

The Birth and Evolution of a Discipline Devoted to Information in Biomedicine and Health Care

As Reflected in its Longest Running Journal

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Keywords

Methods of Information in Medicine, medical informatics, biomedical informatics, health informatics

Summary

Background: The journal *Methods of Information in Medicine*, founded in 1962, has now completed its 50th volume. Its publications during the last five decades reflect the formation of a discipline that deals with information in biomedicine and health care. Objectives: To report about 1) the journal's origin, 2) the individuals who have significantly contributed to it, 3) trends in the journal's aims and scope, 4) influential papers and 5) major topics published in *Methods* over the years.

Methods: Methods included analysing the correspondence and journal issues in the archives of the editorial office and of the publisher, citation analysis using the ISI and Scopus databases, and analysing the articles' Medical Subject Headings (MeSH) in MEDLINE.

Results: In the journal's first 50 years 208 editorial board members and/or editors contributed to the journal's development, with most individuals coming from Europe and North America. The median time of service was 11 years. At the time of analysis 2,456 articles had been indexed with MeSH. Topics included computerized systems of various types, informatics methodologies, and topics related to a specific medical domain. Some MeSH topic entries were heavily and regularly represented in each of the journal's five decades (e.g. infor-

mation systems and medical records), while others were important in a particular decade, but not in other decades (e.g. punched-card systems and systems integration). Seven papers were cited more than 100 times and these also covered a broad range of themes such as knowledge representation, analysis of biomedical data and knowledge, clinical decision support and electronic patient records.

Conclusions: *Methods of Information in Medicine* is the oldest international journal in biomedical informatics. The journal's development over the last 50 years correlates with the formation of this new discipline. It has and continues to stress the basic methodology and scientific fundamentals of organizing, representing and analysing data, information and knowledge in biomedicine and health care. It has and continues to stimulate multidisciplinary communication on research that is devoted to high-quality, efficient health care, to quality of life and to the progress of biomedicine and the health sciences.

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1. Introduction

Founded in 1962, *Methods of Information in Medicine* is the oldest international journal in medical informatics. At the end of 2011 *Methods* published its 50th volume.

On the occasion of the 50th birthday of *Methods*, the editors of the journal – the Editor-in-Chief (R.H.), the Senior Consulting Editor (A.T.M.) and the Associate Editors (D.A., O.G., T.Y.L., I.N.S.) – organized a scientific symposium, which took place in

Heidelberg, Germany from June 9 to 11, 2011. A select number of distinguished colleagues from around the world gathered in Heidelberg to participate in the symposium which had as its theme: “Biomedical Informatics: Confluence of Multiple Disciplines”.

2. The Early Years of *Methods* and its Relationships to International Medical Informatics Organizations

2.1 On the Journal's Origins

The roots of *Methods* go back to developments in Germany in the 1950s. A concise description of this can be found in [1], from which much of the data in Section 2.1 was taken.

In 1951 the first activities of the German Association for Medical Informatics, Biometry and Epidemiology^a (GMDS) [2], as it is called today, began. GMDS is the abbreviation for the Society for Medical Documentation and Statistics^b, the society's first name when it became independent. GMDS is among the oldest, if not the oldest, national society in medical informatics in the world.

At a meeting of the Committee for Mechanizing Documentation^c from December 13 to 15, 1951, a Subgroup in Medicine was established under the auspices of this committee, which itself was part of the German Society for Documentation^d.

On October 28, 1955 the General Assembly of the German Society for Documentation decided that this Subgroup in Medicine should become an independent Working Group for Documentation in Medicine^e, because of the growing interest and specific needs in this field. Dr. Otto Nacke (May 18, 1915 – October 17, 2006) from Bielefeld was elected as its chairman. Dr. Nacke was the initiator and long term director of the in 1956 established documentation center for health care services^f.

