The emerging contribution of Speech and Language Therapists in Awake Craniotomy: a national survey of their roles, practices and perceptions

Keywords

Speech and language therapists, awake craniotomy, survey, multidisciplinary team

Declaration of interest

None

Abstract

Background

Awake craniotomy with electrical stimulation has become the gold-standard for tumour resection in eloquent areas of the brain. Patients' speech during the procedure can inform the intervention and evidence for language experts to support the procedure is building. Within the United Kingdom a burgeoning Speech and Language Therapist awake craniotomy network has emerged to support this practice. Further evidence is needed to underpin the

specific contribution of Speech and Language Therapists working within the awake craniotomy service.

Aims

To investigate and analyse the current practices of Speech and Language Therapists; their role, pre-, intra- and postoperative assessment and management practice patterns and skill set within awake craniotomy.

Methods & Procedures

Speech and Language Therapists in the United Kingdom, who work in awake craniotomy, were invited to complete an online questionnaire. Participants were recruited via several networks supported by a social media campaign. Data was analysed using a mixed methodology approach including descriptive statistics, summative and conventional content analysis.

Outcomes & Results

Twenty-four Speech and Language Therapists completed the survey, an unknown proportion of the available population. All four United Kingdom countries were represented. The majority were highly specialist clinicians 58% (n=14) with the remainder clinical leads 25% (n=6) or specialist clinicians 17% (n=14). Only 29% (n=7) had funding for awake craniotomy or had awake craniotomy in their job description. Median experience with awake craniotomy was 3 years. Median estimated contact time per case was 10.3 hours. Current intraoperative practice is characterised by a sustained period of real-time, dynamic, informal assessment of speech, language, oro

motor and cognitive functions. Respondents describe a range of intraoperative clinical deficits that, once detected, are immediately communicated to surgeons. There was evidence of variable and diverse language mapping practices and barriers to the translation of information at multidisciplinary team level. Barriers to participation in awake craniotomy include lack of: standardised validated language mapping methods, funding, standardised training methods and guidance to direct practice.

Conclusions & Implications

The evidence suggests areas of consistent practice patterns in preoperative preparation and intraoperative assessment. However considerable variability exists within language testing and mapping that would benefit from validation. These Speech and Language Therapists support improved outcomes of awake craniotomy by real-time intraoperative speech, language, oromotor and cognitive assessment, rapid detection of clinical deterioration and immediate communication to surgeons. Further research exploring intraoperative language testing, consistent use of language mapping terminology, and selection of test methods is recommended.

What this paper adds

What is already known on the subject

Efficacy of language specialists in awake craniotomy multidisciplinary teams is acknowledged. In spite of this, the contribution of Speech and Language Therapists within awake craniotomy is ambiguous.

What this paper adds to existing knowledge

This study outlines demographics, role, practice patterns and values of Speech and Language Therapists within awake craniotomy and identifies a dynamic real-time informal speech language and cognitive assessment, intraoperative skillset and practice pattern unique to the awake craniotomy setting. Awake craniotomy requires meticulous pre- intra- and postoperative speech and language assessment. Immediate communication of intraoperative responses has a direct influence on surgical outcomes.

What are the potential or actual clinical implications of this work?

The study is unique in describing the role of the Speech and Language Therapist within awake craniotomy. The study reduces the evidence - practice gap and supports Speech and Language Therapy integration into the awake craniotomy multidisciplinary team. Strategies to improve implementation may include the development of standardised language mapping terminology, universal language mapping processes across disciplines, accessible training and wider recognition of awake craniotomy Speech and Language Therapists as an important component of awake craniotomy processes.

Introduction

Awake craniotomy (AC) with stimulation brain mapping has become the gold-standard for real-time localization of eloquent brain tissue, which includes areas of the brain shown to be involved in language, and is an important tool for achieving maximal safe resection (Leal et al., 2017). The technique enables neurosurgeons to maintain the delicate balance between extensive resections and functional preservation, and is associated with improved survival rates, outcomes and service user satisfaction postoperatively (Lu et al., 2018, Leal et al., 2017, Ius et al., 2012, Sacko et al., 2011, Wahab et al., 2011).

Language experts are common members of the AC service (Kelm et al., 2017, Trimble et al., 2015) and access to language monitoring expertise as part of the multidisciplinary team (MDT) is recommended by practice guidelines (NICE guidelines 2018). Language assessment in AC aims to identify preoperative deficits, rapidly detect the occurrence of new intraoperative impairments and ascertain postoperative function (Bilotta et al., 2014). The role of the language expert includes: preoperative language testing, identification of preoperative symptoms, careful selection of intraoperative tasks, monitoring of whether language is being affected by direct electrical stimulation or resection, management of intraoperative stresses (e.g. discomfort or pain) whilst providing feedback to the surgeon (Kelm et al., 2017, Kanno et al., 2015, Trimble et al., 2015). Intraoperative tests that are sensitive and specific for detection of impairments should be

selected based on tasks that use standardised items, are tailored to the lesion site and take into consideration the service user's preoperative level (De Witte and Marien, 2013, Rofes and Miceli, 2014).

During intraoperative mapping by direct stimulation during AC, the service user performs language tasks that include picture naming, verb-noun associations, comprehension tasks, repetition, reading, and writing tasks (De Witte and Marien, 2013). Performance of tasks requires the interaction of a number of functions and a distributed network of cortical and subcortical areas of the brain. Tasks are not strictly localised to areas of the brain and there is variation between service users. Therefore certain tasks (e.g. counting, naming and reading) may not be sensitive enough to isolate or localise specific functions.

Whilst approaches have been developed for systematic evaluation and recording of language function status that can be accomplished even when a neuropsychologist or Speech and Language Therapist (SLT) are not involved in the MDT (Bilotta et al., 2014), participation of a language specialist in AC results in higher rates of gross tumour resection and shorter durations of surgery (Kelm et al., 2017). In addition, the ability of the proficient language therapist to differentiate between mild intraoperative deficits that are reversible and those that are irreversible can safely facilitate more extreme resections (Trimble et al., 2015).

