Structured abstracts in MEDLINE®, 1989–1991*

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OBJECTIVE: To characterize the structured abstracts in biomedical journals indexed in MEDLINE® over a three-year period as an initial step in exploring their utility in enhancing bibliographic retrieval. DESIGN: The study examined the occurrence of structured abstracts in MEDLINE from March 1989 to December 1991, characteristics of MEDLINE records for articles with structured abstracts, editorial policies of six selected MEDLINE journals on structured abstracts, and a sample of twenty-five structured abstracts from the six journals. RESULTS: The study revealed that the number of structured abstracts in MEDLINE and the number of MEDLINE journals publishing structured abstracts increased substantially between 1989 and 1991. On average, articles with structured abstracts had more access points (Medical Subject Heading [MeSH®] terms and text words) than MEDLINE articles as a whole. The average length of the structured abstract was greater than the average length of all abstracts in MEDLINE. CONCLUSIONS: The presence of structured abstracts may be associated with other article characteristics that lead to the assignment of a higher average number of MeSH headings or may itself contribute to the assignment of more headings. The variations in the structured-abstract formats prescribed by different journals may complicate the exploitation of these abstracts in bibliographic retrieval systems. More research is needed on a number of questions related to the quality and utility of structured abstracts.

INTRODUCTION

In 1969, Ertl proposed the "Table System" for abstracts as a standardized way to present information from clinical articles [1]. The most important information, such as methodology and results, would be put into a tabular arrangement so that the key aspects of an article would be organized in a compact, systematized manner, thereby reducing the time required to assess an article's clinical worth. Ertl thought this tabular arrangement also would facilitate machine manipulation of the data presented.

Although Ertl's proposal had little noticeable impact on biomedical publishing, a more recent effort to promote the use of structured abstracts has met with some success. The structured-abstract format was introduced by *Annals of Internal Medicine* in 1987 [2] and modified in 1990 [3]. Structured abstracts employ

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a standardized format to label explicitly key information from articles they summarize. Structured abstracts were developed primarily to assist health professionals in selecting clinically relevant and methodologically valid journal articles. Secondary objectives were to guide authors in summarizing the content of their manuscripts precisely, to facilitate the peer-review process for manuscripts submitted for publication, and to enhance computerized literature searching [4]. There are no published studies that directly address the extent to which structured abstracts assist in the selection of clinically relevant articles or facilitate the peer-review process [5].

Narine compared unstructured abstracts for clinical studies appearing in *Canadian Medical Association Journal* to criteria derived from the first published format for structured abstracts [6]. Comans compared unstructured abstracts for clinical studies appearing in *Nederlands Tijdschrift voor Geneeskunde* to structured abstracts for clinical studies appearing in *Annals of Internal Medicine, British Medical Journal,* and *New England Journal of Medicine* and found structured abstracts to be more informative [7]. Similarly, Taddio compared unstructured abstracts to structured abstracts for clinical studies appearing in *British Medical Journal, Canadian Medical Association Journal,* and *Journal of the American Medical Association* and found that structured abstracts summarize the content of articles more precisely than do unstructured abstracts [8]. Taddio found that study purpose, setting, number of dropouts, interventions, study variables, statistical analyses, and conclusions were reported more frequently with the structured format than with an unstructured format.

Comparisons of structured abstracts with the full text of the journal articles they summarize have shown that relevant information present in articles is not always reflected in the structured abstracts. Comans found that structured abstracts lacked some details about sample selection, patient demographics, and statistical analyses; in some cases, this information was present in the full text of the articles [9]. Froom [10] found that a large number of structured abstracts published in *Annals of Internal Medicine* in 1991 lacked some information recommended by the modified published format [11]. The missing information, such as patient selection criteria, numbers of refusers, number of dropouts and reason(s) for dropping out, statements concerning extrapolation of findings, need for further study, and current clinical applicability, frequently was found to be present in the full text of the articles. Conversely, National Library of Medicine (NLM) indexers have observed cases in which authors provided specific details on the study design in the methodology section of the structured abstract without expanding or repeating such information in the text of the article.