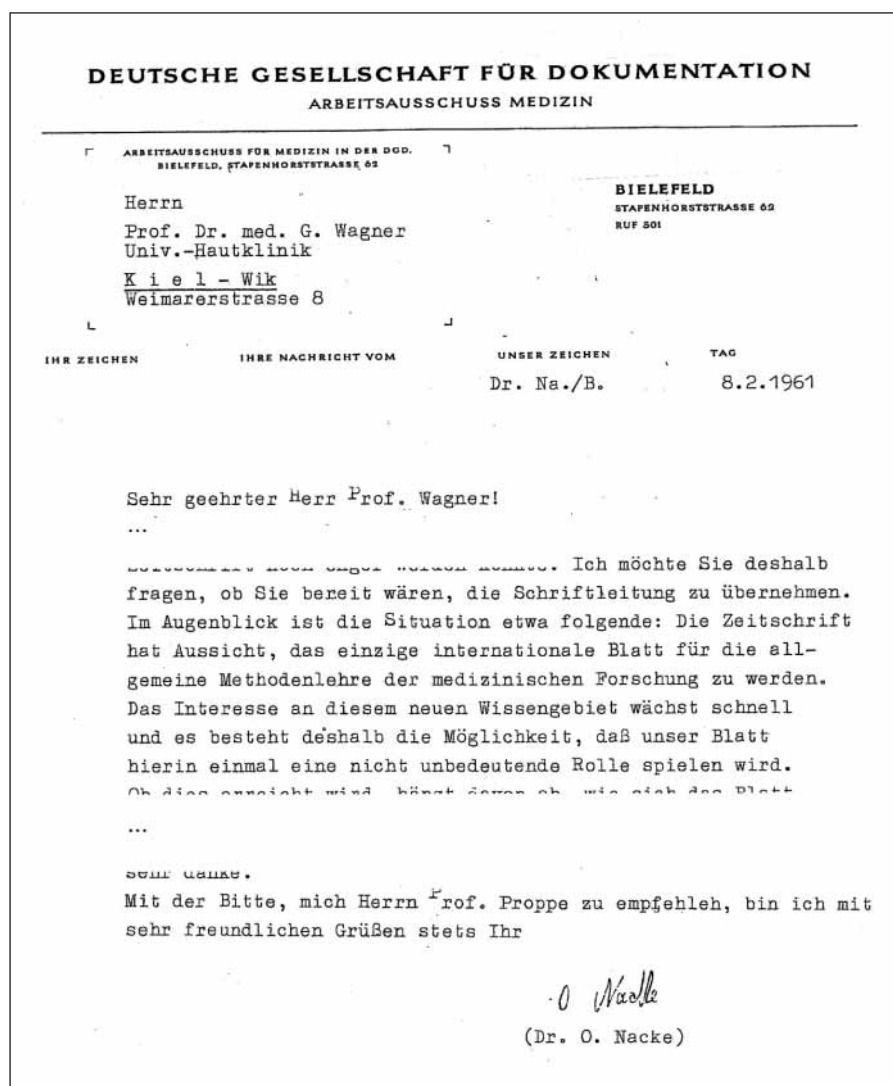


Fig. 1 Letter (excerpt) from Otto Nacke to Gustav Wagner from February 8, 1961 [3]: "Dear Prof. Wagner! ... I would like to therefore ask you, whether you would be willing to take over the editorship. At the moment the situation is the following: The journal has the chance to become the only international magazine for general methodology of medical research. The interest in this new discipline is growing fast and therefore there is the opportunity that our magazine will play a not insignificant role. ... In asking you to send my greetings to Prof. Proppe I remain as always with very kind regards".

At the beginning of the symposium and in order to mark this for our field historic event, the first author presented an overview about the journal's first five decades. The journal's publisher, Dieter Bergemann, and the past editors, Jan van Bommel and Donald Lindberg, joined the journal's current editors of *Methods* to prepare this paper, which is an extended version of the presentation.

In the following we will provide information about the:

- Origin of *Methods of Information in Medicine* (Section 2);
- Individuals who have contributed significantly to *Methods* (Section 3);
- Trends in the aims and scope of *Methods* (Section 4);
- Influential papers published in *Methods* (Section 5); and
- Major topics published in *Methods* over the years (Section 6).

^a Original German name: Deutsche Gesellschaft für Medizinische Informatik, Biometrie und Epidemiologie.

^b Original German name: Gesellschaft für Medizinische Dokumentation und Statistik.

^c Original German name: Ausschuss für Mechanisierung der Dokumentation.

^d Original German name: Deutsche Gesellschaft für Dokumentation.

^e Original German name: Arbeitsausschuss für Dokumentation in der Medizin.

^f Probably best translated from: Dokumentationsstelle für Versorgungsmedizin.

