Longitudinal Analysis of Continuing Medical Education Learning Outcomes
in Relation to Stated Objectives

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THESIS

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LIST OF ABBREVIATIONS

ACCME Accreditation Council for Continuing Medical Education

AANS American Association of Neurological Surgeons

CME Continuing medical education

CNS Central nervous system

SUMMARY

Continuing medical education (CME) activities are required for physician board certification, licensure, and hospital privileges. CME activities are designed to specifically address professional knowledge or practice gaps. Many CME organizers use statements taken from participants of their "intent-to-change" as data to determine whether the CME activity content achieved a stated learning objective.

No prior studies have examined the longitudinal relationship of learning objectives and intent-to-change data over time. We hypothesize that an assessment could prove useful in understanding the efficacy of CME for closing identified knowledge gaps and for determining unmet needs for future CME planning.

We performed a retrospective mixed-method thematic content analysis of written and electronic records from specific CME activities. Specifically, the data were first analyzed using a quantitative, deductive content analysis approach to examine whether meeting objectives result in specific intent-to-change statements in learners' evaluation of the CME activity on a direct basis for one year as well as longitudinally over 6 consecutive years. Intent-to-change data that did not align with meeting objectives were further analyzed inductively using a qualitative content analysis approach to explore potential unintended learning themes.

Data for this study came from a total of 85 CME activities, averaging 12–16 meetings per year over 6 years. This yielded a total of 424 meeting objectives averaging 58–83 meeting objectives each year. The objectives were compared with a total of 1950 intent-to-change statements (146–588 intent-to-change statements in a given year).

SUMMARY (continued)

Thematic patterns of recurrent intent-to-change statements that matched with meeting objectives included topics of resident education, complication avoidance, and clinical best practices and evidence. New innovations and novel surgical techniques were also common themes of both objectives and intent-to-change statements.

Intent-to-change statements were not related to any meeting objective an average of 37.3% of the time. Approximately a quarter of these unmatched statements led to subsequent CME activity new learning objectives. However, the majority of intent-to-change statements were repeated over a number of years without an obvious change in subsequent meeting learning objectives. An examination of CME learning objectives found that 15% of objectives had no intent-to-change statements associated with those objectives. When these learning objectives were analyzed for common themes, we observed that objectives focused on specific (procedural, clinical and medical practice) topics failed to correspond with intent-to-change statements for just one year, while broader (declarative knowledge, academic, scholarly) learning objectives were more likely to lack a corresponding intent-to-change statement for multiple years. On the other hand, CME learning objectives on general topics were more commonly found to be unmatched to intent-to-change statement for multiple years. A number of CME learning objectives are repeated for the same meeting for a number of subsequent years without change. We did not find that repeating a given objective related to unmatched status to intent-to-change statements. An examination of CME learning objectives and participant intent-to-change statements provides a rich source of information for examination of both meeting planner and learner attitudes and motivation for progression of medical knowledge.

I. INTRODUCTION

A. <u>Background</u>

Continuing medical education (CME) is "defined as any activity that serves to maintain, develop, or increase the knowledge, skills, and professional performance and relationships that a physician uses to provide services for patients, the public, or the profession" [1]. CME appears to be effective in contributing to the "acquisition and retention of medical professionals' knowledge, attitudes, skills, behaviors, and clinical outcomes" [2]. CME activities are required for physician board certification, state licensure, maintenance of certification, and hospital privileges. The most common form of CME activity used in neurosurgery is presented in the form of live meeting events. These types of CME opportunities are generally found to be effective in changing physician performance [3, 4]. The American Association of Neurological Surgeons (AANS), through the Joint Providership Council, provides CME accreditation to approximately 20 such CME activities each year, under the guidance of the Accreditation Council for Continuing Medical Education (ACCME). The ACCME stipulates that education activities should be designed to specifically address professional knowledge or practice gaps identified before the CME activity by organizers of that activity [5]. The planning of CME activities to meet the needs of learners participating in those activities can be a difficult task [3, 5]. The AANS Joint Providership Council reviews CME activity evaluations, including "intent-to-change" data, to determine whether the CME activity content achieved the stated learning objective. Intent-to-change statements are described in the literature as statements of motivation to change [6, 7], commitment to change [8-15], and readiness to change [16]. These terms seem to be used interchangeably, but for this study we have used the convention of intent-to-change. In general,

learners engaged in an educational activity are asked to list clinical practice changes they propose to make based on what they feel they gained from the activity [17, 18]. These data are provided to meeting planning committees presumably to be used to plan future meetings. However, this assumption has not previously been empirically tested.

It is important to understand the relationship between intent-to-change data from given CME activities and the learning objectives set for those meetings for several reasons. Learning objectives that align with participant's intent for practice change should be included in future CME activities while those that align with few or no intent-to-change statements might be discarded as something CME attendees are not interested in pursuing. Alternatively, intent-to-change statements that have no relationship to any of the meeting objectives are especially interesting and deserve some exploration. There are several explanations of why this might occur. It is possible that there is an actual discrepancy between the stated meeting objectives and what is the actual content covered or what learning experience evoked. It could be that since there are a limited number of objectives that can be stated for a given CME activity these are not comprehensive of what the meeting planners actually hope to teach during this activity. The level of specificity of the meeting objectives might also account for intent-to-change discrepancies that are broader in nature, or the opposite might occur with broad objectives not seeming to be congruent with specific intent-to-change statements. Finally, and probably most interesting is the case in which the learning is simply outside of the explicit (stated objectives) curriculum of the planned activity. It is well recognized that quite often there is implicit learning that takes place that is termed the "informal curriculum" or "hidden curriculum" [19] These intent-to-change statements that don't seem to align with stated learning objectives might represent the unseen, unplanned learning that takes place at various AANS-sponsored CME activities. A closer

examination of this data has the potential to reveal unmet needs for future meetings. A careful examination of these data could reveal "practice gaps" that meeting planners did not know about or did not think would be of interest to meeting attendees. Further, examination of this type of data over multiple years, as well as examination of whether practice gaps are changed over time, can be used to improve CME activities to better meet the needs of the participants of these events. Finding methods to drive CME activities to correspond with learner needs is an important unmet need for the Joint Providership Council of the AANS in particular and CME meeting planners across all disciplines in general.

B. The Study Question

Do Intent-to-Change Statements Obtained From Attendees of Continuing Medical Education Activities Align with Stated Meeting Objectives for a Given Year and Do They Evolve Longitudinally Over Time? More specifically, what is the relationship between meeting evaluation (i.e., intent-to-change) data from a given CME activity and the learning objectives set for those meetings? This question really has two parts. First, response to objectives in the form of intent-to-change data can be examined for closure of knowledge gaps. Furthermore, if one examines intent-to-change data trends from multiple years for the same CME activities in conjunction with longitudinal changes in objectives, an even more granular examination of the progression of knowledge gained by the CME activities can be ascertained. Secondly, and potentially more interestingly, we examine whether there are common themes that are identified from meeting evaluations that are similar to or could influence subsequent meetings. By taking a look at these data over time, unintended outcomes—or a "hidden curriculum" of sorts—can be discovered that might help guide future CME planning.

C. <u>Working Hypotheses and Purpose of the Study</u>

The purpose of this work is to investigate whether intent-to-change statements made by meeting attendees correlate with the stated meeting objectives of that meeting. Furthermore, we examine whether these intent-to-change statements contribute to future learning objectives. Given some of the prior work in this field as well as an initial look at preliminary data we hypothesized that there would not be an alignment of intent-to-change statements and meeting objectives in the majority of cases. To test this hypothesis, we examined AANS-sponsored CME activity evaluation intent-to-change data to determine whether these evaluation responses align with the specified course objectives identified by the meeting planners. Potential alignment was examined both on a direct basis for one year as well as longitudinally over many years for the same CME activity. If most of the intent-to-change statements can be matched with meeting objectives then our hypothesis is incorrect and the learning that takes place at a given CME activity is that of an explicit nature, intended by the meeting organizers. On the other hand, if the majority of intent-to-change data do not align with meeting objectives, then our hypothesis is supported and the question of implicit or hidden learning requires further examination. The qualitative data analysis of the unmapped intent-to-change data for these CME activities is performed as an exploratory examination of this potential unintended learning that takes place in these meetings. It is possible that this work could discover that unseen forces drive learner intent-to-change outcomes, including the individual interests of invited speakers, topics of submitted oral presentation abstracts, and recent events in neurosurgical innovation.

D. Relevant Literature

This study is based on the concept of mapping CME activity evaluation data in the form of intent-to-change statements directly to CME activity objectives [20, 21]. This methodology is built, in part, on the work of Dolcourt and Zuckerman [20], who found that learner commitment-to-change statements could be used to examine learning outcomes in CME, and extended by Lockyer et al. [21], who demonstrated that commitment-to-change statements are best examined in the framework of CME activity objectives. This framework uses the CME activity objectives as a guide to classify intent-to-change data (Figure 1). A given intent-to-change statement can be mapped to a specific objective or could be classified as not related to any objective of that particular activity.
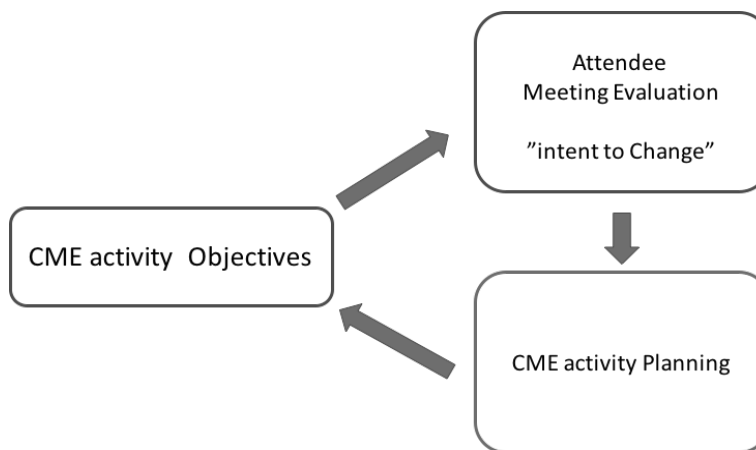
Figure 1. Relationship of participant evaluations and meeting learning objectives.

As described above, the work by Dolcourt and Zuckerman [20] and Lockyer et al. [21] indicated that commitment-to-change statements are an appropriate framework to use

to examine CME activity objectives. However, neither of these studies examined the longitudinal relationship of objectives and intent-to-change data over time. Probably the biggest, unfilled gap in knowledge from these studies related to the amount of intent-to-change data that was not mapped to a specific objective.

A previous survey of physicians in the United States demonstrated that they feel confident in identifying their own learning needs [22]. Intent or motivation to change has been thoroughly studied at the level of the individual learner [6, 7, 23] There is strong evidence to suggest that an individual CME participant's motivation to change leads to knowledge acquisition [6, 23], a process mediated by promoting self-efficacy—the belief that an individual has in his or her own capacity the ability to achieve a given goal. Williams et al. [6, 7] based these observations on social cognitive understanding of change behavior, where the CME activity leads to the motivation and confidence to put the new knowledge into the participant's medical practice.

There is prior work demonstrating that commitment-to-change statements had more congruence with objectives than did unmet-needs statements [21]. Others have demonstrated that intention-to-change data can be used to assess alignment of intended changes in physician behavior with program objectives, confirm and strengthen intended practice change and explore unanticipated learning outcomes [8]. One confounding problem with this type of analysis is that it has been demonstrated that it is possible to have "no significant difference in intention between a health care professional who later reported a behavior change and those who reported no change" [24]. Others have demonstrated just the opposite—that learners that indicated an intent to change immediately after a given lecture were more like to actually use that information in a change of their practice [10],

although this does not always take place with a single CME activity [25]. Not all CME activities are equally effective; didactic lectures, such as those used in the CME activities assessed in this project, are the least likely to effect change [26], whereas small-group interactive sessions are more likely to have this effect [27].

