The introduction, methods, results, and discussion (IMRAD) structure: a fifty-year survey

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Background: The scientific article in the health sciences evolved from the letter form and purely descriptive style in the seventeenth century to a very standardized structure in the twentieth century known as introduction, methods, results, and discussion (IMRAD). The pace in which this structure began to be used and when it became the most used standard of today's scientific discourse in the health sciences is not well established.

Purpose: The purpose of this study is to point out the period in time during which the IMRAD structure was definitively and widely adopted in medical scientific writing.

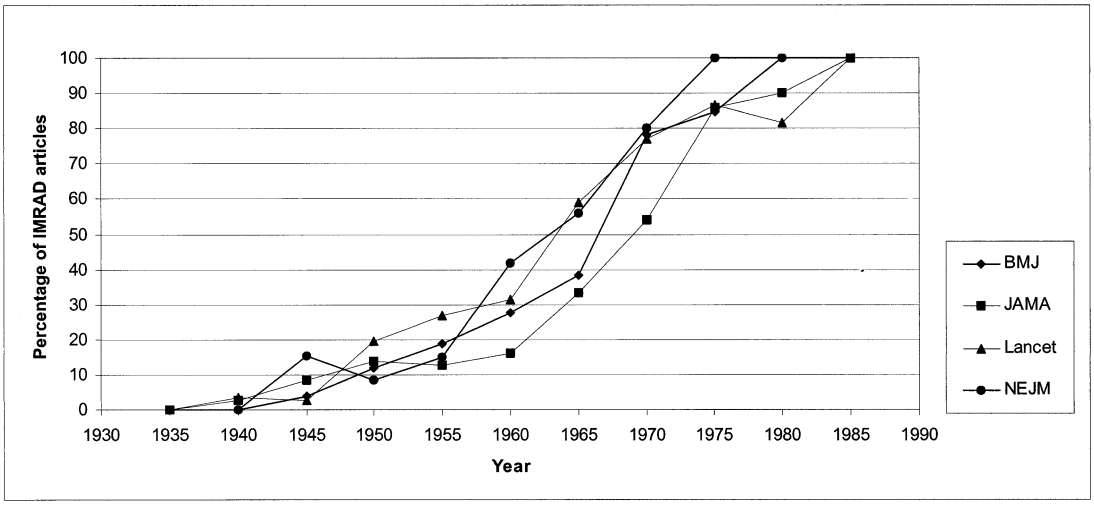
Methods: In a cross-sectional study, the frequency of articles written under the IMRAD structure was measured from 1935 to 1985 in a randomly selected sample of articles published in four leading journals in internal medicine: the *British Medical Journal, JAMA, The Lancet,* and the *New England Journal of Medicine.*

Results: The IMRAD structure, in those journals, began to be used in the 1940s. In the 1970s, it reached 80% and, in the 1980s, was the only pattern adopted in original papers.

Conclusions: Although recommended since the beginning of the twentieth century, the IMRAD structure was adopted as a majority only in the 1970s. The influence of other disciplines and the recommendations of editors are among the facts that contributed to authors adhering to it.

Since its origin in 1665, the scientific paper has been through many changes. Although during the first two centuries its form and style were not standardized, the letter form and the experimental report coexisted. The letter was usually single authored, written in a polite style, and addressed several subjects at the same time [1]. The experimental report was purely descriptive, and events were often presented in chronological order. It evolved to a more structured form in which methods and results were incipiently described and

Figure 1
Proportion of introduction, methods, results, and discussion (IMRAD) adoption in articles published in the *British Medical Journal*, *JAMA*, *The Lancet*, and the *New England Journal of Medicine*, 1935–1985 (n = 1,297)



interpreted, while the letter form disappeared [2]. Method description increasingly developed during the second half of the nineteenth century [3], and an overall organization known as ''theory—experiment—discussion'' appeared [4, 5]. In the early twentieth century, contemporary norms began to be standardized with a decreasing use of the literary style. Gradually, in the course of the twentieth century, the formal established introduction, methods, results, and discussion (IMRAD) structure was adopted [6].

However, neither the rate at which the use of this format increased nor the point at which it became the standard for today's medical scientific writing is well established. The main objective of this investigation is to discover when this format was definitively adopted. Also, to have a global idea of the articles published during the studied period, articles written without the IMRAD structure will be briefly described.

METHODS

In a cross-sectional study, the frequency of articles using the IMRAD structure was measured at 5-year intervals, during the 50-year period from 1935 to 1985. Data collection began at 1960, moving forward and backward from that year until the frequency of IMRAD articles reached 100% and none respectively. A sample of 1 in every 10 issues of 4 leading medical journals in internal medicine was systematically selected to evaluate the articles published in these years. A total of 1,297 original articles—all those from each selected issue—were examined: 341 from the *British Medical Journal,* 328 from *Journal of the American Medical Association (JAMA),* 401 from *The Lancet,* and 227 from the *New England Journal of Medicine.* These journals were chosen based on their similarities in target audience, frequency, and lifespan. The journals had to be currently published at the beginning of the 20th century and show no interruptions during the studied period.

The criteria used by the journal for an original article were accepted. Therefore, if an article was labeled original by the journal, it was regarded as such, even though nowadays it might not be considered so. An article was considered to be written using the IMRAD structure only when the headings ''methods, results, and discussion,'' or synonyms for these headings, were all included and clearly printed. The introduction section had to be present but not necessarily accompanied by a heading. Articles that did not follow this structure were considered non-IMRAD. They could be generally grouped as: (1) continuous text, (2) articles that used headings other than the IMRAD, (3) case reports, and (4) articles that partially adopted the IMRAD structure.

