques, and an online peer-led self-management course. To

learn more, visit: http://sci.washington.edu/empowerment/

- **National Resource Center on Supportive Housing and Home Modification:** This is a website that offers information about home modifications for professionals and consumers. They have many helpful resources for consumers looking for more information on home modifications. Some resources include research articles, links to agencies and organizations that can assist with home modifications, educational videos, and a list of companies that sell adaptive equipment, mobility, and accessibility solutions. For more info, visit: https://homemods.org
- **Rebuilding Together:** This nonprofit organization serves people in need of home repairs and renovations in order to improve their health and safety. They are a large national network, but have local affiliates in Seattle, Tacoma, and Thurston County. For more info, visit: https://rebuildingtogether.org

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Appendix B

Assistive Technology Resource Binder

Prepared for Multicare Good Samaritan Hospital

Created by Bri Brown, Natalie Geisler, and Hannah Terranova
University of Puget Sound School of Occupational Therapy
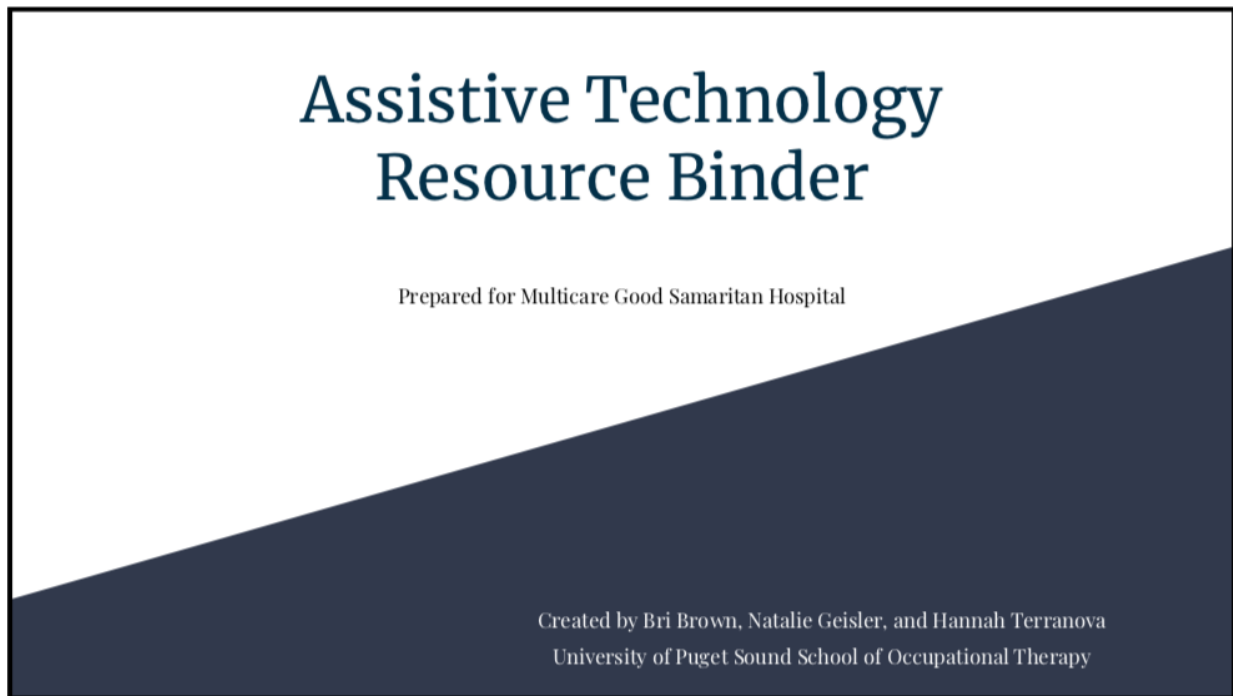
Background

Our Question:

What are the most effective, up-to-date, user friendly assistive technology options to support individuals with quadriplegia in functional tasks?

Question developed in collaboration with:

- George Tomlin, PhD, OTR/L, FAOTA
- Sonia Nurkse, MOT, OTR/L
- Bridget Tanner, MSOT, OTR/L

Research Findings

The rapid and ever-changing nature of technology makes it difficult to find recently developed devices and/or software that are supported by evidence

Several research articles included in our project found inconsequential or negative results with the devices/software

Not all the devices/software examined in the studies are commercially available; some were developed by the researchers

3 major categories of devices identified through our search:
1. Environmental control units
2. Devices that support computer access
3. Devices to restore function

Knowledge Translation

Assistive Technology

Prepared for MultiCare Good Samaritan Hospital
Created by Bri Brown, Natalie Geisler, and Hannah Terranova
University of Puget Sound School of Occupational Therapy

- Binder of available assistive technology software and hardware for individuals with limited to no upper extremity use.

- Binder contains both AT backed by research and AT not backed by research, but still viewed as useful for individuals with quadriplegia.