Overton et al. used qualitative methods to "find that there can be a range of meanings underlying intention-to-change statement" and in fact, for some participants "commitment is too strong a word to describe their intention" [28]. Although many CME participants make changes to their practices, this study "highlights that merely asking learners to specify the changes that they intend to make does not necessarily imply that learners feel a sense of commitment towards the intended changes." When there is a gap between knowledge acquisition and behavioral change, it can be attributed to a number of factors, but there are two factors that are known to drive behavioral change—a sense of urgency and a level of certainty that the behavior change is important [29]. Others have found that physician behavior after CME activities is expected to change if the practice alteration is congruent with values and sense of what the physician's feels is important [9]. Collecting barriers-to-change data along with commitment-to-change statements does not seem to affect practice patterns any more than just collecting commitment-to-change statements alone [10]. This leaves open the question of what other data can be collected from CME activity evaluation that would validate the intent-to-change statement data. This information might be found in our longitudinal data analysis of meeting objectives and intent-to change statements or in the qualitative themes of intent-to-change data identified that do not map to meeting objectives.

II. METHODS

A. <u>Research Design</u>

Our study design is a retrospective mixed-method content analysis of written and electronic records from specific CME activity application records and corresponding CME activity evaluations. These CME activities were multiple day regional and subspecialty organizational meetings. The intent-to-change statements were taken directly from the meeting evaluation data. The data was anonymous and number of participants of the meeting and number of participants that submitted intent to change statements was unknown. It is possible that some participant submitted multiple intent-to-change statements while others may have not submitted any statements. Meeting learning objectives were those formulated for the entire CME activity and not for individual sessions of the meeting. The data were first examined by quantitative content analysis to examine whether meeting objectives result in specific intent-to-change statements in learners' evaluations of the CME activity. This data was examined both on a direct basis for one year as well as longitudinally over many years for the same CME activity. If the yearly data are compared year to year, this framework can be extended to include the effect of intent-to-change data on future meeting planning. On the other hand, if a substantial part of the intent-to-change data fails to align with meeting objectives, this suggests that our research hypothesis is supported. In other words, the is no alignment of meeting objectives and participant intent-to-change statements. Qualitative content analysis was then used to identify patterns in the intent-to-change data that did not align with meeting objectives. The overall scheme of the research design and plan is found in Figure 2.
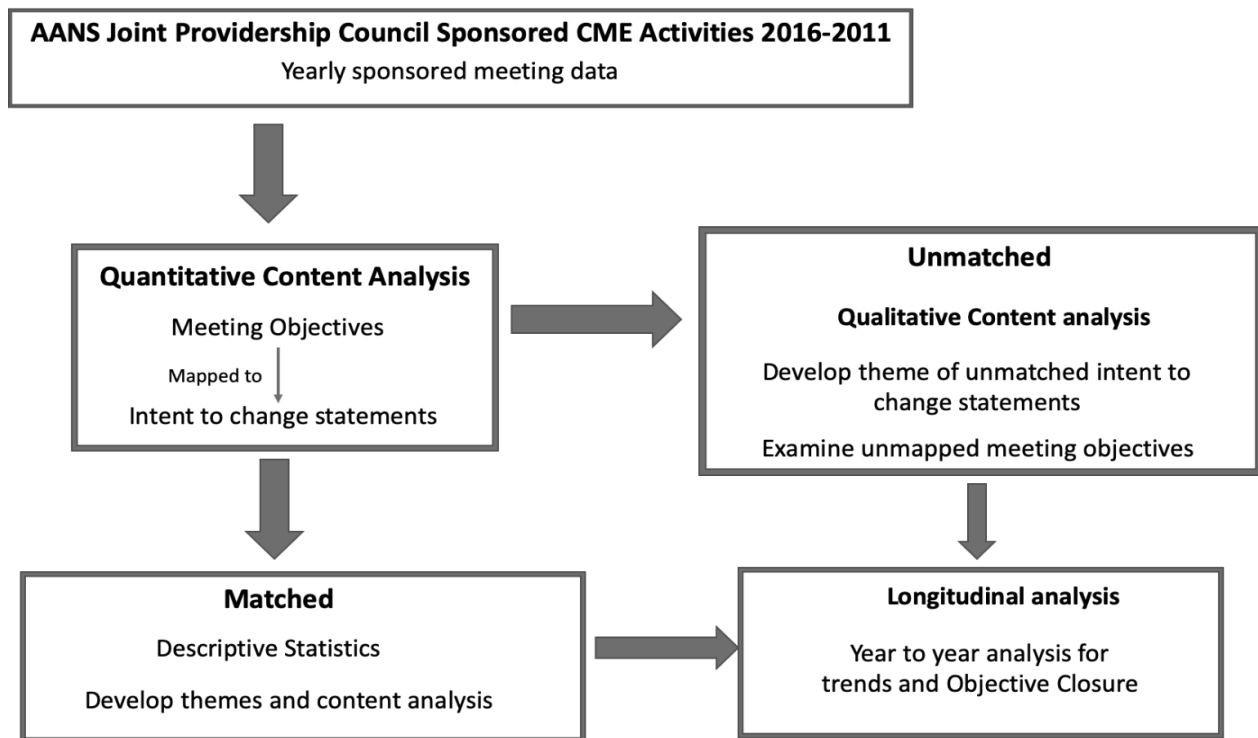
Figure 2. Study Design and Methods

B. Methodological Justification

Most prior studies have used purely quantitative methods for this type of analysis. Because the data come from written and electronic records in the form of free text, content analysis was the most appropriate method for evaluating our research question. Morgan [30] explains that "quantitative content analysis seeks to answer questions about what and how many, while qualitative content analysis seeks to answer questions about why and how the patterns in question came to be." Thus, although the data are qualitative in nature, as mentioned above, quantitative content analysis methods were used to examine specific alignment of objectives and intent-to-change statements while qualitative content analysis methods were used to identify patterns in the intent-to-change data that did not necessarily

align with meeting objectives. In summary, this work required an integrative approach to coding that incorporated both inductive and deductive elements [31, 32].

C. Data Source and Setting

Each year, the AANS Joint Sponsorship Council sponsors 15–20 CME activities. These CME activities were multiple day regional and subspecialty organizational meetings. Specifics about actual meeting organization was available in general terms. No meeting had less than 12 content hours but specifics such as meeting CME activity evaluation data for each of these meetings were examined for the years 2011–2016 (TABLES XXVIII-XXXIII, Appendix). The majority of these CME activities were sequential, occurring on a yearly basis, so trends in change were evaluated over time. The available data were in a format that was examined without significant editing to allow for the most robust examination of the research questions. This study (Protocol #2019-1152) was determined to be IRB exempt status because no human subject data were utilized in this study.

D. Data Collection

The data for this study comes from the AANS Joint Sponsorship collection kept by the AANS and is available to interested meeting planners who are members of the AANS. These data are in the form of free text as a list of intent-to-change statements gathered from each meeting and organized into Excel spreadsheets for a given year. The meeting objective data are taken directly from each meeting application and/or promotional material from that meeting. CME objectives were printed in the preconference brochures and a syllabus. Both of these sources of data were taken from all of the meetings sponsored in a

given year and were examined using content analysis in line with the conceptual

framework of meeting objective themes that could be used to map to intent-to-change data.

E. **Data Analysis and Statistics**

The data were examined by two independent coders, myself and an undergraduate

research associate, using quantitative content analysis [30] to determine whether meeting

objectives result in specific intent-to-change statements in a learner's evaluation of the CME

activity. First, all meeting objectives were examined independently by each reviewer, and a set of

themes based on each meeting objective were formulated. Next, the coders met and, through an

iterative process, decided on a common set of meeting objective themes for each year of study.

Meeting intent-to-change data were then examined and coded for words or phrases that related to

the derived themes by each observer and the data recorded using the computer program Dedoose

(www.dedoose.com, Los Angeles, California) or by manual grouping in Excel spreadsheets.

The frequency that each rater matched a given learning objective theme to a given intent-

to-change statement was calculated. Inter-rater reliability of the raters was measured by weighted

Cohen Kappa. These data are interpreted where values ≤ 0 indicate no agreement, 0.01–0.20 is

interpreted as none to slight, whereas 0.21–0.40 is judged as fair, and 0.41– 0.60 is moderate,

while 0.61–0.80 as rated substantial, and 0.81–1.00 as rated as almost perfect agreement [33]. The

two rater's frequency data were then averaged in the majority of cases. In the rare case that a large

discrepancy was found for a given intent-to-change statement, the raters together examined the

actual data set made by each observer and determined a consensus. The data were then analyzed

for number and percentage of intent-to-change data that mapped to a specific objective theme for

each year. Descriptive statistics were used to characterize frequency counts. Furthermore, the

frequency with which a given objective theme was mentioned in intent-to-change statements was recorded. Comparisons between groups of aggregated data (usually comparing year to year data trends or match and unmatched data) were made by Chi squared test and Fisher's exact test. Continuous variables are compared using the unpaired Student t-test with a two-tailed p value. Continuous variables are reported as the mean ± standard deviation unless otherwise specified. The alpha for significance is set to 0.05. All statistical analyses are performed using IBM SPSS software version 26 (IBM Corp., Armonk, NY).

We next examined the intent-to-change statements that were not related to any meeting objectives, with the goal of identifying unplanned or unforeseen themes emerging from CME activities. This was accomplished using qualitative thematic content analysis [30]. All non-matched intent-to-change statements were separated from the matched statements for a given year and examined in an inductive approach to coding for common themes and topics. Both coders independently generated themes from these intent-to-change statements. We then met to review and edit the themes through a collaborative, iterative process until common final themes were generated and agreed upon. These themes were then examined over multiple years to look for similar themes that reoccurred over time or where eliminated in subsequent years. We also examined whether the unmatched intent-to-change themes led to subsequent-year meeting objectives or continued as unmatched intent-to change themes.

III. STUDY FINDINGS AND RESULTS

A. Overall Study Descriptive Outcomes

Overall CME activity descriptive data are found in TABLE I. During the years

2011–2016, a total of 85 CME activities (yearly range = 12–16, yearly mean = 14, SD 1.3)

were sponsored by the AANS Joint Sponsorship Committee. Meeting objective data was

taken from CME activity application forms. The total number of meeting objectives per

year ranged from 58 to 83, with a mean of 71 (SD 8.6) objectives each year. Learning

objectives for a given CME activity ranged from 3-8 objectives per meeting. There were

overlapping meeting objectives from separate CME activities that were consolidated into

overall objective themes for a given year.

TABLE I. SUMMARY OF DESCRIPTIVE DATA ABOUT MEETINGS

Educational year	Total number of sponsored meetings	Total number of meeting objectives	Total number of intent-to-change statements	Ratio of intent-to-change statements to objectives
2016	16	83	588	7.1
2015	14	67	238	3.5
2014	15	75	278	3.7
2013	14	67	345	5.1
2012	12	74	355	4.8
2011	14	58	146	2.5
Total	**85**	**424**	**1950**	**4.6**
Mean	**14**	**71**	**325**	**4.4**
SD	**1.3**	**8.6**	**146**	**2.5**

The intent-to-change statements were taken directly from the meeting evaluation

data. The total number of intent-to-change statements submitted by participants ranged

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from 146 to 588 during this time period, with a mean of 325 (SD 146) in any given year. Intent-to-change statements outnumber meeting objectives by a ratio of 4.4 (range 2.5 to 7.1, SD 2.5) in any given year.