The AC language mapping contributions of neuropsychologists, SLT and other MDT partners have been documented (Kelm et al., 2017, Trimble et al., 2015). There are considerable challenges associated with language mapping; the localization of function varies greatly among individuals and different pathological conditions with no one specific test to measure function (Kanno et al., 2015). Practice guidelines for language mapping are in existence internationally (DeWitte et al., 2015, Kayama et al., 2012), however there is no standardised language testing method, within and between language mapping experts from various disciplines. Considerable language mapping practice variations exist with a lack of consistent, patient centered, agreed terminology and no standardised mapping practices among the AC community (Kamaya et al., 2012).

To date there is no clear consensus as to the role of the SLT AC practitioner, practice patterns, value judgements or contribution to language mapping in partnership with MDT colleagues. The numbers of these practitioners, their involvement in AC as part of the MDT team, consistency of AC SLT language mapping practices within or across MDT teams is unknown. Whether the UK AC SLT role is an extension of the traditional SLT role or involves a unique practice skill set is also unclear. At present a national AC clinical practice network exists to support and provide guidance for SLTs working in AC in the absence of best practice guidance frameworks.

Clinical application

The overall aim was to capture and analyse the current practice of SLTs in the UK with regards AC. This is needed to elicit and understand current clinical services, as a prerequisite to practice development.

Objectives

To capture and analyse (1) the profile of the AC SLT practitioner, (2) the practices and skill set of the AC SLT and (3) the nature of the AC SLT role.

Methods and Materials

Design

This study used a web-based survey to elicit the clinical reality of SLTs practicing in AC. Planning and description of the online survey and results was influenced by published guidelines (Eysenback et al., 2004).

Participants

Qualified SLTs actively working in AC in the UK were invited to complete the questionnaire.

Survey design

A 72 item survey was devised with the assistance of two clinicians working in AC and three academic SLTs. The survey was piloted by an experienced AC practitioner and wider research team. Pilot feedback; including shortening questions, avoiding repetition and adding questions on MDT debriefing; was incorporated into the final version. The final survey contained seven sections: (1) participant information, (2) preoperative practices, (3) intraoperative practices, (4) postoperative practices, (5) training, (6) the role of SLT in AC and (7) research and quality improvement priorities. Response formats included yes/no questions, multiple choice, Likert scales, open-ended questions and opportunities throughout to provide free text answers in order to more fully describe practice. Completion time was estimated at 45 minutes.

Recruitment and data collection

There were no ethical concerns and Ulster University Research Ethics Committee granted approval. As we were unable to ascertain the total number of AC SLT practitioners in the UK, research participants were targeted strategically across several active SLT networks (AC SLT, neurology and dysphagia) and via social media (a dedicated survey Twitter page and retweets by the Royal College of Speech and Language Therapists). Emailed follow-up reminders were sent out as this has previously been shown to substantially increase the response rate in internet-based surveys of health professionals (Braithwaite et al., 2003). Responses were anonymous. Participants completing and submitting the

survey were deemed to have given consent for participation and storage of responses. No incentives were offered. The survey was open for four weeks between September and October 2017.

Data analysis

Descriptive statistics were used to analyse closed questions. Non-parametric data are presented using the medians with range. The Mann-Whitney-U test and Kruskal-Wallis test were used to compare data sets.

The qualitative methods used are described according to the Standards for Reporting Qualitative Research (O'Brien et al., 2014). As there is no guiding theoretical framework of the role of SLT in AC an overall pragmatic research paradigm was adopted (Glogowska, 2011).

In conventional content analysis (CCA) the codes are elicited directly from the data (Hsieh and Shannon, 2005), this is an inductive approach that is adopted when no previous studies dealing with a phenomenon have been described (Vaismoradi et al., 2013). Responses of survey participants were read numerous times by the lead author (M.O); codes were then derived from key concepts that emerged and sections of text were then assigned to codes (Table 1).

For questions relating directly to practices, summative content analysis (SCA) was used to establish the most frequent approaches. SCA is a more

quantitative approach to qualitative analysis involving counting and comparing words and content, prior to performing an interpretive analysis (Bristowe et al., 2015).

The online survey data was collected using questionnaire software (Qualtrics, Provo, UT). Quantitative comparisons and text analyses for SCA were performed using statistical software (R v3.1.3, R Foundation for Statistical Computing)

Results

A Profile of the Awake Craniotomy Speech and Language Therapist

Twenty-eight eligible participants started the survey; four failed to complete the survey; 86% (n=24) valid responses were analysed. All four United Kingdom countries were represented. As denoted by their employment banding the majority were highly specialist clinicians 58% (n=14) with the remainder clinical leads 25% (n=6) or specialist clinicians 17% (n=14). Only 29% (n=7) had funding for AC or AC in their job description. Median experience with AC was 3 years. The demographic profiles of the participants are summarised in Table 2.

SLTs reported 10.3 hours of service user contact for every AC candidate (median, range 0.3-19.3 hours, Table 3). Clinical input was reflected in the estimated total contact time with service users at different operative phases of AC [preoperative; 2.9 hours, intraoperative; 4.1 hours, postoperative 3.4 hours]. Significantly more time was spent in direct service user contact than indirect at every phase of the AC process (Table 3). Estimated total direct contact time with service users was significantly longer for SLTs with AC in their job description compared to SLTs without AC in their job description [7.8 vs. 6.5 hours, p=0.045].

Almost all SLTs (96% n=23) reported that training is essential to guide the SLT AC role (Table 4). In the absence of best practice guidelines, peer

support networks are a source of learning and support for SLT's working in AC, "I actively sought out peer support" [T10], "I attend the network meeting" [T17], "I have had a couple of phone calls with other SLTs outside London working in the area. These were invaluable" [T18], "I have set up London based peer support group" [T20].