Table 1
Formats for structured abstracts for original research studies and review articles

Original research studies
1. Objective: the exact question(s) addressed by the article
2. Design: the basic design of the study
3. Setting: the location and level of clinical care
4. Patients or participants: the manner of selection and number of patients or participants who entered and completed the study
5. Interventions: the exact treatment or intervention, if any
6. Main outcome measures: the primary study outcome measure as planned before data collection began
7. Results: the key findings
8. Conclusions: key conclusions, including direct clinical applications

Review articles
1. Purpose: the primary objective of the review article
2. Data sources: a succinct summary of data sources
3. Study selection: the number of studies selected for review and how they were selected
4. Data extraction: rules for abstracting data and how they were applied
5. Results of data synthesis: the methods of data synthesis and key results
6. Conclusion: key conclusions, including potential applications and research needs

By 1991, anecdotal evidence suggested to the NLM staff that the number of structured abstracts in MEDLINE® was increasing [12]. A decision was made to obtain objective data on their occurrence, characteristics, and any apparent effect on Medical Subject Heading (MeSH®) indexing as a first step in exploring how these abstracts might aid computerized literature searching. This article reports the results of an initial study of structured abstracts present in MEDLINE from March 1989 to December 1991.

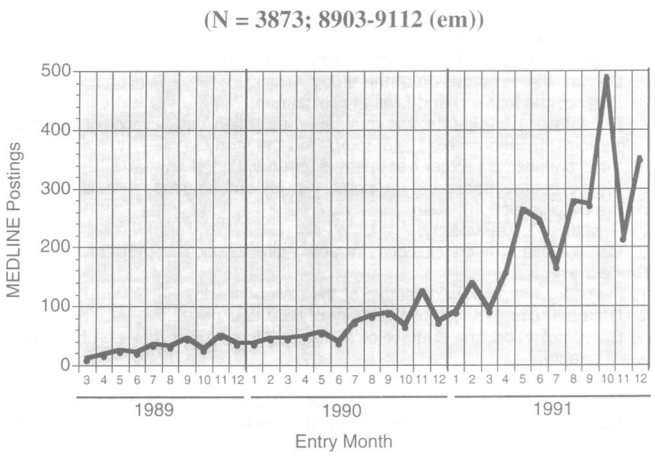
Structured-abstract formats have been defined for original research studies [13–14], review articles [15], and, more recently, practice guidelines [16]. The period covered by this study predates the publication of the structured-abstract format for practice guidelines. The published formats for structured abstracts for original research studies [17] and review articles are presented in Table 1.

STUDY DESIGN

Two sets of MEDLINE records were examined: all 924,748 records (with structured abstracts, unstructured abstracts, or no abstracts) indexed from March 1989 through December 1991 (i.e., 8903 Entry Month [EM] through 9112 EM); and 3,873 records with structured abstracts indexed during the same time period. The second set of records is a subset of the first.

The labels of structured-abstract segments appear in upper-case letters in MEDLINE. The structured-abstract set was identified by a computer program that searched for specific character strings appearing in all upper-case letters in the abstract fields of the 924,748 MEDLINE records. The list of character strings searched was created from a preliminary examination of a sample of structured abstracts appearing in MED-

Figure 1
MEDLINE structured abstracts, breakdown by entry month



LINE, augmented by synonyms found in a thesaurus. The program retrieved all abstracts that began with one of the following upper-case character strings (arranged in the general order in which they might occur in an abstract with synonyms grouped together):

OBJECTIVE	SYNTHESIS	MEASURE
STUDY	SELECTION	MEASUREMENT
STUDIES	IDENTIFICATION	RESULT
GOAL	SETTING	METHOD
BACKGROUND	PATIENT	EXTRACTION
AIM	PARTICIPANT	CONCLUSION
PURPOSE	SUBJECT	OUTCOME
DESIGN	TYPE	END
DATA	INTERVENTION	MAIN

To check the validity of this approach, another program was run to produce a printed list of the unique identifiers and the first thirty characters of all abstracts beginning with words in upper case not contained in the list used in the first program. An examination of this printed list yielded forty additional records that had structured abstracts beginning with other labels such as "INTRODUCTION" and "HYPOTHESIS." Because these forty records represented only 1% of the total universe of structured abstracts, the analysis was conducted on the set of structured abstracts identified by the first program.