A measure of inter-rater reliability of the frequency of intent-to-change statements matched to a given learning objective theme between the two observers is presented in TABLE II. Weighted Cohen Kappa ranged from 0.9160 to 0.9735 when measured for a specific year and 0.9777 (standard error 0.0056, 95% CI 0,9665-0,.9889) when measured overall.

TABLE II. INTER-RATER RELIABILITY OF QUANTITATIVE CONTENT ANALYSIS

Educational year	Weighted Cohen Kappa	Standard Error	95% confidence interval
2016	0.9160	0,0494	0.9686-1.000
2015	0.9527	0.0207	0.9087-0.9966
2014	0.9197	0.0340	0.8362-1.000
2013	0.9195	0.0351	0.8463-0.9927
2012	0.9547	0.0202	0.9120-0.9973
2011	0.9735	0.0114	0.9494-0.9976
All years	**0.9777**	**0.0056**	**0.9665-0.9889**

B. Quantitative Content Analysis of Intent-to-change Statements

CME activity objectives were coded as themes and mapped to participants' intent-to-change statements from the years 2011–2016 For any given year, there were a number of overlapping objective themes among the different AANS-sponsored meetings, making examination as aggregate data the most effective way to assess overall alignment of

meeting planner objectives and participant statements of intention to change. TABLES III-VIII are found in the Appendix for complete data set of themes and subthemes for each given year. For example, for the year 2016 (TABLE III) there were 45 unique objective themes that were identified from 16 AANS-sponsored CME activities. This included 25 major themes with 20 associated subthemes. There were 588 intent-to-change statements from participants available for evaluation. In particular, 175 (29.8%) participant statements did not correspond with any of the 45 themes and subthemes. These will be discussed in more detail in the next section. TABLE IX condenses the data by objective theme over time. This includes only objectives that matched to intent-to-change themes for more than one year during the study. The most frequent category is "none" meaning that a meeting attendee intent-to-change statement did not map to any of the stated meeting objectives. These statements are the subject of the next section and will be discussed there.

TABLE IX summarizes the meeting objective themes with the 5 highest number of intent-to-change statements associated with that objective. Common themes for many years include resident education (found in years 2011, 2012, 2015, 2016), clinical evidence and best practices (found in years 2011, 2013, 2014, 2016), and complication avoidance/morbidity and mortality reduction (found in years 2012, 2013, 2015). Not surprisingly, a common thread through all meeting objective themes was the dissemination of new therapeutic options contained in themes such as recent innovations, novel surgical approaches and techniques, recent progress, and advancements. Another common thread included methods of determining whether our current treatments are appropriate and adequate, expressed in themes such as guidelines and databases, practice change and controversy, surgical treatment and outcomes, and current treatment options.

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TABLE IX. CONDENSED MEETING OBJECTIVES ASSOCIATED WITH INTENT-TO-CHANGE STATEMENT FOR AT LEAST TWO YEARS DURING THE STUDY EXAMINED OVER TIME

Objective themes	Number (%) of intent-to-change statements that track to objectives					
	2016 (n=588)	2015 (n=238)	2014 (n=278)	2013 (n=345)	2012 (n=355)	2011 (n=146)
None	175 (29.8)	87 (36.5)	135 (48.6)	126 (36.5)	155 (43.7)	50 (34.2)
Resident education and mentorship	111 (18.9)	15 (6.3)		10 (2.9)	65 (18.3)	8 (5.5)
Best practices, evidence-based medicine, outcomes	94 (16.0)		33 (11.9)	63 (18.3)	6 (1.7)	15 (10.3)
Reimbursement, socioeconomic, regulatory	31 (5.2)	22 (9.2)	15 (5.4)	7 (2.0)	8 (2.3)	3 (2.0)
Complication avoidance	7 (1.0)	23 (9.7)	6 (2.2)	16 (4.6)	14 (3.9)	3 (2.0)
Treatment options	50 (8.5)					26 (17.8)
Guidelines and databases	27 (4.6)		6 (2.2)	28 (8.1)		
Novel surgical approaches	18 (3.1)			57 (16.5)	56 (15.8)	
Innovation emerging technologies	14 (2.4)		31 (9.9)	1 (0.2)	15 (4.2)	21 (14.3)
New research	13 (2.2)		18 (6.5)	1 (0.2)		3 (2.0)
Clinical trials	13 (2.5)		6 (2.2)		3 (0.8)	
Pediatric neurosurgery		15 (6.3)	13 (4.7)	5 (1.4)	14 (3.9)	
Trauma	1 (0.3)	19 (8.0)			1 (0.3)	
Brain tumor management	2 (0.6)	9 (3.8)			6 (1.7)	
Coagulation pathway inhibitors	2 (0.6)			5 (1.4)	2 (0.6)	
Sport-related injury/concussion	3(0.5)	5 (2.1)		11 (3.2)	1 (0.3)	
Novel imaging, biomarkers/laboratory	2 (0.6)		14 (5.0)	3 (0.8)	2 (0.6)	2 (1.4)
Controversies in central nervous system disease	1 (0.3)		6 (2.2)	18 (5.2)	1 (0.3)	1 (0.7)
Quality of life and value	8 (2)					3 (2.0)
Spinal arthroplasty	12 (2.0)			2 (0.6)		
Spinal deformity and biomechanics	16 (2.7)	5 (2.1)	7 (2.5)		5 (1.4)	
Endovascular		4 (1.7)				1 (0.7)
Radiosurgery		3 (1.3)				1 (0.7)

TABLE X. MEETING OBJECTIVES WITH HIGHEST NUMBER OF ASSOCIATED INTENT-TO-CHANGE STATEMENTS (TOP 5)

Rank	2016	2015	2014	2013	2012	2011
1	Resident education	Complication avoidance	Recent innovations	Best practices and clinical evidence	Novel surgical approaches and technique	Current treatment options
2	Best practices and clinical evidence	Socio-economics	Evidence-based medicine and outcomes	Novel surgical approaches and technique	Surgical treatment and outcomes	Recent progress and advancements
3	Treatment options	Trauma	Research	Practice change and controversy	Neurosurgical resident training and mentorship	Clinical evidence and best practices
4	Guidelines and databases	Education	Reimbursement and regulation	Complication avoidance	Treatment advances	Resident education
5	Patient outcomes	Pediatric neurosurgery	Novel imaging and biomarkers	Concussion and sports-related injury	Morbidity and mortality reduction	Minimally invasive spine surgery

C. Qualitative Content Analysis of Intent-to-change Statements Not Related to Meeting Objectives

TABLE XI contains a summary of intent-to-change statements that did not map to any meeting objective for the years 2011–2016. In total, 728 of 1950 intent-to-change statements did not correspond with any CME meeting objective, a mean of 37.3% (range 29.8–48.6%, SD 6.8%). This represented the largest category of intent-to-change statements for all years studied. We next focused our examination on these unmatched intent-to-change statements made by attendees at these CME activities to determine the nature of the data and look for why they did not map to explicit objectives and whether

there might be implicit learning to account for these statements. Furthermore, we wanted to know if these unmatched intent-to-change statement drive subsequent meeting planning in the form of meeting objectives. To accomplish this, we examined all unmatched intent-to-change statements using qualitative content analysis to discover themes that emerge from these intent-to-change statements on a yearly basis.

TABLE XI. SUMMARY OF INTENT-TO-CHANGE STATEMENTS NOT RELATED TO ANY MEETING OBJECTIVE THEME

Year	Intent-to-change statements that do not track to meeting objectives	Total intent-to-change statements	Percentage
2016	175	588	29.8
2015	87	238	36.5
2014	135	278	48.6
2013	126	345	36.5
2012	155	355	43.7
2011	50	146	34.2
Total	**728**	**1950**	
Mean			**37.3**
SD			**6.8**

TABLES XII-XVII (Appendix) contains all intent-to-change statement themes from 2011-2016 in rank order by year that were mentioned more than once by meeting participants but not related to any meeting objective. TABLE XVIII summarizes this data over the course of the study period. One notable recurrent theme is that of referrals. This theme came up in every year that we studied, but no meeting objectives were ever created by meeting planners to address this perceived need. The other intent-to-change statements not shown in this table are

not sustained over multiple years, suggesting some fulfillment at least on an intermittent basis. In fact, 35/45 of the intent to change statement themes associated with no stated meeting objective occurred only in one year suggesting resolution in subsequent years.

TABLE XVIII. INTENT TO CHANGE STATEMENTS ASSOCIATED WITH NO STATED MEETING OBJECTIVES REPEATED IN MORE THAN ONE YEAR (LISTED BY NUMBER MENTIONED)

Intent-to-change statement themes	Number of times mentioned					
	2016	**2015**	**2014**	**2013**	**2012**	**2011**
Patient referrals	4	4	8	5	7	2
Patient education	4		2	3	3	
Minimally invasive surgery	5	3		3		2
Cost and value/quality		3	6		3	
Imaging	3				7	4
Endoscopic procedures		2	5	4		
Chiari malformation management	2		2	3		
Concussion	4		10			
Patient selection			3	5		
Laser interstitial therapy and magnetic resonance–guided high-intensity ultrasound		4	2			

We next examined how these statements may have led to meeting objective changes by mapping intent to change statements from previous years to subsequent meeting objectives. Some of the unmatched intent-to-change statements appear to have led to a new meeting objective in the following year that had not been seen in the year of the original intent-to-change statement (TABLE XIX). For instance, in 2011 the unmatched intent-to-change statements of

comprehensive and multidisciplinary care and minimally invasive surgery were found as meeting

objectives in 2012. The same is true for stem cell and cellular transplantation in 2012/2013. In

2013, unmatched themes of tumor tissue biomarkers, minimally invasive surgery, neurocritical

care, and outcomes and guidelines are possibly related to the same meeting objectives found in

2014. In the years 2014/2015, the same pattern was found for neurocritical care, and outcomes and

guidelines are possibly related to the same meeting objectives found in 2014. In the years

2014/2015, the same pattern was found for concussion management, Chiari malformation

management, and surgery for intraparenchymal hematoma. No such pattern was found in

2015/2016. Although these seeming relationships exist, TABLE XX shows that this is not the

most common outcome of unmatched intent-to-change statement, as on mean only 22.6% (range

0–41.7%, SD 15.4%) of unmatched intent-to-change statements led to new meeting objectives.