Potential Use & Impact of the Binder

- Provides an idea of what AT is available
  - Applicable for use by OT, PT, and SLP
  - Patients & families/caregivers
- Each device is printed on its own page allowing:
  - Pages to be easily removed and copied for patients to keep
  - Easy removal & replacing as devices become outdated or updated
- Master list of manufacturers & resources with links for additional information

AT Binder

Divided into three major sections

1. Devices that support environmental control
2. Devices that support computer access
3. Safety

Page Layout

Each device page includes:

- Device logo
- Photo of device
- Description of device
- Purpose of device
- Cost
- Link to website for additional information.

Devices that Support Environmental Control

Lights

Device Name	Description	Manufacturer	Cost
Philips Hue	Smart light bulbs	Philips	$14.99+
Vocca Pro Smart Light	Voice activated light bulb	Vocca	$78.77

PHILIPS

hue personal wireless lighting

What is it? Smart light bulbs, light strips and light fixtures

Purpose: Download the Philips Hue app and control lights and set up schedules from the app or use voice control with Amazon Alexa, Google Assistant, or Apple HomeKit to control Philips Hue smart lights throughout the home.

- Compatible with Amazon Alexa, Google Assistant and Apple HomeKit.

Cost: Bulbs start at $14.99; Bridge is $59.99
More Information: https://www2.meethue.com/en-us

Devices that Support Environmental Control

This section contains 29 assistive devices and further divided into:
- Environmental Control Units and Smart Hubs
- Smart Speakers
- Communication Devices
- Door Locks and Video Doorbells
- Fans and Heaters
- Garage Door Openers
- Lights
- Smart Home Product Manufacturers
- Thermostats
- Window Coverings

Devices that Support Computer Access

This section contains 19 assistive devices and further divided into:
- Hands-Free Computer Access & Dictation
- Hands-Free Mice
- Smartphone/Tablet Access
- Hands-Free Video Game Controllers
- Mouth Sticks
- On-Screen Keyboards
- Accessible Computers

Safety

This section contains 1 device and is not further subdivided.

Table on Devices Compatible with Smart Speakers

- With the rise in everyday use of voice-controlled smart speakers like Amazon Echo, Google Home, and Apple HomeKit there has been a large increase in the number of devices and applications compatible with them.

- Following the "safety" section of the binder is a table featuring some of the many devices and apps compatible with Amazon Echo, Google Home, and Apple HomeKit.

- Table includes the name of the product or application, how voice control can be used to operate the device or application and where to go to find more information about the device.

Resources

Last section of binder is a list of resources with a description of the resource and where to find more information. Types of resources include:
- Tools for selecting appropriate assistive technology
- Home modification resources
- Resources for accessing and trialing assistive technology

Survey

- We will now hand out a short survey about this in-service and potential use of the assistive technology binder. It should take no longer than 5 minutes to complete.

- In 2 weeks we will be sending out an additional survey regarding use of the assistive technology binder. We would greatly appreciate your participation in this survey.

Thank you for your feedback!

Questions?

Thank you for your time!

If any additional questions come up, feel free to contact us at:

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Appendix C

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Assistive Technology Binder
In-Service Survey

For Question 1, please circle the number indicating your response (1 = no value . . . 10 = highly valuable):

1) Do you feel the in-service provided valuable information?

1 No value	2	3	4	5 Neutral	6	7	8	9	10 Highly valuable

Please circle YES or NO to Questions 2-3:

2) Do you currently have a client who would benefit from the assistive technology binder?

     YES   NO

3) Have you ever had a client who would benefit from the assistive technology binder?

     YES   NO

Please circle the level of likelihood for Questions 4-5:

4) How likely is it that you will have a client in the future who would benefit from the assistive technology binder?

0 Not Applicable	1 Not likely at all	2 Somewhat Unlikely	3 Neutral	4 Somewhat likely	5 Very likely

5) How likely are you to use the assistive technology binder as a resource with future clients?

0 Not Applicable	1 Not likely at all	2 Somewhat Unlikely	3 Neutral	4 Somewhat likely	5 Very likely

Thank you!

Appendix D

Assistive Technology Binder Follow Up

1. Are you an OT or PT?

☐ OT

☐ PT

2. Have you had the opportunity to use/look at the binder?

○ Yes

○ No

3. If so, on a scale of 1-5, how useful did you find this resource?

Not Useful at all		Neutral		Extremely Useful	N/A
○	○	○	○	○	○

4. Have you had the opportunity to present / give it to a client?

○ Yes

○ No

5. If so, on a scale of 1-5, how useful did you find this resource for your client?

Not Useful at all		Neutral		Extremely Useful	N/A
○	○	○	○	○	○

6. If not, why?

☐ Haven't had a client with quadriplegia   ☐ Binder is not useful

☐ Client not interested in AT   ☐ Not Applicable

☐ I have my own AT resources

7. If not, do you predict that you will present it to a client in the future?

○ Yes

○ No

8. Do you have any additional feedback regarding the binder?

Acknowledgements

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Name: Bri Brown, OTS   Date: _____

Signature of MSOT Student: _____

Name: Natalie Geisler, OTS   Date: _____

Signature of MSOT Student: _____

Name: Hannah Terranova, OTS   Date: _____

Signature of MSOT Student: _____