Otto Nacke recognized the urgent need for having a journal that dealt with the methodology of processing information in medicine and health care and, in addition, with its underlying technology. Starting in 1957 on he edited quarterly circular letters of the aforementioned working group, which was renamed to *Documentation in Medicine and Biology*^g in 1958. The quarterly letters formed the basis for the journal *Medical Documentation*, a journal for the general methodology of medical information^h published in 1960 and 1961. In 1961 the journal added an English journal title: *Medical Documentation – An International Publication for the Study of Medical Communication and Information Transfer*. Otto Nacke served both as editor and publisher of the journal ([1] and *Methods* Editorial Office Archive).

2.2 On Identifying Aim, Scope and Naming of *Methods*

On February 8, 1961 Otto Nacke sent a letter to Prof. Gustav Wagner (January 18, 1918 – September 16, 2006), at this time senior physician in the Department of Dermatology at the Medical Center of the University of Kiel. He asked him whether he would be willing to take over the editorship of the journal, officially effective in 1962 on (►Figure 1 [3]). In his reply of February 15, Gustav Wagner accepted in principle.

Discussions on establishing an international journal, superseding *Medical Documentation*, culminated in editorial meetings during an international seminar on medical documentation and statistics, which took place from October 16 to 28, 1961, in West-Berlin [1, 4]. Finding an appropriate internationally acceptable name and establishing an international editorial board were major topics. It is likely that during this meeting the name *Methods of Information in Medicine* was suggested as an appropriate name for the new journal.

^g Original German name: Dokumentation in Medizin und Biologie.

^h Original German name: Medizinische Dokumentation – Zeitschrift für die allgemeine Methodenlehre der medizinischen Information.

That discussions on the journal's naming took place until shortly before its first issue appeared, can e.g. be seen in a letter of Dr. Hubert Pipberger, Director of the Special Research Program in Medical Electronic Data Processing at Veterans Administration Hospital, Washington (D.C.). He co-chaired the above-mentioned seminar in Berlin. On January 2, 1962 he addressed a letter and wrote "I still think 'Methodology' would be better than 'Methods' in the title of the journal" [5].

A *Methods* editorial meeting on January 5, 1962, was insofar important, as final decisions were made on the journal's scope, on the handling of submissions, and on questions of publication and distribution [6]. ►Figure 2 illustrates that even at this editorial meeting the journal's name was under discussion and that the name "Methods of Medical Information" was manually corrected to the name that the journal still has today: *Methods of Information in Medicine*.

2.3 1962: The Launch of *Methods* and, Later, of Other Journals in Biomedical and Health Informatics

Based on the aforementioned developments and due to the tremendous progress in information processing methodology as well as in information and communication technology with its significant impact on biomedicine and health care, and because of the urgent need to internationally communicate research in this emerging field, the journal *Methods of Information in Medicine* was launched in 1962 as the first international journal in medical informatics.

Other journals in this field and also with an international focus followed. Within the next 10 years these were, according to our knowledge, *Computers and Biomedical Research* (now *Journal of Biomedical Informatics*), established in 1968 and, all established in 1970, *Computers in Biology and Medicine*, *Computer Programs in Biomedicine* (now *Computer Methods and Programs in Biomedicine*) and the *International Journal of Biomedical Computing* (now the *International Journal of Medical Informatics*) [7].

It should be noted that other international journals devoted to the methodology of processing data in biomedicine already existed. A prominent example is the journal *Biometrics*, which was established in 1945 [7]. These journals were, however, primarily focused on statistical methodology. With the rise of computers and other mechanical machines for processing data, publishing research related to what today is called information and communication technology became important, but was not in the scope of the other journals. In addition, many researchers regarded the focus on statistical methodology for processing data as being too narrow for their research.

2.4 Relationships to Regional and International Medical Informatics Organizations

Methods of Information in Medicine was and is an international journal that is connected in multiple ways to international organizations in medical informatics. Its relationships to two prestigious organizations are noteworthy.

In 1976 the European Federation of Medical Informatics (EFMI) was founded to constitute a European umbrella for the national medical informatics societies of this region [8]. In 1978, and, therefore, nearly from the inception of EFMI, *Methods* was endorsed as an official journal of EFMI.

The International Medical Informatics Association (IMIA) was founded in 1967 [9–13], and *Methods* has had close links to IMIA from the beginning. In 2003, IMIA decided for the first time to endorse journals that had longstanding relationships with IMIA as its official journals. The two selected journals were the *International Journal of Medical Informatics* and *Methods of Information in Medicine* [14, 15].

3. The People of *Methods*

3.1 The Publishers

From 1962 to 1964 (Volume 1 to 3 of *Methods*) Dr. Otto Nacke, Bielefeld, Ger-

Sehr geehrter Herr.....