The 3,873 records with structured abstracts were analyzed to determine the number of structured abstracts added to MEDLINE each month of the study period and to identify journal titles that contributed structured abstracts. Average length of abstract and average number of values in various MEDLINE data elements were computed for both the structured-abstract set and the full MEDLINE set. These averages also were computed for the "CLINICAL TRIAL" and "REVIEW" publication types (PT) subsets for both the structured-abstract set and the full MEDLINE set. The structured-abstract set also was examined to identify the most frequently assigned MeSH headings. The relative frequency of these MeSH headings in the complete MEDLINE set then was determined.

The six journals contributing the highest numbers of structured abstracts to MEDLINE from 1989 to 1991 were examined to determine their editorial policies regarding abstract length and the specific labels to be used for the segments of a structured abstract. A sample of twenty-five structured abstracts from these six journal titles was created by selecting every tenth record from a data set of all structured abstracts from the six journals. The sample then was analyzed to ascertain whether the stated editorial policies of the six journals were being followed in the published abstracts.

RESULTS

Twelve structured abstracts were in MEDLINE in March 1989, and 491 were present in October of 1991, the highest number of the months studied (Figure 1). The number of new records added roughly doubled every year: 511 records with structured abstracts were added in 1989, 1,106 in 1990, and 2,256 in 1991. The average number added per month rose from 31 in 1989 to 66 in 1990 and then to 231 in 1991.

The number of journals contributing structured abstracts also increased substantially from 1989 to 1991. There were twenty journals in 1989, thirty-eight in 1990, and fifty-eight in 1991. Ten journals contributed structured abstracts during all three years (Figure 2).

As illustrated in Figure 3, the *British Medical Journal* contributed the highest number of structured abstracts (576) during the three-year period studied. Essentially all of the structured abstracts appeared in clinical journals. Seventy-nine percent of the structured abstract records (3,044) are clustered in 17% (13) of the journals, all listed in Figure 3.

Data element comparison

The records with structured abstracts had an average of three more MeSH headings than did records in the complete MEDLINE set (Table 2). The check tags "FEMALE," "MALE," "ADULT," and "MIDDLE AGE" occurred in 90% of the records in the structured-abstract set and in only 60% of the records in the full MEDLINE set. The average structured abstract is approximately 700 characters longer than the average length of all MEDLINE abstracts. (MEDLINE records without abstracts were excluded from this computation.) Fewer than 100 characters of this difference is attributable to the labels. The difference in abstract