Current practice of AC SLT clinicians

SLT preoperative practices

Current clinical preoperative practices reported by AC SLTs are summarised in Table 4. Nearly all (83% n=20) AC SLTs reported providing a preoperative assessment to service users and reported this was a valuable practice (96% n=23). Preoperatively, 96% (n=23) of SLTs strongly agreed or agreed that the role of SLT includes discussion of any concerns or anxieties the service user may have prior to AC but just 33% (n=8) strongly agreed or agreed that the psychological needs of service users was adequately addressed preoperatively in the service they work in (Table 4).

SLT intraoperative practices

Current clinical intraoperative practices reported by AC SLTs are summarised in Table 4. 25% (n= 6) of SLTs attend the entire AC procedure. SLTs reported that 75% (n=18) of the time they were the MDT professional most likely to lead interactions (verbal and non-verbal) intraoperatively with the service user, followed by joint interactions by the SLT, surgeon and anaesthetist (13% n= 3), surgeon alone (8% n=2) and SLT and anaesthetist

interactions (4% n=1). Most SLTs (83% n=20) reported not collecting written data intraoperatively with reasons cited as a focus on service user interaction, a preference for postoperative documentation, collection of data by the surgeon or neurophysiologist, a single SLT presence limiting the ability of the SLT to write and a lack of time or resources. Four SLTs (16%) reported collecting data intraoperatively, specifying that data collection necessitated the presence of two SLTs.

Many SLTs 71% (n=17) reported that they were the MDT professional most likely to determine the nature of intraoperative speech, language and cognitive assessments to be used with the service user. In the remainder of cases a joint SLT and surgeon determination was reported (29% n=7). During the intraoperative phase of AC 92% (n=22) of SLTs strongly agreed or agreed that they felt integral to the AC multidisciplinary team. Intraoperatively, practice themes emerged to support the existence of a continuous dynamic speech, language and cognitive assessment skill set whereupon SLTs are “aiming for continuous speech throughout and continuous speech monitoring throughout stimulation, mapping and resection” [Intra18]. Reflecting the dynamic nature of the intraoperative skill set, there are a greater variety of reported informal assessments and activity-based assessments in the intraoperative setting as compared to the preoperative setting (Table 4).

SLT postoperative practices

Review of the service user postoperatively was routine practice with all 24 respondents . Collection of outcome measures was not an established practice postoperatively (50% n=12). Twenty SLTs (83%) reported having the opportunity to debrief, either with a fellow SLT or the surgeon, following their involvement in an AC procedure and most 96% (n=23) reported that this was valuable. Current clinical postoperative practices reported by AC SLTs are summarised in Table 4.

Emerging themes included use of a different specialist skill set more comparable to preassessment practices, “post-operatively treatment at ward level is as for any other patient” [Post5], “there is no difference in deficit management compared to other patients” [Post6], “I feel there can be a degree of flexibility in post-op assessment and management” [Post7].

Continuity of care for the AC service user

In an AC service user’s journey, 58% (n=14) of SLTs reported that there was not a consistent SLT for every phase of AC (i.e. preoperative, intraoperative and postoperative phases) with the remainder of SLTs 42% (n=10) reporting that one SLT was solely responsible. Emerging themes here included the importance SLTs place on continuity of care “I feel this allows for better knowledge of baseline abilities and therefore increased abilities to feedback efficiently any deterioration” [Con4], “subtle differences / changes could easily be missed if different SLTs are involved” [Con10]. Post-operative review provided the opportunity to debrief, “post op, on the ward, patients often want to talk about the intraoperative phase and you're unable to do this

if you haven't been there” [Con2], “there is benefit in at least one post op contact for the patient of the therapist who supported them through the surgery as it is part of the patients debrief” [Con19].

A summary of all themes identified on CCA is provided in Table 5.

Discussion

This is the first reported attempt to capture and analyse the role, practice methods and perspectives of SLTs working within UK AC services. The precise number of UK SLTs working in AC remains unknown, so extensive attempts were undertaken to engage AC SLTs by an active social media campaign and enlisting the assistance of several AC clinical networks. Twenty-four SLTs completed the survey, however due to a lack of accurate figures regarding the numbers of SLT contributing to AC in the UK, it is difficult to state what proportion is represented in this survey. Thus, the sample of AC SLT practitioners represented in this study is a self-selecting group of practitioners and we are unable to extrapolate the results to the population as a whole. In future studies NHS trusts and boards could be contacted directly to recruit AC SLTs and provide a fully representative sample.

Preoperative practices and skill set

SLTs outlined a plethora of preoperative language and cognitive assessments for service users undergoing AC with a diverse range of formal, standardised assessments; The Boston Naming Test (Kaplan, Goodglass & Weintrub, 2000), Comprehensive Aphasia Test (Springer and Mantey, 2010) and Pyramids and Palm Trees (Klein and Buchanan, 2009) were frequently used preoperative language assessments. Furthermore, AC SLTs reported a diverse range of informal language preoperative testing methods (Table 4).

AC SLTs highly valued (63% n=15) preoperative detailed evaluation of the service users holistic language functioning prior to surgery to identify baseline language functioning and allow AC SLTs to distinguish between baseline functioning and the effects of surgery. For 42% of SLTs preoperative evaluation is never discussed at a MDT meeting and only 38% of SLTs perceived that their preoperative contribution was of ‘high value’ for determining service user suitability for surgery.

Despite the value placed on preoperative assessment there is a discord between SLT preoperative practice and translation to the wider AC MDT. This barrier may reflect embedded cultural and organisational factors and highlights the need to achieve evidenced based best practice (Fealy et al., 2019). Selection of appropriate candidates for AC is a critical factor in the success or failure of the procedure therefore development of multidisciplinary AC practices and mapping methods involving language practitioners has potential to further improve service user outcomes including fewer late severe neurologic deficits and more extensive resections (De Witt Hamer et al., 2012, Marrone et al., 2016, Nossek et al. 2013). Failed AC is associated with lower rates of gross tumour resection, increased neurological morbidity, an increase in major complications, and longer length of stay in hospital (Nossek et al. 2013).