TABLE XIX. INTENT-TO-CHANGE THEMES THAT WERE SEEN TO DRIVE THE NEXT YEAR'S MEETING NEW OBJECTIVES

Years	Unmatched intent-to-change statement themes	Number of times intent-to-change statement themes were mentioned	Following year objective matched to prior intent-to-change statement	Number of times the objective was matched to an intent-to-change statement in new year
2011/2012	Comprehensive and multidisciplinary care	3	Multidisciplinary care	1
	Minimally invasive spine surgery	2	Surgical treatment and outcomes: minimally invasive surgery	6
2012/2013	Stem cells and cellular transplantation	2	Stem cell and cellular transplantation	2
2013/2014	Tumor tissue biomarkers	5	Novel imaging and biomarkers	14
	Minimally invasive spine surgery	3	Evidence-based medicine and outcomes: minimally invasive spine	6
	Neurocritical care	2	Neurocritical care	1
	Outcomes and guidelines	2	Evidence-based medicine and outcomes: general and practice guidelines, change and controversies	13
2014/2015	Concussion management	10	Concussion management	5
	Chiari malformation management	2	Chiari malformation	5
	Surgery for intraparenchymal hematoma	6	Stroke and extracranial vascular	2
2015/2016	None	0	None	0

TABLE XX: SUMMARY OF INTENT-TO-CHANGE STATEMENT THAT APPEAR TO DRIVE SUBSEQUENT MEETING OBJECTIVES

Years	Percentage of unmatched intent-to-change statement themes for each year that drove a learning objective for the next year
2011/2012	2/9 (22.2%)
2012/2013	1/12 (8.3%)
2013/2014	4/12 (33.3%)
2014/2015	5/12 (41.7%)
2015/2016	0/8 (0%)
Overall	**12/53 (22.6%, SD 15.4)**

D. Content Analysis of Meeting Objective Themes with No Correlated Intent-to-change Statements

We next examined the CME meeting data from a different perspective. TABLE XXI summarizes the number of meeting objective theme over the years studied that did not have any intent-to-change statements associated with theme. In 2016, there were 6 unmatched objective themes, 9 in 2015, 10 in 2014, 16 in 2013, 12 in 2012, and 13 in 2011. On average, there were 11 (SD 3.1) unmatched meeting objectives per year, which represented 15.5% (range 7.2–23.9%, SD 5.7) of all meeting objectives for a given year. It is not clear why these objectives were not aligned with intent-to-change statements. To examine this further we looked at the specific unmatched objectives in more detail

TABLE XXI: MAJOR MEETING LEARNING OBJECTIVE THEMES THAT MATCHED WITH NO INTENT-TO-CHANGE STATEMENTS

Educational year	Total number of sponsored meetings	Total number of meeting objectives	Unmatched meeting objectives	% Unmatched meeting objectives
2016	16	83	6	7.2
2015	14	67	9	13.4
2014	15	75	10	13.3
2013	14	67	16	23.9
2012	12	74	12	16.2
2011	12	58	13	22.4
Mean	**14**	**71**	**11**	**15.5**
SD	**1.5**	**7.8**	**3.1**	**5.7**

We grouped unmatched meeting objectives that were repeated over multiple years in Table XXII by placing similar themes in rows to look for longitudinal patterns of change year by year. Although wording differed slightly year to year, they are grouped by similar themes. TABLE XXIII contains meeting objective themes that were not repeated in other years during our study period. Both TABLE XXII and TABLE XXIII were examined qualitatively for a general sense of differences between objective theme content. One obvious aspect of the meeting objective themes that occurred only once (TABLE XXIV) during the study years is that the objectives were in general terms more topic specific or procedure related knowledge. Topics such as middle cerebral artery aneurysm, syringomyelia, treatment of frontal sinus fractures, decompressive craniectomy, and vertebroplasty and kyphoplasty are focused on more clinically or medical practice-based themes. Conversely, the objectives that occurred in multiple years (Table XXII) seem to be more generally based on scholarly, academic, career-based or declarative knowledge

themes as history, leadership, professionalism, clinical evidence and best practices, and complication avoidance. That said, there are exceptions such as clinically based objectives like atypical meningioma in the multiple-year group and academic topics like ethics and entrepreneurship in the single-year group. We further examined the number of specific/procedural versus general/declarative knowledge objective theme topics found in the multiple-year objectives versus the single-year objectives (TABLE XXIV).

TABLE XXII: MAJOR MEETING OBJECTIVE THEMES THAT MATCHED WITH NO INTENT-TO-CHANGE STATEMENTS REPEATED OVER MULTIPLE YEARS

2016	2015	2014	2013	2012	2011
		Helmets in athletics and motor sports	Helmet use in sports	Concussion in the NFL	
Atypical meningiomas	Atypical meningiomas				
				Socioeconomic factors	Socioeconomic factors
Historical perspectives	History of neurosurgery	Trends in neurosurgery	Future trends in neurosurgery		
		Complication avoidance	Morbidity and mortality	Morbidity and mortality	Morbidity and mortality
Professional-ism	Leadership		Organized neurosurgery and volunteerism		Leadership and stewardship
Pediatric neurosurgery			Transition of care from pediatric to adult neurosurgery		
	Evidence-based practices		Complex data sets for outcomes and methods	Assessment tools and interventions	Clinical evidence and best practices
			Resident mentorship	Resident mentorship	
	Surgery in eloquent cortex		Adjuncts for surgery in eloquent cortex	Low-grade glioma resection	
		Functional neurosurgery	Multi-disciplinary management of movement disorders		Surgery for psychiatric disease
Spinal spondylosis	Spine metastasis management	Spinal cord injury	Difficult spine case management	Surgical treatment of lumbar stenosis	Role of spinal surgery in neurosurgical practice
		Surgical management of median neuropathy			Evaluation and management of peripheral nerve disorders

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TABLE XXIII: MAJOR MEETING OBJECTIVE THEMES THAT MATCHED WITH NO INTENT-TO-CHANGE STATEMENTS THAT WERE NOT REPEATED OVER MULTIPLE YEARS

2016	2015	2014	2013	2012	2011
Traumatic brain injury demographics	Skull base techniques	Syringomyelia treatment	Treatment of frontal sinus fractures	Translational science	Understanding of neuroanatomy
	International neurosurgery	Complex middle cerebral artery aneurysm	Use of boot camps for new milestones	Virtual surgery planning	Trends in patient safety
	Endovascular stents	Recent innovations and advancements	Interpersonal conflict management	Decompressive craniectomy	Current status of lumbar arthroplasty
		Stem cell and cellular transplant	Ethics and entrepreneurships	Vertebroplasty and kyphoplasty	Controversies in neurosurgery
			Trauma transfer protocols	Clinical trials in cerebrovascular, neurooncology	Posterior cervical fusion procedures
			Challenges facing neurosurgery		Vaccine therapy for malignant gliomas

TABLE XXIV: QUANTITATIVE COMPARISON OF MEETING OBJECTIVE THEMES THAT MATCHED WITH NO INTENT-TO-CHANGE STATEMENTS

	Total topics	General/declarative knowledge Academic/scholarly topic	Specific/procedural clinical/medical practice topic	X^2 value
Multiple-year unmatched objective	41	31 (75.6%)	10 (24.4%)	X^2 M(1, n=2) = 10.2 p=0.0014
Single-year unmatched objectives	25	9 (36.0%)	16 (64%)	

General (declarative knowledge, academic, scholarly) topics were found in 31

(75.6%) multiple-year objectives and 9 (36.0%) single-year objectives, while more specific

(procedural, clinical, medical practice) topics were found in 10 (24.4%) multiple-year

objectives and 16 (64.0%) single-year objectives; these values were statistically

significantly different ($X^2(1, n=2)=10.2$, p=0.0014). There were more multiple-year

objectives than single-year objectives in all of the years studied, with no significant

differences in frequency from year to year (TABLE XXV, Fisher's exact = 13.4, p=0.933).

TABLE XXV: COMPARISON OF MEETING OBJECTIVE THEMES THAT MATCHED WITH NO INTENT-TO-CHANGE STATEMENTS ON MULTIPLE YEARS VS. ONLY ONE YEAR

Educational year	Total unmatched meeting objectives	Unmatched meeting objectives for single year	Unmatched meeting objectives for multiple years	Comparison of percentages
2016	6	1 (16.7%)	5 (83.3%)	
2015	9	3 (33.3%)	6 (67.7%)	
2014	10	4 (40.0%)	6 (60.0%)	Fisher's
2013	16	6 (37.5%)	10 (62.5%)	exact=13.4
2012	12	5 (41.7%)	7 (58.3%)	p=0.933
2011	13	6 (46.1%)	7 (53.8%)	
Mean	11	4.2 (38.2%)	6.8 (61.8%)	
SD	3.2	1.9 (10.3%)	1.7 (10.4%)	

In one last look at the meeting objectives, we examined whether meeting planners

reused prior objectives from year to year (TABLE XXVI). We found 11 CME activities

(deidentified) that used similar objectives over more than one year. Five of the CME

activities repeated only some of prior meeting objectives, with 1–7 unchanged objectives

constituting anywhere from 12.5 to 80% of the total meeting objectives. The remaining six

CME activities used exactly the same learning objectives for all of the learning objectives

over a range of anywhere from 1 year (2 activities), 2 years (2 activities), 3 years (1

activity), and 4 consecutive years (1 activity).

TABLE XXVI: CME ACTIVITIES WITH UNCHANGED MEETING OBJECTIVES OVER A COURSE OF YEARS

Deidentified CME activity	Number of learning objectives unchanged	Years learning objectives were unchanged	Total number of learning objectives per meeting	Percentage of learning objectives unchanged
1	4	2011–2012	2011=17 2012=14	2011=23.5 2012=28.6
2	4 2	2011–2012 2011–2013	2011=5 2012=6 2013=5	2011=80.0 2012=66.7 2013=40.0
3	4	2011–2013	2011–2013=4	2011–2013=100.0
4	5	2012–2016	2012–2016=5	2012–2016=100.0
5	1 1	2012–2013 2013–2014	2012=8 2013=6	2012=12.5 2013=16.7
6	3	2013–2016	2013–2016=3	2013–2016=100.0
7	3	2013–2014	2013–2014=5	2013–2014=60.0
8	3	2014–2016	2014–2016=3	2014–2016=100.0
9	4 7 6	2014 2015 2016	2014=10 2015=10 2016=11	2014=40.0 2015=70.0 2016=54.5
10	3	2015–2016	2015–2016=3	2015–2016=100.0
11	4	2015–2016	2015–2016=4	2015–2016=100.0

We next examined the effect of reusing meeting learning objectives over repeated

years on correlation with intent-to-change statements. To accomplish this, we examined all

repeated learning objectives over the study period for each year repeated and classified the

objective as either associated or unassociated to any intent-to-change statements for that

given year (TABLE XXVII). There were 119 repeated objectives in total over the 6 years

of our study. Of these repeated objectives, only 26/119 (21.8%) were unmatched to intent-

to-change statements, suggesting that repeated use of the same learning objectives is not a

major source of intent-to-change statements that do not align with meeting planner's

intended CME learning objectives.