Figure 2
Number of journals contributing structured abstracts

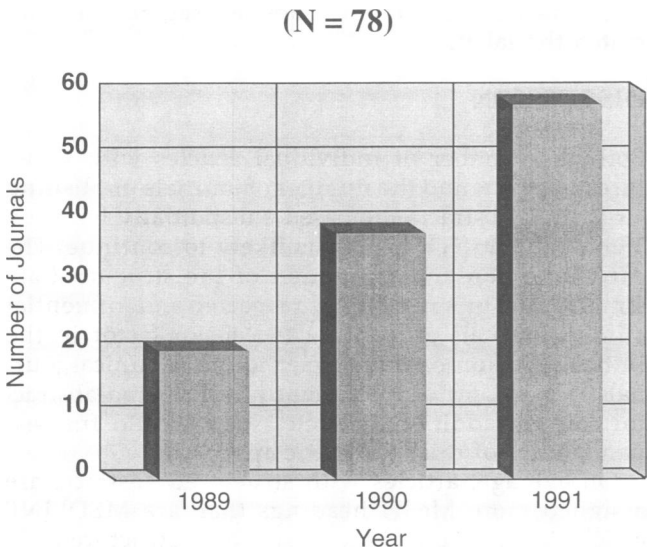
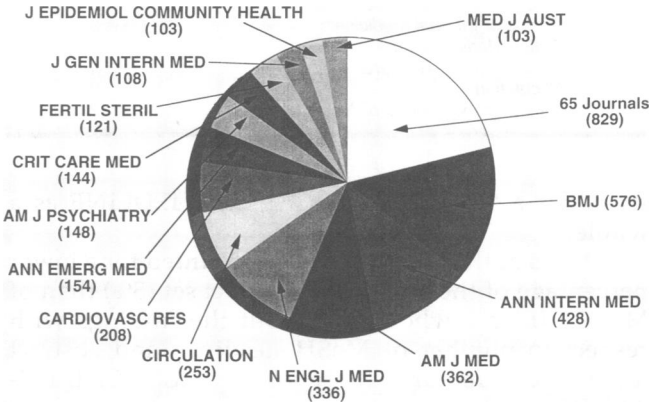


Figure 3
Titles of journals contributing structured abstracts, 1989–1991



length is influenced slightly by NLM policy. In general, abstracts that exceed 250 words or, in some cases, 400 words, are truncated, but structured abstracts are entered into MEDLINE regardless of length, up to the NLM system limit of 4,096 characters. Only 4% of the abstracts in MEDLINE are truncated, however, so this policy does not account for much of the difference in average abstract lengths.

There were other discernible differences between the two sets of records as well. The structured-abstract subset had a larger percentage of journals with a high indexing priority status, 94%, than did MEDLINE as a whole, with 78%. The distribution of types of articles also differs. The PTs of articles in the structured-abstract set were primarily limited to those appropriate for original research studies or reviews. MEDLINE as a whole included a broader spectrum of article types, including letters, editorials, and individual case studies. By definition, some of these article types receive fewer MeSH headings than others and lack abstracts.

To determine whether the types of articles represented in the structured-abstract set were a factor in the observed differences in the number of MeSH terms assigned and abstract length, two subsets of the structured-abstract set were examined more closely. These subsets were records for "CLINICAL TRIAL" and "REVIEW" PTs.

Reports of clinical trials accounted for a much higher percentage (15%) of the structured-abstract set than of MEDLINE as a whole (2%). Table 2 compares data element averages from the "CLINICAL TRIAL" PT records in the structured-abstract set and in the complete MEDLINE set. The "CLINICAL TRIAL" records in the structured-abstract set had a higher number of MeSH headings per record (15.3) than did the "CLINICAL TRIAL" records in the complete MEDLINE set (13.2). Similarly, the average length of a structured abstract for a "CLINICAL TRIAL" record was substantially greater than the average length of an ab-

Table 2
Data element comparison of structured-abstract set to full MEDLINE set

	Structured-abstract set, overall	MEDLINE set, overall
MeSH headings	14.1	10.6
Abstract length (in characters)	1,739.2	1,062.8
	"CLINICAL TRIAL" PT subset	"CLINICAL TRIAL" PT subset
MeSH headings	15.3	13.2
Abstract length (in characters)	1,826.9	1,195.0
	"REVIEW" PT subset	"REVIEW" PT subset
MeSH headings	10.1	8.2
Abstract length (in characters)	1,749.1	977.3

Table 3
Journal title breakdown of twenty-five structured abstracts

American Journal of Medicine	5
Annals of Internal Medicine	3
British Medical Journal	9
Cardiovascular Research	4
Circulation	2
New England Journal of Medicine	2

stract for a "CLINICAL TRIAL" in MEDLINE as a whole.

Articles of the "REVIEW" PT accounted for a lower percentage of the structured-abstract set (3%) than of MEDLINE as a whole (10%), but the findings with respect to number of MeSH headings and abstract length were similar to those for the "CLINICAL TRIAL" PT.