SLT preoperative assessment as part of a multidisciplinary service user work up should lead to more appropriate service user selection for AC and a reduction in failed AC. Protocols have been described that involve

identification of serious language or cognitive deficits that will preclude execution of intraoperative tasks and thus lead to service user exclusion from AC where it is likely to be ineffective (Santini et al., 2012). If significant language impairment is observed during preoperative SLT assessment then it is doubtful that AC will be successful since intraoperative testing focuses on repeated use of tasks that the individual is able to consistently answer without difficulty (Hervey-Jumper and Berger, 2016).

Intraoperative AC SLT practices and skill set

The survey data points to a dynamic intraoperative speech and language skill set and practice that utilises continuous live assessment and diverse informal language tasks to rapidly detect clinical deterioration in the service user from their preoperative baseline. This is a consistent practice pattern utilized by the SLT, specific to the unique surgical environment and different from pre- and postoperative practice methods, which involved standardised test batteries.

Similar to other studies, intraoperative language mapping practice methods cited include a variety of informal activity based measures allowing AC SLTs to evaluate utterance, visual naming, comprehension, expression and cognition (Trimble et al., 2015, Kayama et al., 2012). This is the first study to report a UK wide intraoperative AC SLT practice and skill.

Current SLT practice methods of intraoperative language testing of eloquent brain functions are diverse and variable, reflecting similar findings from

neuroclinicians from different disciplines and perhaps the absence of standardized validated mapping methods (De Witte and Marien, 2013, Rofes and Miceli, 2014). Further information on the method of neurolinguistic testing selected (e.g. research on the general protocols utilised and patient specific tests selected on the basis of lesion site) and the variability of practice between language practitioners within SLT and other disciplines is recommended due to its direct effect on the clinical outcomes of service users (Kelm et al., 2017, DeWitte et al., 2015, Talacchi et al., 2011, Hamberger et al., 2005).

SLTs perceived their contribution to the AC procedure was most clearly demonstrated intraoperatively. SLTs strongly agreed or agreed that they were integral to the AC multidisciplinary team in the intraoperative phase when compared to the preoperative phase of AC (92% vs. 71%). SLTs were unanimous that intraoperatively the role of the SLT was to alert the MDT to clinical deterioration in speech, language and/or communication difficulties and the MDT in turn valued most highly their intraoperative contribution in monitoring for language difficulties and motor speech problems. Accordingly the MDT member who most frequently determined the intraoperative interactions with the service user was reported as the SLT. UK AC SLTs report an intraoperative systematic real-time speech, language, cognitive and oro motor assessment, which assists and directs the real-time surgical plan and advocates an integrated MDT approach to language mapping and optimal tumor resection.

SLT dynamic intraoperative practice, which is highly responsive to change from baseline measures and highly variable in nature, is consistent with research evidence alluding to the variability in multidisciplinary AC language mapping methods and may reflect a lack of standardised validated mapping methods across disciplines (Kelm et al., 2017, Trimble et al., 2015). However, variability in testing, particularly informal testing methods, which have not been rigorously tested and standardised, presents the potential for inaccurate brain mapping, lack of sensitivity to detect impairment and variable patient outcomes. Indeed there have been efforts to standardise approaches internationally and develop a protocol for cognitive assessment in AC (Rofes et al., 2017).

Similar to other practice based surveys (Chang et al., 2018) this study has found that SLTs in the intraoperative phase of AC have had to apply standard aphasia assessments to a spectrum of communication disorders to meet clinical needs with limited guidance from the literature. The implications for language mapping are that these tasks, such as automatic speech and object naming, may not map language with sufficient accuracy (Rofes and Miceli, 2014). It is therefore recommended that initiatives towards standard assessments are implemented in the UK (Rofes et al., 2017). These standardized assessment protocols should be validated and postoperative service user outcomes should be compared to the current standard of care.

Postoperative practices

Respondents noted that all service users were reviewed postoperatively, and were managed just like other patients requiring SLT input. Immediate and frequent postoperative aphasia gradings to identify any surgery related deficits has been recommended (Kelm et al., 2017). By repeating language measures in a standardised way, identification of transient and permanent language impairment is possible, thus impacting rehabilitation. There is potential benefit to service user outcomes from more consistent language assessment postoperatively. SLTs reported that outcome measures were collected for approximately 50% of service users.

Recognition of the contribution to AC practice

Despite the key role of the AC SLT in promoting optimal tumor resection, at present SLT contribution and participation towards AC in the UK is largely unrecognised. The role is rarely acknowledged in the job description of AC SLTs (29%), practitioners are rarely given additional time to assist with the complex needs of this unique population of service users (33%) and rarely is the role formally commissioned under a contract or agreement (4%). The presence of AC in the SLT job description resulted in a significant association with increased total direct contact time with service users (7.8 vs. 6.5 hours), however the impact of increased service user contact remains unknown.

Despite the lack of practice recognition, AC SLTs spend considerable time with each AC service user (median 10.3 hours) and highly value their contribution to the AC procedure and their role. Few studies within the UK or

internationally have investigated the composition of UK AC multidisciplinary teams, the specific roles of language practitioners from various disciplines and the impact of an agreed AC mapping terminology on surgical and MDT practice and service user outcomes (Bilotta et al., 2014).

Training methods and the use of published guidelines or protocols

Across the course of intervention, few AC SLTs used evidence based or validated language mapping methods or protocols to guide intervention (e.g. The Dutch Linguistic Intraoperative Protocol) (DeWitte et al., 2015) with considerable variability in practice demonstrated at each operative stage. This in turn has implications for replication and consensus as to what constitutes best practice. There is evidence of SLTs providing input for a range of communication disorders in the intraoperative phase of AC and psychological support specific to the surgical context to meet clinical need, with limited guidance from the literature. This is consistent with other papers exploring different areas of SLT clinical practice (Chang et al., 2018, Beckley et., 2016). The lack of support in the form of job recognition, a formalized training program, poor resourcing and accessible MDT based training and practice guidance may have resulted in low uptake of evidenced based protocols.