TABLE XXVII: CME ACTIVITIES WITH UNCHANGED MEETING OBJECTIVE THEME OVER A COURSE OF YEARS REVIEWED FOR ASSOCIATED INTENT-TO-CHANGE STATEMENTS

Mtg	Repeated learning objective theme	Years repeated	Associated with intent-to-change statement					
			2011	2012	2013	2014	2015	2016
1	1. Evidence-based medicine	2011–2012	No	Yes				
	2. Techniques for spinal surgery		Yes	Yes				
	3. New techniques		Yes	Yes				
	4. Developments in tumor biology		Yes	Yes				
2	1. Current approaches for spinal disorders	2011–2012	Yes	Yes	Yes			
	2. Socioeconomic factors		No	No	Yes			
	3. New technologies		Yes	Yes	Yes			
	4. New basic science information	2011–2013	Yes	Yes	Yes			
3	1. Current research and clinical develop	2011–2013	Yes	Yes	Yes			
	2. Controversial clinical and research		No	Yes	Yes			
	3. Morbidity and mortality		No	No	No			
4	1. Current clinical evidence	2012–2016		Yes	Yes	Yes	No	Yes
	2. Current clinical and laboratory studies			Yes	Yes	Yes	Yes	Yes
	3. Evidence-based medicine			Yes	Yes	Yes	No	Yes
	4. Reimbursement and regulatory policies			Yes	Yes	Yes	Yes	Yes
	5. New advances			Yes	Yes	No	Yes	Yes
5	1. Basic sciences	2012–2013		Yes	Yes	Yes		
	2. Stem cell and cellular transplantation	2013–2014		Yes	Yes	No		
6	1. Complication avoidance	2013–2016			Yes	Yes	Yes	Yes
	2. Future trends in neurosurgery				No	No	No	No
	3. Innovations				Yes	No	Yes	Yes
7	1. Affordable Care Act	2013–2014			Yes			
	2. Negotiating with hospital				Yes			
	3. Organized neurosurgery				No			
8	1. Evidence-based clinical practice	2014–2016				No	No	Yes
	2. Multidisciplinary care					Yes	Yes	Yes
	3. Innovative technologies					Yes	Yes	Yes
9	1. Clinical decision-making	2014–2016				Yes	Yes	Yes
	2. Emerging technologies	2014–2016				Yes	Yes	Yes
	3. Complications avoidance	2014–2016				No	Yes	Yes
	4. Reimbursement	2014–2015				Yes	Yes	Yes
	5. Contemporary management	2015–2016				Yes	Yes	Yes
	6. Neuromodulation	2015–2016				No	Yes	Yes
	7. Controversies	2015–2016				Yes	Yes	Yes
10	1. Pediatric neurosurgical disorders	2015–2016					Yes	No
	2. Complication management						Yes	Yes
	3. Recent developments						Yes	Yes
11	1. Eloquent cerebral tissue	2015–2016					No	Yes
	2. Atypical meningiomas						No	No
	3. Traumatic brain injury						Yes	No
	4. Brain edema						Yes	Yes

IV. DISCUSSION

A. Overall Study Approach and Importance

The ACCME defines "joint providership as the provision of a CME activity by one accredited and one nonaccredited organization." In this study, the AANS is the accredited organization and the multiple meetings we have examined are cosponsored by nonaccredited organizations. The accredited provider is responsible for the conduct of the nonaccredited organization's CME activity. Thus, the AANS has a special interest in the quality of the CME activities sponsored under its cooperation. To ensure that a given CME activity is appropriate for sponsorship from the AANS, a couple of guiding principles must be followed. The first is that the "audience of the activity must be made up of at least 50% neurosurgeons" and second is that the "mission statement, purpose, or function must be congruent with the AANS CME Mission Statement" (https://www.aans.org/en/Education/CME-Accreditation). This Mission Statement includes the following "The AANS aims to achieve excellence in continuing medical education (CME) through educational activities built on evidence-based medicine and adult learning principles. The AANS CME program provides activities to meet the participants' identified education needs and to support their life-long learning towards a goal of improving neurosurgeon's competency skills with a measurable result. The AANS sustains a rigorous program of continuing medical education that impacts the provision of health care in neurological surgery and related sciences by focusing on relevant curricula taught by renowned neurosurgical and related neuroscience faculty" (https://www.aans.org//media/Files/AANS/Education/ AANS_CME_Mission_Statement.ashx?la=en&hash=28FCBAE1D225F60CA907E83AE91FDA F62919CD8E).

The reaccreditation process required by the ACCME includes that the AANS verify that CME activities sponsored by the AANS meet all ACCME requirements. The AANS staff, through the Joint Providership Application, review the CME activity for practice knowledge gaps, data sources, and needs of the meeting attendees. Learning objectives are also reviewed. Practice gap data sources used on this application include previous evaluation results, program committee consensus, expert opinion, survey of target audience, journal articles and medical literature review, and outcomes data. There have been calls to "focus CME activities on improving practice rather than disseminating information" [1]. Making this happen requires a shift in how CME activities are evaluated including "going beyond measuring learner satisfaction and change in medical knowledge to the level of physician performance and patient outcome" [17]. The AANS Joint Sponsorship Chair and Committee use the intent-to-change data from each CME activity as a measure of the educational value of that activity. Furthermore, these intent-to-change data are given to meeting organizers to use as a framework for future planning and feedback of previous meeting outcomes. It is important to understand the relationship between intent-to-change data from given CME activities and the learning objectives set for those meetings. The most practical rationale for this study is to examine the use of meeting evaluation data and meeting objective data to improve CME activities. Furthermore, one can use this data to explore how intent-to-change data are used by CME organizers to plan educational activities and discover how meeting objectives are formulated and how they evolve over time. The data we examined has the granularity for both qualitative and quantitative content analysis [30]. Mixed-method content analysis was used to answer the direct question of meeting planner use of objectives and outcomes of learners. In addition,

by using more traditional inductive qualitative techniques we were able to show that many intent-to-change statements made by CME attendees did not map to any predetermined meeting objectives. As will be discussed below there are a number of ways to interpret this data but consider that at least one possibility is this represents unseen, unplanned learning that takes place at various AANS-sponsored CME activities. A close examination of this data has the potential to reveal themes of "hidden curriculum" or unmet needs that might represent "practice gaps" that meeting planners did not know about or did not think would be of interest to meeting attendees. Examination of this type of data over multiple years, as well as examination of whether practice gaps are changed over time, can be used to improve CME activities to better meet the needs of the participants of these events. Some of the practice gap information is specific and useful only for the AANS Providership committee and meeting organizers. However, the patterns and themes that evolve from this work have widespread implications for all CME activities across a broad field of disciplines. Furthermore, because the data covers more than a 6-year period of time, longitudinal outcomes, "drift" of objectives, and learner intent can be explored. An understanding of the motivations that drive CME activities to correspond with learner needs is an important unmet need for the Joint Providership Council of the AANS in particular and CME meeting planners across all disciplines in general. This work is based on 85 CME activities sponsored by the AANS and is focused on these intent-to-change statements.

B. **Intent-to-change Statements and Adult Learning Theory**

The intent-to-change statement procedure has been linked to established educational learning theories. Bandura's social learning theory upholds that clear specification of a behavioral

goal facilitates its accomplishment [34, 35]. This work holds that behavior is dominated by two sets of influences. The first is "outcome expectations based on the estimate of a person that a given behavior will lead to certain outcomes." The second, "efficacy expectations, which involve the conviction that one can successfully execute the behavior required to proceed a specific outcome" [36]. This is supported by work demonstrating that physicians change their behavior (e.g., treatment of the patient) only after a series, and perhaps a particular series, of education and corroboratory influences have been brought to bear on a particular unsatisfactory set of patient situations in which the new behavior is likely to be more successful than the prior behavior [34, 37]. Ausubel's theory of meaningful learning emphasizes the role of advance organization by meeting planners. The emphasis is on a given learning experience that summarizes beforehand to orient the individual to look for, notice, and act on those specifics when opportunity and information appear [34, 38, 39]. In the context of our study, this would imply that meeting objectives alert the learner to what the intent-to-change would be for each individual. Information processing theory holds that making a summary at the end of a learning experience moves the contents of the summary from short-term memory into long-term memory [34, 40, 41]. The process of intent-to-change statement generation allows participants to summarize what they learned during the activity and access what was of sufficient impact and value to stimulate change in their patient management. This can lead to retention of this information and change [34].

C. **Intent-to-change Statements as a Measure of Learning**

Intent-to-change statements are also described in the literature as statements of motivation to change [6, 7], commitment to change [8-15], and readiness to change [16]. These seem to be used interchangeably, but for this work we have used the convention of intent-to-change. The intent-to-change approach is used by CME evaluators as a method of assessing the changes in

clinical practice patterns that come as a result of a learning activity. This approach is based on asking educational activity participants to write down "descriptions of the changes they propose to make as a result of what they learned during the activity" [17, 18]. This in turn has been used as a measure of clinical practice change [23, 42]. The use of participant intent-to-change statements in CME has served a number of purposes as described below.

First, intent-to-change statements are a means for promoting reflection on current practice and encouraging participants to identify and commit to specific planned practice changes [11, 23, 43, 44]. They can serve as a marker or proxy for actual practice change since physicians who make intent-to-change statements are more likely to follow through with making changes than those who do not. Studies of educational interventions that employ a commitment-to-change or intent-to-change approach have found that 47–87% of the intended changes were implemented as reported [8, 10, 12, 13, 23, 34, 42, 43, 45-47]. Overton and MacVicar [48] discussed the conceptualization of commitment and the psychosocial variables contributing to follow-through on planned practice changes. They found a relationship between the degree of cognitive complexity embodied by intent-to-change statements and implementation of changes in practice [11, 48]. To impact practice and implement intent-to-change statements, a deeper level of learning needs to take place [11, 49]. Deep learning requires critical evaluation of new information, integrating or linking new knowledge with previous knowledge, and interpreting information and applying it appropriately, e.g., to a clinical case [11]. Conversely, surface learning focuses on information and memorization, often without association and reflection [3, 11, 50]. This concept was examined by evaluating intent-to-change statements with Bloom's Taxonomy of the Cognitive Domains as a conceptual framework for assessing cognitive complexity. Bloom's Taxonomy classifies thinking into "6 increasingly complex levels: knowledge, comprehension,

application, analysis, synthesis, and evaluation" [51]. The simplest levels include recall or reproduction of facts and represent surface learning, following by increasingly more abstract and complex levels that denote deeper learning. Thus, application and evaluation are at deeper levels than are knowledge and comprehension, according to Bloom's framework [45, 51-53].

The second way that intent-to-change statements have been used is as a "tool to assess the effectiveness of the specific educational intervention" [8, 10-13, 18, 23, 34, 42, 43, 45, 47]. These statements can be used as an evaluation tool in a number of ways. One method involves quantitative evaluation of impact of the CME activity by measuring the "number of intended practice changes, number of learners who made intent-to-change statements, mean number of commitments per learning episode, and percentage of compliance with stated commitments" [54]. As mentioned in the introduction, others have collected the intent-to-change statements and compared them with the meeting objectives [20, 21] as we have done in this study.

D. Quantitative Content Analysis of Intent-to-change Statements

Our data over many years suggest that the majority of intent-to-change statements can be directly tied to stated meeting objectives. From a broad overview, we identified resident education, best treatment practices and treatment options, socioeconomic issues, databases and registries, complication avoidance, patient outcomes, innovation, and new surgical techniques and approaches as common threads from year to year. This is hardly surprising given the audience of a relatively like-minded and focused practice group of neurosurgical learners as the majority audience at these events. There are variations from year to year, but many of the differences are in terminology and not necessary in the intent of the meeting planners or the actual meaning of the individual participants' statements.

As described previously, intent-to-change statements are acknowledged as a valuable evaluation tool for educational program evaluation. Some have opined that these statements are based on Locke's goal-setting theory, which holds that behavior is affected by individual motivation and draws on the principle that adults learn what is relevant to their needs [13, 55]. The majority of the intent-to-change statement found in TABLE IX would support this notion. These statements all paint a picture of learners committed to practice change and improvement. The heavy reliance of the field of neurosurgery on new technology is reflected in these statements and has be found in the work of others examining CME meeting outcomes from meetings involving rapidly evolving technologies [56]. Our study data are not sufficient to demonstrate, actual practice change by participants of the CME activities we have examined here. Others have criticized work similar to ours as incomplete without verification of data on the actual clinical practice change and impact on physician behavior. Our data, and most similar study data, involve information gathered from participants only at the immediate end of a CME activity with no follow up at a later date [17, 57]. Some have questioned the validity of this approach without adding follow-up at a later date to confirm that the commitment to change has been carried out [23, 54]. These authors have argued that the self-reported nature of the statements was the major limitation of this method [17]. Other have demonstrated that, in fact, self-reported intent-to-change statements can be a valid measure of changes in clinical practice behavior [34]. Spending time to complete a post-meeting questionnaire and write intent-to-change statements may, in and of itself, reflect a seriousness about the intent to change that may, in turn, predict action [9].