...

Wer heute in der Medizin wissenschaftlich arbeitet,
~~der~~ ^{aktiv} steht ~~praktisch~~ vor folgenden Fragen:

Wie ist die beabsichtigte Untersuchung zu planen?
 (Methoden der Planung, ~~therapeutischer, ätiologischer, und~~
 epidemiologischer Forschung)

Wie werden die gewonnenen Daten am rationellsten
 fixiert, geordnet und zusammengestellt?
 (Methoden der mechanischen Selektion mit Hand~~loch-~~
~~karten, Maschinenlochkarten, ^{und} elektronischer ^{Einsatz} Rechenmaschinen~~
 usw)

...

Wer eine Befunddokumentation in der Klinik aufbauen und
 führen will, der fragt:

Wie ~~sollte~~ ^{sollte} ein dokumentationsgerechtes Krankenblatt ^{aussehen?}
~~verwendet bzw. zu entwickeln? wie ist eine Befunddokumentation~~
~~zu organisieren?~~

Welches Schlüsselssystem ist anzuwenden?
 Welches Verfahren der mechanischen Selektion ist ^{für meine Zwecke}
 geeignet?
 Wie ist die Prozedur für die Befunddokumentation ^{der klinischen Befunde}

...

Antwort auf diese und andere Fragen der medizinischen
 Information soll Ihnen eine neue Zeitschrift geben.
 Sie heißt: " Methods of ^{in der Medizin} ~~Medical~~ Information", "Methodik
 der ^{in der Medizin} ~~Medizinischen~~ Information" (vormals "Medizinische
 Dokumentation");

Fig. 2 Draft letter to possible subscribers (excerpt) discussed in an editorial meeting in January 5, 1962 (as appendix in [6]): "Dear ... Who today is doing scientific work in medicine often asks the following questions: How to plan the respective investigation? (methods to design therapeutic, etiological and epidemiological research) How to efficiently fix, code and arrange the gathered data? (methods of mechanical selection with hand and machine punch cards, use of electronic computing machines etc.) ... Who intends to establish and manage a clinical findings documentation in a hospital asks: What should appropriately documented medical records look like? How to organize a clinical findings documentation? Which coding system should be applied? Which principle for mechanical selection is appropriate for my purposes? ... Answers for you to these and other questions will be presented in a new journal. It is called: "Methods of Information in Medicine", "Methodik der Information in der Medizin" (formerly "Medizinische Dokumentation)". Handwritten notes by Gustav Wagner.

many, was the publisher, as he had been since 1957 of the preceding publications.

In 1965, Schattauer Verlag [16], a publishing house for medicine and the natural sciences at Stuttgart, Germany, acquired the publishing rights for *Methods* from Otto Nacke, who wanted to reduce his until then tremendous activities for the journal.

Gustav Wagner, who in 1965 became Director of the Institute for Medical Documentation, Information and Statistics of the German Cancer Research Center at Heidelberg, was willing to continue as editor and supported this change to a professional publishing house with an excellent

reputation [17]. A letter from Gustav Wagner to Prof. Paul Matis of Schattauer, at this time Publishing Director at Schattauer and heavily involved in this matter, indicates that the transfer from a self-publisher to a professional publishing house was challenging and not without tensions [18].

Methods continues to be published by Schattauer Verlag. From 1965 to 1967 Karl Friedrich Schattauer was publisher and CEO, and from 1967 to 1982, Paul Matis assumed these responsibilities (comprising the publishing of Volumes 5 to 21 of *Methods*). From 1983 on (i.e., from Volumes 22 of *Methods* on) the publisher has

been Dieter Bergemann, who in 1983 acquired Schattauer Verlag. For more than 28 years now, and assisted by a team of co-workers at Schattauer, he personally has been involved in overseeing the progress of *Methods*.

For his long-term support as publisher of medical informatics journals Dieter Bergemann was named an Honorary Fellow of IMIA in 2006. This recognition acknowledged, in addition to *Methods*, his significant contributions to the development of the IMIA Yearbook of Medical Informatics, since 1992 jointly published by IMIA and Schattauer. Later, in 2009, and also with Dieter Bergemann's strong support, Applied Clinical Informatics was launched. As a bridge to practitioners in the field, Applied Clinical Informatics became IMIA's third official journal and Schattauer's first online only journal.