Importance, strengths and limitations

This is the first study to attempt to capture and report the role, practices and perceptions of the UK SLT contributing to AC. The strengths of the study include the high survey completion rate of 86% and extensive piloting with

clinicians active in AC further served to improve content, rigour and design of the study. Furthermore, this is first SLT survey to attempt to understand the practices and experiences of AC SLTs working clinically and therefore is an important baseline upon which to develop health services and policy research (VanGeest and Johnson, 2011). This study has several limitations. Extensive attempts were undertaken to engage AC SLTs by an active social media campaign and enlist the assistance of several AC networks.

However, the limitations of the small sample size and respondent bias are noted and the authors are unable to extrapolate to the entire AC SLT population. The generalisability of the results internationally is limited due to extensive variability in practice and roles amongst health professionals e.g. in the United States, neurophysiologists may assist surgeons with language mapping and not SLTs (Sanai et al., 2008).

Our findings are based exclusively on SLT perceptions. Triangulation with other clinicians and using other research methodologies is needed. Investigation of the current MDT AC approaches, and working towards an agreed terminology and standardised language mapping practice and protocols, further UK based AC service user experiences, perceptions of the entire AC MDT on their practices and observation of AC in practice with language practitioners from all disciplines may provide further insights to barriers and facilitators to evidence based language mapping methods.

Conclusions

The AC SLT is a highly skilled practitioner who utilises a variable and diverse range of language testing and mapping methods. Intraoperatively, practice patterns suggest continuous live assessment and diverse informal assessments to rapidly detect clinical deterioration in the service user from their preoperative baseline, which has the potential to direct the surgical plan in real-time. This intraoperative discrete skill set has not previously been reported regarding SLT UK wide practice and adds to the clinical evidence supporting SLT involvement in AC.

References

BECKLEY, F., BEST, W. and BEEKE, S., 2016, Delivering communication strategy training for people with aphasia: what is current clinical practice? International Journal of Language and Communication Disorders, 57, 197–213.

BILOTTA, F., STAZI, E., TITI, L., LALLI, D., DELFINI, R., SANTORO, A. & ROSA, G. 2014. Diagnostic work up for language testing in patients undergoing awake craniotomy for brain lesions in language areas. Br J Neurosurg, 28, 363-7.

BRAITHWAITE, D., EMERY, J., DE LUSIGNAN, S. & SUTTON, S. 2003. Using the Internet to conduct surveys of health professionals: a valid alternative? Family Practice, 20, 545-551.

BRISTOWE, K., SELMAN, L. & MURTAGH, F. E. 2015. Qualitative research methods in renal medicine: an introduction. Nephrol Dial Transplant, 30, 1424-31.

CHANG, H. F., POWER, E., O'HALLORAN, R. & FOSTER, A. 2018. Stroke communication partner training: a national survey of 122 clinicians on current practice patterns and perceived implementation barriers and facilitators. Int J Lang Commun Disord, 53, 1094-1109.

DE WITT HAMER, P. C., ROBLES, S. G., ZWINDERMAN, A. H., DUFFAU, H. & BERGER, M. S. 2012. Impact of intraoperative stimulation brain mapping on glioma surgery outcome: a meta-analysis. *J Clin Oncol,* 30**,** 2559-65.

DE WITTE, E. & MARIEN, P. 2013. The neurolinguistic approach to awake surgery reviewed. *Clin Neurol Neurosurg,* 115**,** 127-45.

DE WITTE, E., SATOER, D., ROBERT, E., COLLE, H., VERHEYEN, S., VISCH-BRINK, E. & MARIEN, P. 2015a. The Dutch Linguistic Intraoperative Protocol: a valid linguistic approach to awake brain surgery. Brain Lang, 140, 35-48.

EYSENBACH, G. 2004. Improving the quality of Web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). J Med Internet Res, 6, e34.

EYSENBACH, G. & WYATT, J. 2002. Using the Internet for Surveys and Health Research. Journal of Medical Internet Research, 4, e13.

FEALY, G., DONNELLY, S., DOYLE, G., BRENNER, M., HUGHES, M., MYLOTTE, E., NICHOLSON, E. & ZAKI, M. 2019. Clinical handover practices among healthcare practitioners in acute care services: A qualitative study. J Clin Nurs, 28, 80-88.

GLOGOWSKA, M. 2011. Paradigms, pragmatism and possibilities: mixed-methods research in speech and language therapy. Int J Lang Commun Disord, 46, 251-60.

HAMBERGER, M. J., SEIDEL, W. T., MCKHANN, G. M., 2ND, PERRINE, K. & GOODMAN, R. R. 2005. Brain stimulation reveals critical auditory naming cortex. Brain, 128, 2742-9.

HERVEY-JUMPER, S. L. & BERGER, M. S. 2016. Maximizing safe resection of low- and high-grade glioma. *J Neurooncol,* 130**,** 269-282.

HSIEH, H. F. & SHANNON, S. E. 2005. Three approaches to qualitative content analysis. Qual Health Res, 15, 1277-88.

IUS, T., ISOLA, M., BUDAI, R., PAULETTO, G., TOMASINO, B., FADIGA, L. & SKRAP, M. 2012. Low-grade glioma surgery in eloquent areas: volumetric

analysis of extent of resection and its impact on overall survival. A single-institution experience in 190 patients: clinical article. J Neurosurg, 117, 1039-52.

KANNO, A. & MIKUNI, N. 2015. Evaluation of Language Function under Awake Craniotomy. Neurol Med Chir (Tokyo), 55, 367-73.

KAPLAN, E., GOODGLASS, H., WEINTRAUB, S. & GOODGLASS, H. 1983. Boston naming test, Philadelphia, Lea & Febiger.

KAYAMA, T. 2012. The guidelines for awake craniotomy guidelines committee of the Japan awake surgery conference. Neurol Med Chir (Tokyo), 52, 119-41.

KELM, A., SOLLMANN, N., ILLE, S., MEYER, B., RINGEL, F. & KRIEG, S. M. 2017. Resection of Gliomas with and without Neuropsychological Support during Awake Craniotomy-Effects on Surgery and Clinical Outcome. Front Oncol, 7, 176.