E. <u>**Content Analysis of Meeting Objective Themes with No Correlated Intent-to-change Statements**</u>

One of the most interesting aspects of this study is the 30–48% of yearly intent-to-change statements that did not map to any meeting objectives. This was the largest single theme of intent-to-change statements for each of the years; however, admittedly it was simply a compilation of unmatched statements. This could be interpreted in a number of ways. It is possible that there may be a disconnection between the intent of the meeting planners and the participants' judgement of importance of a given subject. Another explanation is simply that none of the speakers chose to present information on these objective topics. Furthermore, the number of CME learning objectives for any given meeting is limited. It is possible that some of the intent-to-change statements did reflect actually teaching that took place during the meeting but was not stated as an actual meeting objective. The data available for this study doesn't necessarily help us know if any of these scenarios are true. That said, if this was the case one might expect the meeting objectives to evolve over time to reflect this, which we did not necessarily observe.

Another interpretation of the data revolves around the explicit and implicit nature of learning objectives and intent-to-change statements [19]. It is possible that our interpretation of the meeting objectives and coding into themes did not reflect the implicit intent of the meeting planners but the meeting participant's intent-to-change statements were written with this in mind. We observed that some intent-to-change statements are vague enough in nature that our methods were unable to categorize the true meaning of the participant and subsequently failed to recognize the correlation with a given objective. An example of this is the recurrent theme of "referrals." This theme came up in every year that we studied, but no meeting objectives were ever created by meeting planners to address this perceived need. The most obvious reason would be the rather

general nature of this theme. A review of the actual intent-to-change statements reveals learners describing both the need to send out more referrals for specific cases they were not comfortable managing or statements saying they would like to be referred more patients from other physicians to manage a particular neurosurgical disorder. Thus, crafting objectives to meet these types of statements might be difficult for meeting planners. It has been shown that explicit curricular intentions can converge with implicit learning outcomes that benefit expansion of knowledge [58]. If the implicit learning is based on improving patient care it may not necessarily exactly align with the stated, explicit learning objectives. It is even more complicated when comparing intent-to-change statements or meeting learning objectives formulated with declarative knowledge gains in mind vs those aimed at improving procedural knowledge. We tried to factor this into our initial theme creation and during the coding process to eliminate errors of alignment between explicit and implicit intent.

Nevertheless, it does appear that unmatched intent-to-change statements may represent unintended consequences of the CME activity. This of course, is not an unwanted outcome if it means that learning expanded outside of the planned curriculum [59]. Unanticipated practice change statements have been found in a number of studies that have used techniques similar to those in our work [11, 17, 48]. In fact, the work we have used as a conceptual framework for this project, that of Dolcourt and Zuckerman [20], compared intent-to-change statements for a meeting they hosted with the stated meeting objectives for that CME activity and documented anticipated and unanticipated learning outcomes. They found that slightly more than two thirds of the intent-to-change statements were anticipated learning outcomes (mapped to meeting objectives); however, similar to our findings, "almost one third (32%) of the self-identified intent-to-change statements were not precisely related to any of the instructional objectives and appeared to

represent unintended outcomes." They proposed three reasons for these unintended outcomes. First, the learners' specific "prior knowledge domain enhances and improves acquisition of new domain-related information." It has been pointed out that an assumption of the intent-to-change approach is that the educational activity corrects an existing gap between optimal practice and actual practice. However, this is not necessarily true for all participants especially if their medical practices are already consistent with the learning outcomes designed for that activity [17]. Second, if the "CME objectives themselves are written from the perspective of the planners rather than that of the learners, these objectives might provide only ready-made solutions." This concept is supported by studies showing that addition of more number of learning objectives "does not make it possible for CME planners to develop objectives that fully anticipate all of the learning that takes place at a given activity" [60]. Third, "the instructional objectives communicate the planners' broad intent of instruction to a heterogenous audience, but intent-to-change statements are personalized and individualized and were more complex and specific than the predetermined instructional objectives." We agree with the latter when examining the themes of the unmapped intent-to-change statements. Many of the meeting objectives are broad in scope, and some of the unmatched intent-to-change themes are quite specific in nature and intent. Adult learners attending CME activities bring their own mix of educational history and lifetime experiences. Their understanding of the world is not a "passive reception of preexisting objectives but a relational process of creation, whereby the search for knowledge involves interaction with environmental influences, schema, and the need for solutions to practical problems" [20]. What is not taken into account in the intent-to-change process is that the "learning of medical practitioners is intertwined with their ongoing practice, making it likely that what they learn will be adapted to influence and support their own practice in meaningful ways" [61].

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The wording, timing, and procedures for collecting intent-to-change statements have been questioned as important in data collection [17]. For example, if the initial request for commitment- or intent-to-change statement contains an explicit request for "commitment" versus "intention" for change, one might expect different attitudinal responses [48]. In a similar way, asking participants what they "plan to do" versus "plan to change" may result in intent-to-change statements that more accurately predict actual practice change [17, 23]. In prior studies that used the intent-to-change approach, some of the statements contained wording other than "intended practice change," such as "intend to learn more" or "continue to do" or other changes in attitude rather than practice [8, 17, 23, 43]. Some of our unmatched statements were similar, expressing a preference or attitude rather than a specific intent of practice change. Others have found that not all intent-to-change statements were related to the "essential points or, indeed, to the course content all at" [34]. Curry and Purkis found that the statements were "often derived from tangential or minor points, reflected unpredictable combinations of teaching points, or occasionally reflected something that had not been formally taught in the course" [34]. They noted that "perhaps this finding could be interpreted as indicating the powerful effects of coffee break conversation or other informal, idiosyncratic sources of information or confirmation that occur at CME courses." In fact, it is recognized that unstructured time (breaks) during formal CME activities can "yield clarifying understandings through discussion with peers and exchanging practice tips with colleagues" [62]. In light of the discussion above, one strength of our study is that all of the CME activity evaluations were sponsored by a single entity (AANS) with similar evaluation format and timing (end of meeting) for all activities across all meetings and over time. It would appear that the method of collection of intent-to- change statements does not influence our data. We do not see a clear pattern of intent-to-change statement themes yearly

or in aggregate that imply specific attitudinal or objective pattern of organized practice gap recognition.

F. <u>Longitudinal Changes in Unmatched Intent-to-change Statements and Meeting Objectives</u>

TABLE XVII demonstrates that some of the intent-to-change statement themes do persist over time. As was discussed above, some of these unmatched themes are rather vague, which could account for not correlating with meeting objectives. That does not, however, account for why these themes carry over from year to year. The same could be said for the more specific unmatched themes. We specifically looked to see whether unmatched intent-to-change statement themes drive subsequent CME activity objectives. We found that this did take place but had wide variation from year to year. On average, a quarter of unmatched intent-to-change themes drove a new learning objective for the following year. This suggests indirectly that meeting planners use these statements to some extent for formulating stated meeting objectives. We found no prior studies that could shed light on this subject. This led us to more closely examine CME meeting objectives over the study period.

We found that 10–20% of yearly meeting objectives do not have any associated intent-to-change statements. An examination of these objectives over time suggested that very specific (procedural, clinical and medical practice) objectives tended to be unmatched and not repeated in later years. On the other hand, unmatched objectives repeated over a number of years tended to be more general (declarative knowledge, academic, scholarly) in nature. This does not necessarily account for why they were unmatched because objectives that were related to specific topics were as common as those that were of more general nature. It might be that meeting planners tend to drop the more specific objectives if they perceive they are not met with intent-to-change

statements from the learners. In this line of reasoning, the more general objectives persist because of meeting planners' hopes that with the seemingly broad-scoped appeal of a more general objective they will eventually be found worthy of participant mention in their intent-to-change statements. It is also possible that a meeting learning objective was so specific that when we mapped the intent-to-change statements we failed to recognize that the subtle meaning of the participants' intent-to-change statement was indirectly related to that objective.

We found that some meeting objectives were not changed from year to year by meeting planners for a given meeting. This is most likely explained by the cumbersome task of creating new meeting objectives each year. The path of least resistance is simply reusing prior objectives. We wondered whether this might be source of unmatched intent-to-change statements. In the 119 total repeated meeting objectives over the 6-year period of our study, only 26 (21.8%) were unmatched to intent-to-change statements, which suggests that this was not a source for a disconnection between objectives and participant intended practice change.

G. <u>Limitations</u>

There are certainly limitations in our study. One is that this work relied on two coders to perform the content analysis of meeting objective themes and the actual thematic coding of the intent-to-change statements. We attempted to eliminate unintentional bias and errors by having both observers independently start this process. The initial examination of content analysis data involved independent generation of the deductive codes. We later met to review and edit codes through a collaborative, iterative process until final objective themes/codes were generated. Because the second observer was an undergraduate research assistant, it is possible that the senior author may have introduced more unintended bias on themes as a result of greater familiarity with the process of AANS-associated CME and with neurosurgical topics. When examining intent-to-

change data that did not map to specific meeting objectives, we took a more inductive coding approach, looking for unknown themes of learning that took place in the CME activities examined in this study. This approach is subject to a similar source of unintended bias. It is possible that even more unintentional bias could be eliminated with participation of additional independent coders.

Another obvious limitation of this study in general is the indirect nature of the data. The data was collected prospectively but is limited by a retrospective analysis. Furthermore, the data was collected for meeting evaluation but not necessarily for the direct comparison to meeting objectives as we have done in this study. Since this was not the intended use of the intent-to-change data there are limitations of the "fit" to the meeting learning objectives. The opposite is true as well, the meeting objectives were not necessarily designed by the meeting planners for later comparison to learner intent-to-change statements. For the sake of simplicity, the data are aggregated from multiple CME activities for analysis. Attempts at a more granular examination of the relationship of meeting objectives and learner perceptions of take-home messages from the CME activity proved difficult because of the reduced number of both objectives and intent-to-change statements. Even more problematic were attempts at examining data from a particular meeting using classification by particular neurosurgical subspecialty. The data were available with this level of detail from the Joint Sponsorship Council but did not prove to be adequate for meaningful examination.

Since meeting evaluations and specific intent-to-change data is anonymous it is not possible to know the number of participants for any given CME activity examined in this study. Furthermore, it is possible that an individual participant may have submitted multiple intent-to-change statements while other learners may have not participated in the evaluation process at all.

A participant with a particular agenda or perception of the CME activity might skew the evaluation data in a certain direction. This can certainly add bias to the interpretation of the intent-to-change statements and not reflect the true overall outcome of a given CME activity.

While we felt that qualitative and quantitative content analysis methods were the best approach for these data, it is entirely possible that that some intent-to-change statements or learning objectives were sufficiently vague that our methods were not sensitive enough to categorize the true meaning of the participant and subsequently failed to capture the relationship between a given objective and intent-to-change statement. It must be acknowledged that there are certainly differences in implicit and explicit meaning for many learning objectives, and intent-to-change statements as well. This can complicate the process of alignment of the data in a study like that presented here. In a similar manner, when a meeting objective was overly broad or narrowly specific in theme, we may have not properly associated a given intent-to-change statement to that objective even though the participants intent was a fulfillment of that objective. This is most certainly possible when intent-to-change statements or learning objectives are more oriented to declarative knowledge compared to procedural knowledge. We recognize that is not possible for meeting planners to state every desired learning goal in their stated meeting objectives. It is likely that some of these unwritten objectives might be found in the intent-to-change statements that we categorized as unmatched or unintended learning and, in fact, represent topics very much included in the meeting planners hoped for learning outcome objectives. Finally, this work is an indirect measure of outcomes of CME activities and does not measure whether the intent-to-change statements, either matched or unmatched to meeting learning objectives, indeed led to physician practice change.