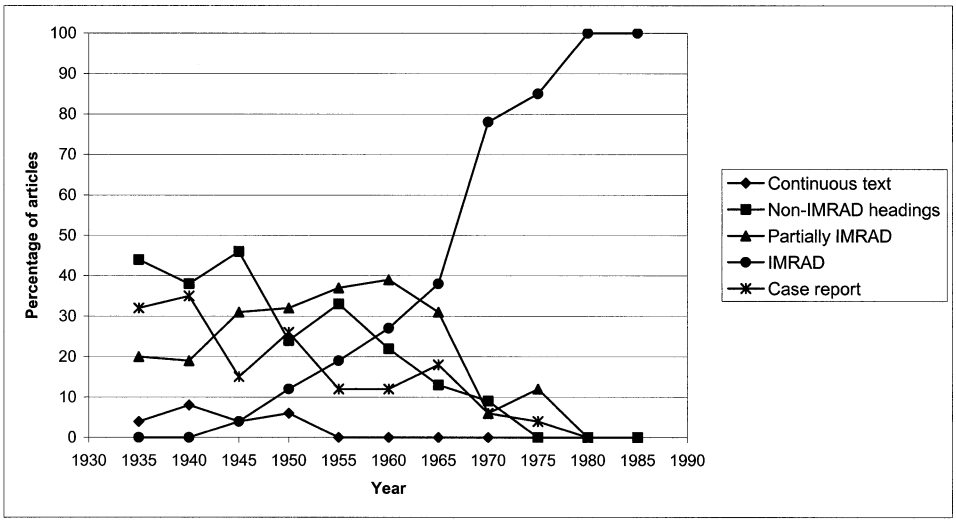
One of the authors (Sollaci) collected the data. In a randomly selected subsample of forty-eight articles, the data collection was independently repeated after six months. A high agreement was found (*Kappa* = 0.95; CI 95%:0.88; 1.0).

RESULTS

The frequency of articles written using the IMRAD structure increased over time. In 1935, no IMRAD article could be found. In 1950, the proportion of articles presented in this modern form surpassed 10% in all journals. Thereafter, a pronounced increase can be observed until the 1970s, when it reached over 80%. During the first 20 years, from 1935 to 1955, the pace of IMRAD increments was slow, from none to 20%. However, during the following 20 years, 1955 to 1975, the frequency of these articles more than quadrupled (Figure 1).

All four journals presented a similar trend: the *New England Journal of Medicine* fully adopted the structure

Figure 2
Text organization of published articles in the *British Medical Journal* from 1935 to 1985 (n = 341)



in 1975, followed by the *British Medical Journal* in 1980, and *JAMA* and *The Lancet* in 1985.

Regarding the non-IMRAD articles, the evolution and variations of text organization for all journals can be delineated. In the *British Medical Journal* and *The Lancet,* articles that used non-IMRAD headings prevailed from 1935 to 1945. A shift to articles that partially adopted the IMRAD structure occurred from 1950 to 1960. From 1965 and beyond, the full structure tends to predominate. Until 1960, texts with different headings and partial IMRAD headings shared the lead in *JAMA.* From 1965 onward, the complete format is the most used. The *New England Journal of Medicine* had a slightly different pattern. Until 1955, continuous text, non-IMRAD headings, and case reports predominated. After 1960, the IMRAD structure takes the lead.

As an example, Figure 2 shows the text organization in the *British Medical Journal* from 1935 to 1985. The ascending curve represents the IMRAD articles. It is the same as shown in Figure 1, and the descending curves represent all other forms of text organization. A similar tendency was observed for *The Lancet, JAMA,* and the *New England Journal of Medicine.*

One interesting finding is that during the initial period of our study, the order of the IMRAD headings did not follow today's convention; results could be presented before methods or discussion before results, and, although a few articles followed the IMRAD structure in the 1940s, they were not the same as articles written with the IMRAD structure in the 1980s. Information, which today is highly standardized in one section, would be absent, repeated, or dispersed among sections in earlier articles.

DISCUSSION

Gradually and progressively, the IMRAD structure was adopted by the studied journals. Until 1945, articles were organized in a manner more similar to a book chapter, mainly with headings associated with the subject, and did not follow the IMRAD structure. From 1950 to 1960, the IMRAD structure was partially adopted, and, after 1965, it began to predominate, attaining absolute leadership in the 1980s.

The authors did not find definite reasons explaining the leadership of the IMRAD structure in the literature. It is possible that sciences other than medicine might have influenced the growing use of this structure. The field of physics, for example, had already adopted it extensively in the 1950s [7].

This structure was already considered the ideal outline for scientific writing in the first quarter of the 20th century [8, 9]; however, it was not used by authors [10]. After World War II, international conferences on scientific publishing recommended this format [11], culminating with the guidelines set by the International Committee of Medical Journal Editors, formerly known as the Vancouver Group, first published in the late 1970s [12]. According to Huth [13], the wide use of the IMRAD structure may be largely credited to editors, who insisted on papers being clearly formatted to benefit readers and to facilitate the process of peer review.

According to Meadows [14], development and changes in the internal organization of the scientific article is simply an answer to the constant growth of information. The IMRAD structure facilitates modular reading, because readers usually do not read in a linear way but browse in each section of the article, looking for specific information, which is normally found in preestablished areas of the paper [15].

Four major leading journals of internal medicine were examined. It might be assumed that patterns set by these journals would be followed by others; nevertheless, caution should be taken in extrapolating these findings to other journals.

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