KLEIN, L. A. & BUCHANAN, J. A. 2009. Psychometric properties of the Pyramids and Palm Trees Test. J Clin Exp Neuropsychol, 31, 803-8.

LEAL, R. T., DA FONSECA, C. O. & LANDEIRO, J. A. 2017. Patients' perspective on awake craniotomy for brain tumors-single center experience in Brazil. Acta Neurochir (Wien), 159, 725-731.

LU, V. M., PHAN, K. & ROVIN, R. A. 2018. Comparison of operative outcomes of eloquent glioma resection performed under awake versus general anesthesia: A systematic review and meta-analysis. Clin Neurol Neurosurg, 169, 121-127.

MARRONE, F., O'NEILL, M., EMELIFEONWU, A., WAITE, A., KELLY, K. & DEMETRIADES, A. 2016. Introducing the 'PADS' criteria for patient selection

in awake craniotomy: results of a systematic review of the literature. EANS Academy, Sep 4, 166679.

NICE 2018. National Institute for Health and Care Excellence. Brain tumours (primary) and brain metastases in adults. Available at: https://www.nice.org.uk/guidance/ng99/ [Accessed 05/02/2019].

NOSSEK, E., MATOT, I., SHAHAR, T., BARZILAI, O., RAPOPORT, Y., GONEN, T., SELA, G., KORN, A., HAYAT, D. & RAM, Z. 2013. Failed awake craniotomy: a retrospective analysis in 424 patients undergoing craniotomy for brain tumor. J Neurosurg, 118, 243-9.

O'BRIEN, B. C., HARRIS, I. B., BECKMAN, T. J., REED, D. A. & COOK, D. A. 2014. Standards for reporting qualitative research: a synthesis of recommendations. Acad Med, 89, 1245-51.

ROFES, A., MANDONNET, E., GODDEN, J., BARON, M. H., COLLE, H., DARLIX, A., DE AGUIAR, V., DUFFAU, H., HERBET, G., KLEIN, M., LUBRANO, V., MARTINO, J., MATHEW, R., MICELI, G., MORITZ-GASSER, S., PALLUD, J., PAPAGNO, C., RECH, F., ROBERT, E., RUTTEN, G. J., SANTARIUS, T., SATOER, D., SIERPOWSKA, J., SMITS, A., SKRAP, M., SPENA, G., VISCH, E., DE WITTE, E., ZETTERLING, M. & WAGER, M. 2017. Survey on current cognitive practices within the European Low-Grade Glioma Network: towards a European assessment protocol. *Acta Neurochir (Wien),* 159**,** 1167-1178.

ROFES, A. & MICELI, G. 2014. Language mapping with verbs and sentences in awake surgery: a review. *Neuropsychol Rev,* 24**,** 185-99.

SACKO, O., LAUWERS-CANCES, V., BRAUGE, D., SESAY, M., BRENNER, A. & ROUX, F. E. 2011. Awake craniotomy vs surgery under

general anesthesia for resection of supratentorial lesions. Neurosurgery, 68, 1192-8; discussion 1198-9.

SANAI, N., MIRZADEH, Z. & BERGER, M. S. 2008. Functional outcome after language mapping for glioma resection. N Engl J Med, 358, 18-27.

TALACCHI, A., SANTINI, B., SAVAZZI, S. & GEROSA, M. 2011. Cognitive effects of tumour and surgical treatment in glioma patients. J Neurooncol, 103, 541-9.

SANTINI, B., TALACCHI, A., CASAGRANDE, F., CASARTELLI, M., SAVAZZI, S., PROCACCIO, F. & GEROSA, M. 2012. Eligibility criteria and psychological profiles in patient candidates for awake craniotomy: a pilot study. *J Neurosurg Anesthesiol,* 24**,** 209-16.

TRIMBLE, G., MCSTRAVICK, C., FARLING, P., MEGAW, K., MCKINSTRY, S., SMYTH, G., LAW, G., COURTNEY, H., QUIGLEY, G. & FLANNERY, T. 2015. Awake craniotomy for glioma resection: Technical aspects and initial results in a single institution. Br J Neurosurg, 29, 836-42.

SPRINGER, L. & MANTEY, S. 2010. The Comprehensive Aphasia Test: A review. Commentary on Howard, Swinburn, and Porter, “Putting the CAT out: What the Comprehensive Aphasia Test has to offer”. Aphasiology, 24, 75-78.

VAISMORADI, M., TURUNEN, H. & BONDAS, T. 2013. Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. Nurs Health Sci, 15, 398-405.

WAHAB, S. S., GRUNDY, P. L. & WEIDMANN, C. 2011. Patient experience and satisfaction with awake craniotomy for brain tumours. Br J Neurosurg, 25, 606-13.

VANGEEST, J. & JOHNSON, T. P. 2011. Surveying nurses: identifying strategies to improve participation. Eval Health Prof, 34, 487-511.

Tables

Table 1: Code Dictionary: showing codes with definitions derived from key concepts that emerged in CCA. Sections of text were then assigned to codes under a corresponding key.

Code	Code description addresses	Key
Resources	Capacity, resources, funding and or time dedicated to AC service users/procedures	F
Training	Training provided to meet AC service users needs	T
Preoperative practices	Investigative work with service user: imaging, case history, establishing baselines	Pre
Intraoperative practices	Type of SLT interactions with the service user, rationale for intervention and whom directs the interaction	Intra
Postoperative practices	Postoperative pathway for service users, follow up procedures including onward referral	Post
Continuity	Continuity or lack of continuity in SLTs involved in different phases of AC service user's journey (pre-, intra- and postoperatively)	Cont
Extended role	SLT practices perceived as an extension of practice	Ext
Role recognition	Interactions and working relationship with AC MDT colleagues	RR