H. Conclusions

It appears that intent-to-change data can be useful to examine the relationship between a CME activity and whether it achieved a stated learning objective. The longitudinal examination of objectives and intent-to-change data over time is useful in understanding the efficacy of CME for closing identified knowledge gaps and for determining unmet needs for future CME planning. Intent-to-change statements can be mapped to meeting objectives in a majority of CME activities studied. Theme patterns of recurrent intent-to-change statements that matched with meeting objectives for neurosurgical CME activities are focused on resident education, reduction of patient complications, evidence-based practice change, and innovation of surgical procedures and technical advances. A little over a third of intent-to-change statements were not related to any meeting objective. Approximately a quarter of these unmatched statements led to subsequent CME activity new learning objectives. However, the majority of intent-to-change statements were repeated over a number of years without resolution. A small number of CME learning objectives had no associated intent-to-change statements. When these objectives went unmatched for multiple years, we found that the themes of these objectives tended to be somewhat general/declarative knowledge in topic, whereas objectives on specific/procedural topics were more likely to be unmatched for only a single year. A number of CME learning objectives are repeated for a number of subsequent years without change. This however, was not found to correlate with unmatched status to intent-to-change statements. An examination of CME learning objectives and participant intent-to-change statements is a rich source of information for examination of both meeting planner and learner attitudes and motivation for acquisition of medical knowledge.

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TABLE III: 2016 MAJOR MEETING OBJECTIVE THEMES THAT MATCHED WITH INTENT-TO-CHANGE STATEMENTS (588 TOTAL)

Objective themes	Subthemes	Number of intent-to-change statements that track to these objectives
None		175 (29.8%)
Resident education		111 (18.9%)
Best practices and clinical evidence		75 (12.8%)
	General	12
	Cerebrovascular	10
	Intracerebral hemorrhage	13
	Skull base	4
	Spinal deformity	7
	Spinal oncology	13
	Tumor	3
Treatment options		50 (8.5%)
	General	9
	Intracranial lesions	1
	Movement disorders	5
	Pain	11
	Pediatric	5
	Trauma	2
	Tumor	18
Guidelines and databases		27 (4.6%)
	General	18
	Cranial disorders	3
	Traumatic brain injury	5
Patient outcomes		19 (3.2%)
	General	9
	Cerebrovascular	2
	Functional	1
	Pediatric	0
	Radiosurgery	4
	Spinal	1
	Tumor	0
Surgical approaches		18 (3.1%)
Innovation, emerging technologies, future trends		14 (2.4%)

TABLE III (continued): 2016 MAJOR MEETING OBJECTIVE THEMES THAT MATCHED WITH INTENT-TO-CHANGE STATEMENTS (588 TOTAL)

Objective themes	Subthemes	Number of intent-to-change statements that track to these objectives
Research		13 (2.2%)
Reimbursement		13 (2.2%)
Spinal disc replacement		12 (2.0%)
Clinical trials		10 (1.7%)
Healthcare reform		10 (1.7%)
Quality and value		8
Spinal biomechanics		7
Complication avoidance		7
Surgical indications and clinical decision-making		5
Spinal scoliosis surgery		4
Sport-related injury		3
Separation spinal surgery		3
Communication		3
Identify eloquent cortex		2
Cerebrospinal fluid dynamics		1
Organized neurosurgery		1
Brain edema		1
Employment opportunities		1

TABLE IV: 2015 MAJOR MEETING OBJECTIVE THEMES THAT MATCHED WITH INTENT-TO-CHANGE STATEMENTS (238 TOTAL)

Objective themes	Subthemes	Number of intent-to-change statements that track to these objectives
None		87 (36.5%)
Complication avoidance		23 (9.7%)
Socioeconomic		22 (9.2%)
Trauma		19 (8.0%)
	General	3
	Head	13
	Spine	3
Education		15 (6.3%)
Pediatric neurosurgery		15 (6.3%)
Brain tumor management		9 (3.8%)
Functional neurosurgery		8 (3.4%)
Cerebrovascular disease		6 (2.5%)
Chiari malformation		5 (2.1%)
Spinal deformity		5 (2.1%)
Concussion management		5 (2.1%)
Endovascular		4 (1.7%)
Epilepsy		3 (1.3%)
Radiosurgery		3 (1.3%)
Stroke and extracranial vascular		2 (0.8%)
Ethics		1
Vestibular schwannoma		1
Peripheral nerve surgery		1
Awake craniotomy		1

TABLE V: 2014 MAJOR MEETING OBJECTIVE THEMES THAT MATCHED WITH INTENT-TO-CHANGE STATEMENTS (278 TOTAL)

Objective themes	Subthemes	Number of intent-to-change statements that track to these objectives
None		135 (48.6%)
Recent innovations		31 (9.9%)
	Tumor surgery	8
	Epilepsy surgery	6
	Spine surgery and instrumentation	6
	Brain tumor biology	4
	Glioma therapy	3
	Facial pain	2
	Cerebrovascular surgery	2
Evidence-based medicine and outcomes		33 (11.9%)
	General	7
	Minimally invasive spine	6
	Spine disorders and stabilization	11
	Peripheral nerve disorder	3
	Radiosurgery	3
	Traumatic brain injury	3
Research		18 (6.5%)
Reimbursement and regulation		15 (5.4%)
	General	5
	ICD-10 codes	4
	Affordable Care Act	2
	Negotiations with hospital	3
	Role of organized medicine	1
Novel imaging and biomarkers		14 (5.0%)
Pediatric neurosurgery		13 (4.7%)
	General	7
	Basic and translational studies	3
	Patient safety	1
	Training requirements	2
Sacroiliac joint disorders		7 (2.5%)
Clinical trials		6 (2.2%)

TABLE V (continued): 2014 MAJOR MEETING OBJECTIVE THEMES THAT MATCHED WITH INTENT-TO-CHANGE STATEMENTS (278 TOTAL)

Objective themes	Subthemes	Number of intent-to-change statements that track to these objectives
Complication avoidance		6 (2.2%)
Practice guidelines, change and controversies		6 (2.2%)
Current clinical and laboratory testing		3
Postoperative pain management		3
Multidisciplinary care		1
Neurocritical care		1
Medicolegal issues		1

TABLE VI: 2013 MAJOR MEETING OBJECTIVE THEMES THAT MATCHED WITH INTENT-TO-CHANGE STATEMENTS (345 TOTAL)

Objective themes	Subthemes	Number of intent-to-change statements that track to these objectives
None		126 (36.5%)
Best practices and clinical evidence		63 (18.3%)
	General	11
	Cerebrovascular neurosurgery	18
	Spinal disorders	19
	Tumors	15
Novel surgical approaches and technique		57 (16.5%)
	General	7
	Tumors	8
	Cerebrovascular—including bypass and endarterectomy	7
	Endovascular/flow diverter	1
	Epilepsy and functional	7
	Spinal surgery	12
	Spinal instrumentation	11
Practice change and controversy		18 (5.2%)
Complication avoidance		16 (4.6%)
Concussion and sports related injury		11 (3.2%)
National registries and database		10 (2.9%)
Resident education		10 (2.9%)
Coagulation pathway inhibitors		5 (1.4%)
Pediatric practice parameters		5 (1.4%)
Current trends in reimbursement and health care delivery		5 (1.4%)
Negotiating with hospital		4 (1.2%)
Evolution of skull base surgery		4 (1.2%)
Rationale for clinical and laboratory test		3 (0.8%)
Retractor-less intracranial surgery		2 (0.6%)
Stem cell and cellular transplantation		2 (0.6%)
Venous thrombosis management		2 (0.6%)
Regulatory practices		2 (0.6%)

TABLE VI (continued): 2013 MAJOR MEETING OBJECTIVE THEMES THAT MATCHED WITH INTENT-TO-CHANGE STATEMENTS (345 TOTAL)

Objective themes	Subthemes	Number of intent-to-change statements that track to these objectives
Disc arthroplasty		2 (0.6%)
New technologies in neurosurgery		1
Basic science data evaluation		1

TABLE VII: 2012 MAJOR MEETING OBJECTIVE THEMES THAT MATCHED WITH INTENT-TO-CHANGE STATEMENTS (355 TOTAL)

Objective themes	Subthemes	Number of intent-to-change statements that track to these objectives
None		155 (43.7%)
New surgical approach and techniques		56 (15.8%)
	General	13
	Spinal	9
	Skull base endoscopy	2
	Vascular lesions	7
	Peripheral nerve surgery and stimulation	25
Surgical treatment and outcomes		40 (11.3%)
	Pediatric brain tumors	2
	Tumor	3
	Vascular/aneurysms	6
	Lumbar fusion	5
	Minimally invasive surgery	6
	Movement disorders	16
	Type II odontoid fractures	2
	Epilepsy	2
Neurosurgical resident training and mentorship		25 (7.0%)
Treatment advances		15 (4.2%)
	General	5
	Brain tumors	2
	Cerebrovascular	7
	Spinal surgery	1
Morbidity and mortality reduction		14 (3.9%)
Pediatric neurosurgery		14 (3.9%)
	General	4
	New technology	1
	Fetal myelomeningocele repair	5
	Traumatic brain injury	4
Business, coding, and legislative issues		8 (2.3%)
Brain tumor biology and research		6 (1.7%)
Evidence-based practice		6 (1.7%)

TABLE VII (continued): 2012 MAJOR MEETING OBJECTIVE THEMES THAT MATCHED WITH INTENT-TO-CHANGE STATEMENTS (355 TOTAL)

Objective themes	Subthemes	Number of intent-to-change statements that track to these objectives
Spinal column tumor treatment		5 (1.4%)
	General	3
	Radiosurgery	2
Clinical trial rationale and benefits		3 (0.8%)
Promote professionalism and communication		3 (0.8%)
Indications for anticoagulation therapy		2 (0.6%)
Rationale for clinical and laboratory testing		2 (0.6%)
Multidisciplinary care		1 (0.3%)
Controversies in central nervous system disease		1 (0.3%)
Insular glioma complication avoidance		1 (0.3%)
Management of sports-related injury		1 (0.3%)
Traumatic brain injury treatment		1 (0.3%)

TABLE VIII: 2011 MAJOR MEETING OBJECTIVE THEMES THAT MATCHED WITH INTENT-TO-CHANGE STATEMENTS (146 TOTAL)

Objective themes	Subthemes	Number of "intent-to-change" statements that track to these objectives
None		50 (34.2%)
Current treatment options		26 (17.8%)
	General	2
	Arachnoid cyst	12
	Brain tumors	3
	Hydrocephalus	3
	Thalamic lesions	3
	Spinal surgery	1
	Interbody fusion	2
Recent progress and advancements		21 (14.3%)
	General	4
	Brain tumors	2
	Cerebrovascular disease	2
	Endovascular treat	3
	Neuromodulation/deep brain stimulation for movement disorder and epilepsy	7
	Trauma	3
Clinical evidence and best practices		15 (10.3%)
	General	2
	Trauma	2
	Cerebrovascular disease and aneurysm	6
	Spinal fusion	5
Resident education		8 (5.5%)
Minimally invasive spine surgery		4 (2.7%)
Quality of life measures		3 (2.0%)
Morbidity and mortality, surgical complication avoidance		3 (2.0%)
New research		3 (2.0%)
	Traumatic brain injury	1
	Stem cell	1
	Disc regeneration, biological replacement	1