Editorial policies

The editorial policies concerning structured abstracts published in *British Medical Journal, Annals of Internal Medicine, American Journal of Medicine, New England Journal of Medicine, Circulation,* and *Cardiovascular Research* were examined. Most of these journals stated a maximum of 250 words as an acceptable abstract length. None stated different maximum abstract lengths for particular article types. Two of the six journals, *British Medical Journal* and *Annals of Internal Medicine,* required the exact abstract segment labels that appear in the first published format [18] for structured abstracts. Three journals requested the same types of information required by the published format but in a different arrangement. The sixth journal, *Cardiovascular Research,* did not specify the labels to be used for structured abstracts but instructed authors to consult current issues of the journal.

Variations from the published format included different labels for the same segment (e.g., "PURPOSE" rather than "OBJECTIVE"), labels that encompass more than one segment of the published format (e.g., use of "METHODS" to cover "DESIGN," "SETTING," "PATIENTS," and "PARTICIPANTS") and combination labels that merge two labels into one (e.g., "METHODS AND RESULTS"). All journals requested an initial label for the topic of the article and a final label called "CONCLUSIONS." The instructions regarding the intervening labels varied.

Abstract analysis

The breakdown by journal of the twenty-five structured abstracts examined is listed in Table 3. Abstract length ranged from 112 to 369 words, for an average of 268 words. Average abstract length for any one journal ranged from 220 to 300 words. All twenty-five abstracts used labels outlined in the corresponding journal's editorial policies, with few exceptions. In a few instances, the exact wording of the label was repeated in the abstract segment following the label; in others, the content of the abstract segment did not match the label.

DISCUSSION

Both the number of individual articles with structured abstracts and the number of journals publishing structured abstracts increased substantially between 1989 and 1991. This trend is likely to continue. The early adoption and promotion of the structured-abstract format by some highly respected and influential clinical journals probably was a major factor in the initial diffusion of this format to other clinical journals. The recent development of structured-abstract formats for additional article types should fuel expanded use of this systematic approach.

On average, articles with structured abstracts are assigned more MeSH headings than are MEDLINE articles as a whole. The presence of structured abstracts may be associated with other article characteristics leading to the assignment of higher numbers of MeSH headings or may itself contribute to this phenomenon. The difference in the number of MeSH headings assigned is not solely a function of the types of articles that have structured abstracts. This was demonstrated by the analysis of articles of the "CLINICAL TRIAL" and "REVIEW" PTs. The difference in the number of headings assigned might be due to a greater average article length for articles with structured abstracts than for those without. Longer articles may discuss more concepts than do shorter articles. A preliminary analysis of selected articles in the "CLINICAL TRIAL" PT subsets did not reveal a substantial difference in article length between the two subsets. However, more work is needed to determine whether article length is a significant factor in the assignment of additional MeSH headings.

There is some indication that extra MeSH headings result from more complete reporting of "check-tag" conditions for routine concepts such as sex or age groups rather than additional substantive subject terms. It is also possible that the larger percentage of journals with high indexing priority status in the structured-abstract subset could influence the higher number of MeSH headings. NLM indexing practice assigns more MeSH headings to articles in journals with a high priority indexing status.

On average, structured abstracts are substantially longer than are other abstracts published in journals indexed in MEDLINE. This remains true when the length of structured-abstract labels is subtracted and when NLM's policy of truncating some unstructured abstracts is taken into account. The average length of the structured abstracts in MEDLINE is within range

of the 250-word maximum specified for structured abstracts in the International Committee of Medical Journal Editors' (ICMJE) "Uniform Requirements for Manuscripts Submitted to Biomedical Journals" [19]. The ICMJE uniform requirements specify 150 words as the maximum length for unstructured abstracts.