Table 2: Demographics of AC SLTs participating in the survey

	N	**%**
Gender Female Male Prefer not to say	 23 0 1	 96% 0% 4%
SLT NHS Banding Six Seven Eight	 4 14 6	 17% 58% 25%
UK country in rank order of number of participating SLTs (statistics not provided to preserve anonymity): England Scotland Northern Ireland Wales		
Length of AC work experience Range 0-10 years (median 3 years) </=5 6-10	 16 8	 67% 33%
No of procedures of AC supported in practice Range 2-200 procedures (median 20 procedures) </=25 26-49 50-100 >100	 14 5 3 2	 58% 21% 13% 8%
AC in SLT job description Yes No	 7 17	 29% 71%
Allocated time for AC Yes No	 8 16	 33% 67%
Allocated funding for AC in job plan Yes No	 7 17	 29% 71%

Table 3: Estimated direct and indirect contact time for each phase of awake craniotomy and in total for a single service user. Results are expressed as medians with range in parentheses

Pre-operative direct (Hours)	Pre-operative indirect (Hours)	Pre-operative total (Hours)
2.0 (0-4.3)**	1.0 (0.1-3.1)	2.9 (0.1-6.1)
Intra-operative direct (Hours)	Intra-operative indirect (Hours)	Intra-operative total (Hours)
2.6 (0-4.8)***	0.9 (0.1-3.7)	4.1 (0.1-6.3)
Post-operative direct (Hours)	Post-operative indirect (Hours)	Post-operative total (Hours)
2.0 (0.1-5.0)*	1.0 (0.1-3.0)	3.4 (0.1-8.0)
Total direct (Hours)	Total indirect (Hours)	Total (Hours)
7.0 (0.1-13.1)****	2.8 (0.2-7.0)	10.3 (0.3-19.3)

*p=0.01 vs. postoperative indirect

**p<0.001 vs. preoperative indirect

***p<0.0001 vs. intraoperative indirect

****p<0.0001 vs. total indirect

Table 4: Current Clinical Practices reported by AC SLTs

Preoperative practices:	**N**	**%**
Preoperative SLT contribution is important		
Strongly agree	23	96%
Agree	1	4%
Percentage of cases SLTs have the opportunity to preoperatively perform an evaluation of service users before an AC		
100%	20	83%
90%	2	8%
80%	1	4%
0%	1	4%
What degree do surgeons value SLT preoperative contribution;		
Determining service user suitability for AC		
High value	9	38%
Medium value	10	42%
Low value	2	8%
No value	3	13%
Providing information about the procedure to the service user		
High value	10	42%
Medium value	8	33%
Low value	5	21%
No value	1	4%
Baseline evaluation for future comparison		
High value	15	63%
Medium value	4	17%
Low value	3	13%
No value	2	8%
Planning intraoperative assessments		
High value	15	63%
Medium value	6	25%
Low value	2	8%
No value	1	4%
Before AC what percentage of cases is SLT preoperative contribution discussed at MDT team		
0%	10	42%
1%	4	17%
2%	1	4%
4%	1	4%
30%	1	4%
40%	1	4%

70% 80% 85% 90% 100%	1 1 1 1 2	4% 4% 4% 4% 8%
How do SLTs convey information from preoperative assessment to the MDT (more than one option could be selected) Face to face discussion with surgeon Email to surgeon Discussion with SLT colleague Discussion with service user Other MDT meeting Letter to surgeon Information not conveyed to the MDT	 18/69 17/69 8/69 8/69 8/69 5/69 4/69 1/69	 26% 25% 12% 12% 12% 7% 6% 1%
Referencing SLT pre-operative contribution for service users undergoing AC, what degree does the SLT agree or disagree; *Role of SLTs includes discussion of any concerns or anxieties the service user may have prior to the AC* Strongly agree Agree Somewhat agree *Preoperative assessment considers how speech, language and communication difficulties may impact the service users ability to participate in society* Strongly agree Agree Somewhat agree *Preoperatively SLTs feels integral to the AC MDT team* Strongly agree Agree Somewhat agree Neither agree or disagree Somewhat disagree Disagree Strongly disagree *Preoperative assessment focuses on speech, language and/or communication difficulties at the impairment level which the service user may present with* Strongly agree Agree Somewhat agree Neither agree or disagree	 22 1 1 16 5 3 14 3 1 0 2 1 3 9 9 5 0	 92% 4% 4% 67% 21% 13% 58% 13% 4% 0% 8% 4% 13% 38% 38% 21% 0%

Somewhat disagree	1	4%
Disagree	0	0%
Strongly disagree		
In the AC service SLTs work, the psychological profile of service users is adequately addressed preoperatively		
Strongly agree	7	29%
Agree	1	4%
Somewhat agree	3	13%
Neither agree or disagree	0	0%
Somewhat disagree	4	17%
Disagree	5	21%
Strongly disagree	4	17%
Preoperative assessment of cognition is an integral part of SLT preoperative work up		
Strongly agree	3	13%
Agree	4	17%
Somewhat agree	6	25%
Neither agree or disagree	3	13%
Somewhat disagree	7	29%
Disagree	1	4%
Strongly disagree	0	0%
Most commonly used published assessment ranked in order (more than one could be listed)		
Boston Naming Test	15/24	63%
CAT	12/24	50%
Mount Wilga	10/24	42%
Pyramids & palm trees	7/24	29%
PALPA 4	4/24	17%
RCBA-2	3/24	13%
Western Aphasia Battery	3/24	13%
Armstrong Naming Test	2/24	8%
Cookie Theft	2/24	8%
MCLA	2/24	8%
Putney	2/24	8%
TROG	2/24	8%
Barnes	1/24	4%
CLQT	1/24	4%
Graded Naming Test	1/24	4%
Informal methods most commonly used by SLTs:		
Service user's description of communication	22	92%
Observation and/or recording of connected speech in conversation	18	75%
Oral-motor examination	15	63%
Judgment ratings of conversation partner's interaction skills in conversation	15	63%

Informal language screen	15	63%
Service user's rating of social participation	14	58%
Screen of cranial nerve function	10	42%
Significant other's rating of the service user's social participation	9	38%
Observation of cognitive communication	1	4%
Noun-Verb relationships, Antonym assessment, verbal	1	4%
fluency/category generation, procedural narrative	1	4%
Verb generation and word generation antonyms	1	4%
Complex picture description	1	4%
Automatic speech, informal assessment of functional language	1	4%
Antonyms, synonyms, noun-verb naming	1	4%