3.2 The Editors

A list of those individuals who edited *Methods* during its first five decades can be found in ► Table 1. Unless noted otherwise, all data were obtained from the print versions of the journal issues. The roles of Otto Nacke and of Gustav Wagner, the two key persons in the early days of *Methods*, remained somewhat vague with respect to the title of Editor-in-Chief. In a rate card on *Methods* for the US market "being effective from January 1, 1963" on, Otto Nacke is denoted as the editor of *Methods* [19]. The term "editor" was likely translated from the German term "Herausgeber", which can also have the meaning of "publisher", which Otto Nacke was at this time. In the aforementioned letter of Otto Nacke to Gustav Wagner on February 8, 1961, Gustav Wagner was asked whether he would be willing to take over the editorship of the journal, officially being effective from 1962 on ([3] and ► Fig. 1). The term in this letter is "Schriftleitung" (editorship). This may lead to the – probably most likely – conclusion that between 1962 and 1965 Otto Nacke was mainly the publisher and Gustav Wagner the editor of *Methods*. The documents of the *Methods* editorial archive until 1965 also at least implicitly confirm this conclusion.

Gustav Wagner served as the journal's Editor-in-Chief for 26 years and shaped the face of *Methods* more than anyone else. During his editorship also ten supplements to *Methods of Information in Medicine* – all in German and all conference proceedings – were published as Schattauer books [20–29].

In 1987 Gustav Wagner planned to step down as Editor-in-Chief of *Methods*. It was intended that Prof. Peter L. Reichertz, who was then Director of Hannover Medical School's Institute for Medical Informatics, should succeed him. A first meeting took place at Schattauer Verlag in Stuttgart on February 10, 1987. There it was decided that Peter Reichertz would take over as Editor-in-Chief in 1988 [30]. Unfortunately, Peter Reichertz passed away on August 18, 1987 [31]. In a meeting between Peter Reichertz and Gustav Wagner in June 15, 1987, they created a list of possible successors as Editor-in-Chief of *Methods*, which Gustav Wagner later presented to Dieter Bergemann.

At the top of this list was Prof. Jan van Bommel, Rotterdam [30], who was then Director of the Department of Medical Informatics at the Erasmus University of Rotterdam's Faculty of Medicine and Health Sciences. He accepted and took over from Gustav Wagner in 1988 [32], until he himself "transferred the helm" to others 2001 [33, 34]. In 1988 a Special Issue of *Methods* was published in order to honour Gustav Wagner [35]. During Jan van Bommel's term as editor this was the only supplement to *Methods*, in content and style already a kind of predecessor of the, from 1992 onwards appearing *IMIA Yearbook of Medical Informatics*.

Jan van Bommel led the journal for almost 14 years. In addition to Otto Nacke, who contributed substantially to the founding of the journal, and Gustav Wagner who was the journal's founding editor, Jan van Bommel was the third person, who significantly shaped *Methods of Information in Medicine*. Under his editorship *Methods of Information in Medicine* became a truly international journal.

Beginning in 2001 Reinhold Haux and Alexa McCray became the new Editors-in-Chief, and since 2007, Reinhold Haux has served in this role, together with