Different journals prescribe different structured-abstract formats, although they all require explicitly labeled text segments. Of the six journals with the largest number of structured abstracts in MEDLINE in the period studied, only two required the original format published in the *Annals of Internal Medicine* in 1987. The remaining four specified modifications of this format. For the sample of structured abstracts from these six journals, editors enforced the format specified in their instructions to authors. The differences in the names and meanings of the labels prescribed by different journals probably are insignificant to the readers for whom structured abstracts are intended. However, these variations and the discrepancies between labels and the abstract segments they introduce are likely to complicate development of automated systems that can exploit the structure to enhance bibliographic retrieval.

CONCLUSIONS

Structured abstracts represent a serious attempt to help clinicians identify articles that are methodologically sound and relevant to particular practice situations. The rapid increase in the number of journals publishing structured abstracts is evidence that journal editors recognize clinicians' need for such assistance. On average, articles with structured abstracts have more access points (MeSH headings and text words in abstracts) than do MEDLINE articles as a whole. Although it is not clear whether the presence of a structured abstract or other article characteristics account for the larger number of MeSH headings assigned, the additional searchable terms are likely to assist in bibliographic retrieval. Variations in structured-abstract formats are probably inconsequential to the reader but will complicate more sophisticated use of structured abstracts in automated retrieval systems.

More research is needed on the quality and usefulness of structured abstracts for their intended audience. If such research confirms that structured abstracts are helpful to users, then increased standardization of structured-abstract formats will make it easier for automated systems to exploit the structure in retrieval and display.

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REFERENCES

1. ERTL N. A way of documenting scientific data from medical publications. Karger Gaz 1969;20:1–4.
2. *AD HOC* WORKING GROUP FOR CRITICAL APPRAISAL OF THE MEDICAL LITERATURE. A proposal for more informative abstracts of clinical articles. Ann Intern Med 1987 Apr;106: 598–604.
3. HAYNES RB, MULROW CD, HUTH EJ, ALTMAN DG ET AL. More informative abstracts revisited: a progress report. Ann Intern Med 1990 Jul 1;113(1):69–76.
4. IBID.
5. HAYNES RB. More informative abstracts: current status and evaluation. J Clin Epidemiol 1993 Jul;46(7):595–7; discussion 599.
6. NARINE L, YEE DS, EINARSON TR, ILERSICH AL. Quality of abstracts of original research articles in *CMAJ* in 1989. Can Med Assoc J 1991 Feb 15;144(4):449–53.
7. COMANS ML, OVERBEKE AJ. The structured summary: a tool for reader and author. Ned Tijdschr Geneeskd 1990 Dec 1;134(48):2338–43.
8. TADDIO A, PAIN T, FASSOS FF, BOON H ET AL. Quality of nonstructured and structured abstracts of original research articles in the *British Medical Journal*, the *Canadian Medical Association Journal* and the *Journal of the American Medical Association*. Can Med Assoc J 1994 May 15;150(10):1611–5.
9. COMANS, op. cit.
10. FROOM P, FROOM J. Deficiencies in structured medical abstracts. J Clin Epidemiol 1993 Jul;46(7):591–4.
11. HAYNES. More informative abstracts revisited.
12. LEVY N. Structured abstracts. NLM Tech Bull 1988;235: 10.
13. *AD HOC* WORKING GROUP FOR CRITICAL APPRAISAL OF THE MEDICAL LITERATURE, op. cit.
14. HAYNES. More informative abstracts revisited.
15. MULROW CD, THACKER SB, PUGH JA. A proposal for more informative abstracts of review articles. Ann Intern Med 1988 Apr;108(4):613–5.
16. HAYWARD RS, WILSON MC, TUNIS SR, BASS EB ET AL. More informative abstracts of articles describing clinical practice guidelines. Ann Intern Med 1993 May 1;118(9): 731–7.
17. HAYNES. More informative abstracts revisited, 70.
18. *AD HOC* WORKING GROUP FOR CRITICAL APPRAISAL OF THE MEDICAL LITERATURE, op. cit.
19. INTERNATIONAL COMMITTEE OF MEDICAL JOURNAL EDITORS. Uniform requirements for manuscripts submitted to biomedical journals. BMJ 1991 Feb 9;302(6772):338–41.

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