Intraoperative practices	**N**	**%**
SLTs attend a preoperative brief		
Yes	16	67%
No	8	33%
SLT contribution to preoperative brief or meeting includes:		
Liaison with surgeons and neurophysiologists regarding planned assessments	4/16	25%
Review of imaging with surgeons	4/16	25%
Description of service users baseline language	3/16	19%
Discussion regarding anxiety levels	3/16	19%
Positioning during surgery for access to SLT assessment	2/16	13%
Do SLTs attend the whole AC procedure		
Yes	6	25%
No	18	75%
Which member or members of the AC team determines intraoperative interactions with the service user (verbal and non verbal)		
SLTs	18	75%
Joint interactions between SLT, surgeon and anaesthetist	3	13%
Surgeon	2	8%
SLT and anaesthetist	1	4%
Collect data intraoperatively		
Yes	4	17%
No	20	83%
MDT professional most likely to determine intra-operative speech, language and cognitive assessments to be used with the service user		
SLT	17	71%
Joint SLT and surgeon	7	29%
Referring to the role of SLT in the intraoperative assessment of service users undergoing AC to what degree does the SLT agree or disagree with:		

The role of SLTs is to alert the MDT to clinical deterioration in speech, language and/or communication difficulties		
Strongly agree	23	96%
Agree	1	4%
Surgeons expect SLTs to convey any episodes of clinical deterioration in speech, language and communication directly during the AC procedure		
Strongly agree	21	88%
Agree	3	13%
Role of the SLT is to communicate service user symptoms (e.g. pain, nausea) to the wider MDT team		
Strongly agree	21	88%
Agree	3	13%
Role of the SLT is to help reduce service user anxiety during the AC procedure		
Strongly agree	20	83%
Agree	2	8%
Somewhat agree	2	8%
During the AC procedure SLTs feels integral to the AC MDT team		
Strongly agree	20	83%
Agree	2	8%
Somewhat agree	1	4%
Neither agree nor disagree	1	4%
Role of SLTs may include monitoring for deterioration in vision, apraxia, physical abilities and/or cognition		
Strongly agree	14	58%
Agree	4	17%
Somewhat agree	5	21%
Neither agree nor disagree	0	0%
Somewhat disagree	1	4%
Intraoperative SLT clinical input assists with surgical decision making		
Strongly agree	13	54%
Agree	10	42%
Somewhat agree	1	4%
Most commonly used published assessment (more than one could be listed)		
Boston Naming Test	9/24	38%
Pyramids & palm trees	7/24	29%
PALPA	5/24	21%
CAT	3/24	13%
Armstrong Naming Test	2/24	8%
Putney	2/24	8%

Noun Verb Test Western Aphasia Battery	2/24 1/24	8% 4%
Informal methods most commonly used (more than one could be listed) General conversation Automatic speech Oral motor examination Antonyms Noun verb Sentence completion Category generation Picture description Pictures Verbal fluency Following commands Picture naming Procedural narrative Reading Reading aloud Semantics Sequencing Synonyms Verb generation Verb pictures Yes no questions (A further 34 informal assessments were reported by one SLT each)	 8 5 5 4 4 4 3 3 3 3 2 2 2 2 2 2 2 2 2 2 2	 33% 21% 21% 17% 17% 17% 13% 13% 13% 13% 8% 8% 8% 8% 8% 8% 8% 8% 8% 8% 8%

Postoperative practices	**N**	**%**
Do SLTs review the AC service user post-operatively Yes	 24	 100%
Do SLTs have the opportunity to debrief either with a fellow SLT or surgeon following their involvement in an AC procedure Yes No	 20 4	 83% 17%
Do SLTs think the opportunity to debrief following an AC would be useful Yes No	 23 1	 96% 4%
Do SLTs collect outcome measures for service users undergoing AC? Yes No	 12 12	 50% 50%

Training	**N**	**%**
Do SLTs feel that a training process is necessary for SLTs working in AC		
Yes	23	96%
No	1	4%
How valuable do SLTs feel that initial supervision by an experienced SLT is for SLTs new to AC		
High Value	20	83%
Medium Value	4	17%
Do SLTs currently participating in AC feel the training and support they received prepared them for their role with service users		
Yes	13	54%
No	11	45%

Table 5: Summary of themes. Sections of text were assigned to defined codes under a corresponding key in CCA. Themes were then identified from assigned text.

Code	Themes identified from assigned text	Sections of text assigned to code that identified theme
Funding	● Lack of funding, time and resources are barriers to SLT participation in AC	● F1-11
Training	● Pioneering nature of AC SLTs role ● Experience gained while participating in procedures ● Peer support	● T1-9 ● T4-6 ● T10, T12-13, T15-20
Preoperative practices	● Counselling ● Anticipating intraoperative problems ● Tailoring assessments based on relevant neuroanatomy	● Pre2, Pre4-5, Pre11, Pre13 ● Pre3, Pre5-6, Pre7, Pre10, Pre12 ● Pre8-9, Pre14
Intraoperative practices	● Continuous live monitoring ● Immediate clear feedback of difficulties to the surgeon ● Advocating for the service user during the procedure	● Intra5, Intra8, Intra17-18 ● Intra1-3, Intra11-12, Intra14-15 ● Intra9-10, Intra13, Intra16
Postoperative practices	● Less emphasis placed on specialist SLT input postoperatively compared to	● Post1, Post3, Post5-7

	other phases of AC	
Continuity	• Importance of SLT continuity in order to detect any changes from baseline intraoperatively	• Cont1-19
Extended role	• Counselling • Advocacy • Emotional support	• Ext2-3, Ext 8, Ext15 • Ext5, Ext11, Ext14, Ext18, Ext20 • Ext4, Ext6, Ext9-10, Ext12-13, Ext16-17, Ext19
Role recognition	• Variability in SLT role recognition	• RR1-22