Table 1 The Editors of *Methods of Information in Medicine* from 1962 to 2011

Volume (Issue)	Year	Editors (Roles and Location)
1	1962	Otto Nacke (Redactor) Bielefeld, Germany Gerhard Oberhoffer (Redactor) Bonn, Germany Gustav Wagner (Redactor) Kiel, Germany I. Welt (Abstracting and Indexing Editor) Washington/DC, USA
4	1965	Gustav Wagner (Redactor) Heidelberg, Germany Gerhard Oberhoffer (Redactor) Hubert V. Pipberger (Redactor) Washington/DC, USA
10	1971	Gustav Wagner (Editor-in-Chief) Hubert V. Pipberger (Associate Editor) only in 10(1): G.W.: Editor in Chief, H.V.P.: Assistant Editor
22	1983	Gustav Wagner (Editor-in-Chief) Donald A. B. Lindberg (Associate Editor) Columbia/MO, USA, since 1985: Bethesda/MD, USA
26	1987	Gustav Wagner (European Editor) Peter L. Reichertz (European Editor) Hannover, Germany Donald A. B. Lindberg (American Editor)
27	1988	Jan H. van Bommel (Chief Editor) Rotterdam, The Netherlands, until 27(4): European Editor Donald A. B. Lindberg (Associate Editor) until 29(1): American Editor Gustav Wagner (Senior Editor) until 27(2): European Editor
38 (3)	1999	Jan H. van Bommel (Chief Editor) Donald A. B. Lindberg (Associate Editor) Reinhold Haux (Associate Editor) Heidelberg, Germany Gustav Wagner (Senior Editor)
40 (4)	2001	Reinhold Haux (Editor-in-Chief) since 1/2002: Heidelberg, Germany and Innsbruck, Austria, since 4/2002: Innsbruck, Austria, since 2005: Braunschweig, Germany Alexa T. McCray (Editor-in-Chief) Bethesda/MD, USA, since 2/2005 Boston/MA Jan H. van Bommel (Senior Editor) Donald A. B. Lindberg (Senior Editor) Gustav Wagner (Senior Editor)
46	2007	Reinhold Haux (Editor-in-Chief) since 1/2008 Braunschweig and Hannover, Germany Dominik Aronsky (Associate Editor) Nashville/TN, USA Tze Yun Leong (Associate Editor) Singapore Alexa T. McCray (Senior Consulting Editor) Jan H. van Bommel (Senior Editor) Donald A. B. Lindberg (Senior Editor) Gustav Wagner (†) (Founding Editor)
50	2011	Reinhold Haux (Editor-in-Chief) Dominik Aronsky (Associate Editor) Olaf Gefeller (Associate Editor) Erlangen, Germany Tze Yun Leong (Associate Editor) I. Neil Sarkar (Associate Editor) Burlington/VT, USA Alexa T. McCray (Senior Consulting Editor) Jan H. van Bommel (Senior Editor) Donald A. B. Lindberg (Senior Editor) Gustav Wagner (†) (Founding Editor)



Fig. 3 Methods editors-publisher meeting on May 9, 2003 at Heidelberg. From left to right: Reinhold Haux (editor), Jan van Bommel (editor), Dieter Bergemann (publisher), Andrea Schürg (Director of journals at Schattauer), Heidi Kampe-Hauk (editorial assistant), Gustav Wagner (editor), Alexa McCray (editor), Gudrun Hübner-Bloder (editorial assistant), Helga Bergemann.

an expanded international core editorial team.

On the newer developments from 2001 forward, a report was recently presented by the current editors in [36]. There it was also announced that, from 2011 on (i.e., from Volume 50), all articles that have ever been published in *Methods* can now be accessed online at the Schattauer web site [17]. Also, when this article appears, all *Methods* articles have been completely indexed in the U.S. National Library of Medicine's MEDLINE database, including all publications from the very early volumes. Since *Methods* is the oldest international journal in biomedical informatics, this online access will also help preserve the history of our field.

During this period three supplements have been published in addition to regular issues of *Methods*. As in 2005 it became evident that the IMIA Yearbook of Medical Informatics needed to be adapted to new publication developments, from 2006 to 2008 the volumes of the Yearbook were published as supplements of *Methods* ([37] – [39]). Through this step, the Yearbook articles became since 2006 until today accessible through and indexed in PubMed. From 2009 on the Yearbook is again published as separate periodical.

► Figure 3 shows a photograph taken at an editors-publisher meeting on May 9, 2003 in Heidelberg, Germany, and includes the Publisher and all previous Editors-in-Chief of *Methods* with the exception of Otto Nacke.

3.3 Editorial Board Members

The editorial board members of a journal play a crucial role in the development of a journal and in the quality of its publications. ► Table 2 displays all 208 editorial board members of *Methods* during the last five decades (including the editors, who were often also board members before or afterwards). It might be worthwhile mentioning that all recipients of the prestigious IMIA Award of Excellence (2004: François Grémy, 2007: Jan van Bommel, 2010: Marion Ball and Hans Peterson) have been long-term members of the editorial board.

► Table 3 shows the distribution of the journal's editorial board members per region (region as defined by IMIA). Starting as a mainly German-US-journal, *Methods* has become more international over the last five decades, although the majority of

the editorial board members come from Europe and from the United States of America, and although members from Africa and from the Middle-East regions are still missing.

Members of the editorial board of *Methods* serve for quite a long time. ► Figure 4 contains the distribution of duration of board membership participation during these five decades. The median time as editorial board member and/or editor is 11 years (interquartile range: 5–17 years). ► Table 4 lists the 20 individuals, who served for the longest time periods on the journal's editorial board and/or as editor.

4. Scope Statements over Time

Before commenting on the scope statements and discussing the journal's aims, it might be worth recalling the mentioned roots of *Methods* in Germany.