TABLE VIII (continued): 2011 MAJOR MEETING OBJECTIVE THEMES THAT MATCHED WITH INTENT-TO-CHANGE STATEMENTS (146 TOTAL)

Objective themes	Subthemes	Number of "intent-to-change" statements that track to these objectives
Practice implications of federal and state regulation		3 (2.0%)
Clinical and laboratory studies for CNS tumor diagnosis		2 (1.4%)
International program outreach		1 (0.7%)
Safety, efficacy and value		1 (0.7%)
Role of radiosurgery in treatment of CNS disease		1 (0.7%)
Surgery for Alzheimer's disease		1 (0.7%)
C1 lateral mass screw anatomy		1 (0.7%)
Controversies in CNS disease		1 (0.7%)
Flow diversion for aneurysms		1 (0.7%)
Nonsurgical pain management		1 (0.7%)

TABLE XII. 2016 INTENT-TO-CHANGE STATEMENT THEMES THAT WERE NOT RELATED TO ANY MEETING OBJECTIVE

Intent-to-change statement themes	Number of times mentioned
Minimally invasive spinal surgery	5
Vitamin D levels, calcium, bone density in spinal patients	5
Patient referrals	4
Patient education	4
Concussion	4
Epilepsy surgery	3
Headache management	3
Spontaneous cerebrospinal fluid leak	3
Imaging	3
Chiari malformation management	2
Development of neuroscience centers	2
Seizure prophylaxis	2

TABLE XIII. 2015 INTENT-TO-CHANGE STATEMENTS THEMES THAT WERE NOT RELATED TO ANY MEETING OBJECTIVE

Intent-to-change statement themes	Number of times mentioned
Laser interstitial therapy and magnetic resonance–guided high-intensity ultrasound	4
Referrals	4
Minimally invasive surgery	3
Posterior fossa dural closure techniques	3
Teamwork/operating room support	3
Sacroiliac joint	3
Cost and value	3
Endoscopic procedures	2
Anticoagulants	2
Local anesthesia uses and practices	2

TABLE XIV. 2014 INTENT-TO-CHANGE STATEMENT THEMES THAT WERE NOT RELATED TO ANY MEETING OBJECTIVE

Intent-to-change statement themes	Number of times mentioned
Concussion management	10
Referrals	8
Movement disorders	7
Value/quality	6
Surgery for intraparenchymal hematoma	6
Endoscopic procedures	5
Patient selection	3
Leadership	3
Patient education	2
Laser interstitial therapy	2
Chiari malformation management	2
Moya Moya management	2

TABLE XV. 2013 INTENT-TO-CHANGE STATEMENT THEMES THAT WERE NOT RELATED TO ANY MEETING OBJECTIVE

Intent-to-change statement themes	Number of times mentioned
Tumor tissue biomarkers	5
Referrals	5
Patient selection	5
Endovascular therapies	4
Endoscopic procedures	4
Chiari malformation management	3
Patient education	3
Minimally invasive spine surgery	3
Neurocritical care	2
Outcomes and guidelines	2
Patient evaluations	2
Tethered cord management	2

TABLE XVI. 2012 INTENT-TO-CHANGE STATEMENT THEMES THAT WERE NOT RELATED TO ANY MEETING OBJECTIVE

Intent-to-change statement themes	Number of times mentioned
Pain management	10
Improved patient imaging	7
Use of spinal cord stimulation	7
Outcome measurement	7
Referrals	7
Peripheral nerve stimulation	6
Use of bone morphogenetic protein in spinal surgery	5
Patient education	3
Cost and quality	3
Clinical decision-making	3
Indications and use of epidural injections	3
Stem cells and cellular transplantation	2

TABLE XVII. 2011 INTENT-TO-CHANGE STATEMENT THEMES THAT WERE NOT RELATED TO ANY MEETING OBJECTIVE

Intent-to-change statement themes	Number of times mentioned
Imaging	4
Comprehensive and multidisciplinary care	3
Sagittal balance	3
Stroke	3
Statin use in trauma	3
Bypass surgery	2
Instrumentation/devices	2
Referrals	2
Minimally invasive spine surgery	2

TABLE XXVIII: MEETINGS EVALUATED IN 2016

Meeting Name
American Academy of Neurological Surgery 78th Annual Meeting
13th Annual Symposium: Current Techniques in the Treatment of Cranial and Spinal Disorders
39th Annual Meeting of the American Society of Pediatric Neurosurgeons
62nd Annual Meeting of The Western Neurosurgical Society
67th Southern Neurosurgical Society Annual Meeting
California Association of Neurological Surgeons CANS Annual Meeting
Interurban Neurosurgical Society 2016 Annual Meeting
Minnesota Neurosurgical Society 2016 Annual Meeting
New England Neurosurgical Society Annual Meeting
The 69th Annual Meeting of the Neurosurgical Society of America
Richard Lende Winter Neurosurgery Conference
Rocky Mountain Neurosurgical Society 51st Annual Meeting
Tennessee Neurosurgical Society Annual Meeting
The Society of Neurological Surgeons 107th Meeting in the 96th Year
The Society of University Neurosurgeons – 2016 Annual Meeting
The 2016 Winter Clinics for Cranial & Spinal Surgery

TABLE XXVIX: Meetings Evaluated in 2015

Meeting Name
12th Annual Symposium: Current Techniques in the Treatment of Cranial and Spinal Disorders
38th Annual Meeting of the American Society of Pediatric Neurosurgeons
61st Annual Meeting of the Western Neurosurgical Society
66th Southern Neurosurgical Society Annual Meeting
California Association of Neurological Surgeons CANS Annual Meeting
Interurban Neurosurgical Society 2015 Annual Meeting
Minnesota Neurosurgical Society 2015 Annual Meeting
New England Neurosurgical Society Annual Meeting
The 68th Annual Meeting of the Neurosurgical Society of America
Richard Lende Winter Neurosurgery Conference
Rocky Mountain Neurosurgical Society 50th Annual Meeting
Tennessee Neurosurgical Society Annual Meeting
The Society of University Neurosurgeons – 2015 Annual Meeting
The Winter Clinics for Cranial & Spinal Surgery

TABLE XXX: Meetings Evaluated in 2014

Meeting Name
American Academy of Neurological Surgery 76th Annual Meeting
11th Annual Symposium: Current Techniques in The Treatment of Cranial and Spinal Disorders
37th Annual Meeting of the American Society of Pediatric Neurosurgeons
60th Annual Meeting of the Western Neurosurgical Society
California Association of Neurological Surgeons CANS Annual Meeting
Interurban Neurosurgical Society 2014 Annual Meeting
Minnesota Neurosurgical Society 2014 Annual Meeting
The 67th Annual Meeting of the Neurosurgical Society of America
New England Neurosurgical Society Annual Meeting
Richard Lende Winter Neurosurgery Conference
Rocky Mountain Neurosurgical Society 49th Annual Meeting
Tennessee Neurosurgical Society Annual Meeting
The Society of Neurological Surgeons 105th Meeting in Its 94th Year
The Society of University Neurosurgeons – 2014 Annual Meeting
The Winter Clinics for Cranial & Spinal Surgery – 2014 Annual Meeting

TABLE XXXI: Meetings Evaluated in 2013

Meeting Name
American Academy of Neurological Surgery 75th Annual Meeting
10th Annual Symposium: Current Techniques in The Treatment of Cranial and Spinal Disorders
36th Annual Meeting of the American Society of Pediatric Neurosurgery
64th Southern Neurosurgical Society Annual Meeting
AANS Neurosurgery Training and Practice
California Association of Neurological Surgeons 2013 Annual Meeting
Interurban Neurosurgical Society 2013 Annual Meeting
Minnesota Neurosurgical Society 2013 Annual Meeting
Neurosurgery at Jackson Hole Annual Meeting
The 66th Annual Meeting of the Neurosurgical Society of America
New England Neurosurgical Society Annual Meeting
Richard Lende Winter Neurosurgery Conference
Rocky Mountain Neurosurgical Society 48th Annual Meeting
The Society of University Neurosurgeons – 2013 Annual Meeting

TABLE XXXII: Meetings Evaluated in 2012

Meeting Name
American Academy of Neurological Surgery 74th Annual Meeting
9th Annual Symposium: Current Techniques in the Treatment of Cranial and Spinal Disorders
35th Annual Meeting of the American Society of Pediatric Neurosurgery
63rd Southern Neurosurgical Society
Minnesota Neurosurgical Society 2012 Annual Meeting
Neurosurgery at Jackson Hole Annual Meeting
The 65th Annual Meeting of the Neurosurgical Society of America
New England Neurosurgical Society Annual Meeting
Richard Lende Winter Neurosurgery Conference
Rocky Mountain Neurosurgical Society 47th Annual Meeting
Tennessee Neurosurgical Society Annual Meeting
The Society of Neurological Surgeons 103rd Meeting in Its 92nd Year

TABLE XXXIII: Meetings Evaluated in 2011

Meeting Name
American Academy of Neurological Surgery 73rd Annual Meeting
34th Annual Meeting of the American Society of Pediatric Neurosurgery
57th Annual Meeting of the Western Neurosurgical Society
Interurban Neurosurgical Society 2011 Annual Meeting
Minnesota Neurosurgical Society 2011 Annual Meeting
Neurosurgery at Jackson Hole Annual Meeting
The 66th Annual Meeting of the Neurosurgical Society of America
New England Neurosurgical Society Annual Meeting
Richard Lende Winter Neurosurgery Conference
Tennessee Neurosurgical Society Annual Meeting
The Society of Neurological Surgeons 102nd Meeting in Its 91st Year
The Winter Clinics for Cranial & Spinal Surgery

VITA.

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M.D., University of Utah School of Medicine, Salt Lake City, Utah, 1991

Ph.D., Loyola University of Chicago, Chicago, Illinois, 1997

ACADEMIC APPOINTMENTS: Professor of Neurosurgery, Radiation Oncology, and Oncological Sciences,
University of Utah, 2011-present

Associate Professor of Neurosurgery, Radiation Oncology, and Oncological Sciences, University of Utah, 2004-2011

Assistant Professor of Neurosurgery, Radiation Oncology, and Oncological Sciences, University of Utah, 1998-2004

HONORS: Society of Huntsman Translational Scholars, Huntsman Cancer Institute, 2019
Dr Clark Lowe Rich Distinguished Surgeon and Mentor Award, University of Utah School of Medicine, 2018
Journal of Neurooncology Award, Congress of Neurological Surgeons, 2010.
Academy Cup, Rocky Mountain Neurosurgery Society, 2010
Mahaley Clinical Research Award, CNS Annual Meeting 2007
Fellow, American College of Surgeons, 2005
Tumor Young Investigator Award, Congress of Neurological Surgeons Annual Meeting, 2001
"Gold Doc" Award for Humanism in Medicine, Arnold P. Gold Foundation, 2001
Resident Competition Winner, First Annual Chicago Academic Neurological Surgery Colloquium, 1997
University of Utah School of Medicine Dean's summer Research Grant, 1988, 1989, and 1990

American Society for Laser Medicine and Surgery Student
Research Grant 1988, 1989, and 1990
B.A. and B.S. Magna Cum Laude, 1987
President's Scholarship at University of Utah, 1982-1987
Phi Eta Sigma Honor Society, 1982
Golden Key Honor Society, 1985
Phi Kappa Phi Honor Society, 1987