In contrast to other countries, Germany maintains a rather collaborative scientific environment among researchers from biostatistics, medical informatics and, to some extent, biomedical engineering. This collaborative environment led in 1951 to the establishment of the GMDS as a scientific society.

The research conducted by members of this society was and is primarily devoted to the methodology of processing data in biomedicine and health care in order to contribute to high quality and efficient health care and to progress in biomedicine and in the health sciences. This research community was, in addition, open to applying and even developing new information and communication technology. In this scientific environment there has never been a strict separation between, e.g., medical informatics and biostatistics, which in other countries tend to be organized in separate scientific societies. The same holds for informatics (in German: Informatik) and computer science (in German: Informatik) and for research in biomedical engineering, such as biomedical signal and image processing, which was at this time (and still is today) regarded as part of medical informatics. *Methods* clearly reflects this tradition from its beginning until the present time.

Table 2 The 208 editorial board* members of *Methods of Information in Medicine* from 1962 to 2011**, also including the editors

Abu Hanna, A.	NL	since 2009	Fizman, M.	USA	since 2007	Knaup, P.	D	since 2011
Adlassnig, K.P.	A	1992–1999	Flagle, C. D.	USA	1971–1999	Koch, S.	S	since 2009
Åhlfeld, H.	S	2000–2003	Fletcher, C. M.	GB	1965–1976	Koepcke, W.	D	2003–2005
Ammenwerth, E.	A	since 2005	Fox, J.	GB	1989–1999	Kohane, I.	USA	2002–2004
Anderson, J.	GB	1971–1991	E.D. Freis	USA	1963–1980	Koller, S.	D	1962–1991
Andreassen, S.	DK	2000–2003	G. Fuchs	D	1971–1986	Korhonen, I.	FIN	2003–2008
Aronsky, D.	USA	2003–2006 ^{AE}	S. Garde	D	2008–2010	Kuhn, K.	D	since 2002
Bai, J.	China	2003–2005	Gardner, R.	USA	since 2003	Kulikowski, C.	USA	since 2000
Bakken, S.	USA	since 2011	O. Gefeller, O.	D	2006–2010 ^{AE}	Künkel, H.	D	1981–1991
Ball, M.	USA	2002–2010	Geissbuhler, A.	CH	2003–2008	Kwak, Y. S.	ROC	2005–2007
Barber, B.	GB	1981–1991	Giere, W.	D	1977–1991	Lachenbruch, P. A.	USA	1978–2002
Barnett, G. O.	USA	1970–1999	Gell, G.	A	2000–2006	Lamson, B. G.	USA	1971–1980
Beecher, H. K.	USA	1962–1976	Grant, A. M.	CDN	2004–2010	Lange, H.-J.	D	1972–1988
Bellazzi, R.	I	since 2007	Graul, E. H.	D	1971–1991	Lasagna, L.	USA	1962–1991
Bleich, H. L.	USA	1977–1991	Greenes, R. A.	USA	since 2000	P. Le Beux	F	2000–2002
Bochnik, H. J.	D	1972–1988	Grémy, F.	F	1971–2001	Lehmann, C. U.	USA	since 2009
Brinkley, J.	USA	since 2003	Griesser, G.	D	1971–1991	Lehmann, H.	USA	since 2009
Burgun, A.	F	2002–2010	Härö, S. A.	FIN	1977–1991	Leiber, B.	D	1972–1986
Cardus, D.	USA	1977–1991	Hales, J.	USA	2002–2004	Leong, T. Y.	SGP	2005–2006 ^{AE}
Cerutti, S.	I	since 2009	Hall, P.	S	1965–1988	Li, Y.-C.	Taiwan	since 2003
Chapman, W. W.	USA	2007–2010	Handels, H.	D	since 2003	Lindberg, D. A. B.	USA	1970–1982 ^{AE&SE}
Cimino, J. J.	USA	since 2000	Hasman, A.	NL	since 2002	Lorenzi, N. M.	USA	2000–2010
Clayton, P. D.	USA	1989–2005	Haux, R.	D	2002–2004 ^A	Lovis, C.	CH	since 2006
Coiera, E.	AUS	2005–2007			^{AE & EIC}	Lun, K. C.	SGP	2000–2004
Collen, M. F.	USA	1970–1999	Hayes, G.	GB	2000–2006	Maglaveras, N.	GR	since 2000
Cornfield, J.	USA	1971–1980	Hirakawa, A.	J	1984–1985	Mansmann, U.	D	2003–2008
De Faria Leão, B.	BR	2000–2001	Hristovski, D.	SLO	2004–2010	Mantas, J.	GR	since 2005
Degoulet, P.	F	1992–2006	Huang, H. K.	USA	2003–2005	Maojo, V.	E	since 2007
de Moor, G.	B	2000–2005	Huron, S.	F	1963–1980	Marin, H.	BR	2004–2010
Deserno, T. M.	D	since 2007	Immich, H.	D	1971–1988	Martin, L.	B	1962–1980
de Dombal F. T.	GB	1981–1996	Jacquez, J. A.	USA	1971–1988	Martin-Sanchez, F.	E since 2011 AUS	since 2003
Eden, M.	USA	1963–1980	Jaspers, M.	NL	since 2008			
Ehlers, C. T.	D	1977–1991	Jørgensen, M.	DK	1979–1991	Martini, P.	D	1962–1964
Ehrensgruber, H.	CH	1981–1988	Joubert, M.	F	2003–2005	Matheson, N. W.	USA	1988–1999
Fieschi, M.	F	1989–2006	Kaihara, S.	J	1978–2001	McCray, A. T.	USA	2000–2001 ^{EIC&SCE}
Fink, H.	D	1971–1988	Kay, S.	GB	2010 ²	Medalie, J.	IL	1971–1978
Finney, D. J.	GB 1987 RP 1988 NL	1973–1991	Kent, A.	USA	1963–1980	Michaelis, J.	D	1981–2001
Fischer, G.	A	since 2010 ²	Kieser, M.	D	since 2009	Mihalas, G.	Ro	2000–2010
Fishbein, M.	USA	1963–1976	Kimura, M.	J	since 2007	Miller, R. A.	USA	1989–2000
			Klar, R.	D	2002–2007			

Table 2 The 208 editorial board* members of *Methods of Information in Medicine* from 1962 to 2011**, also including the editors (continued)

J.H. Milsum	CDN	1977–1991	Rodrigues, R. J.	BR	1984–1999	Talmon, J. L.	NL	since 2000
Modell, W.	USA	1962–1976	Roger France, F. H.	B	1981–2010	Tanaka, H.	J	since 2004
Moehr, J. ^x	D since 1987 CDN	1981–2006	Rosenbloom, S. T.	USA	since 201	Tautu, P.	D	1981–1991
Morales, E.	C	1984–1991	Rubel, P.		2000–2001	Tilg, B.	A	2003–2005
Mosbech, J.	DK	1977–1991	Rutstein, D. D.	USA	1962–1980	Überla, K.	D	1971–1999
Müller, H.	CH	since 2009	Safran, C.	USA	since 2000	Vallbona, C.	USA	1970–1991
Musen, M.	USA	1992–2006	Salamon, R.	F	1991–200	van Bommel, J. H.	NL	1981–1987 ^{C&SE}
Nacke, O.	D	1965 ^{R1} –1991	Saranummi, N.	FIN	since 2009	van Brunt, E. E.	USA	1981–1991
Neiß, A.	A	1987–1991	Sarkar, I. N.	USA ^{AE11}	1962–1980	van der Lei, J.	NL	2002–2007
Oberhoffer, G.	D	1971 ^{R2} –1985	Satomura, Y.	J	1986–1991	van Egmond, J.	B	1977–1978
Olivieri, N.	RA and USA	2004–2006	Scherrer, J. R.	CH	1986–2002	van Eimeren, W.	D	1992–1999
O’Moore, R.	IRL	1981–1999	Scadding, J. G.	GB	1963–1978	van Ginneken, A. M.	NL	1992–2006
Orr, R. H.	USA	1962–1980	Schneider, B.	D	1970–1999	Victor, N.	D	1977–2006
Patel, V.	CDN since 2002 USA	2000–2003	Schneider, W.	S	1977–1999	Wagner, G.	D ^{R&EIC & SE}	
Peek, N.	NL	since 2009	Selbmann, H. K.	D	1992–1999	Walter, E.	D	1972–1985
Peleg, M.	IL	since 2007	Senn, S.	GB	2006–2009	Weigelin, E.	D	1965–1980
Peng, L.	China	1984–1987	Shahar, Y.	IL	since 2007	Weil, M. H.	USA	1977–1991
Peterson, H.	S	1978–1991	Shepard, R.	USA	1971–1980	Welt, I. D.	USA	1965 ^{AIE} –1980
Pfeiffer, K. P.	A	2003–2008	Shires, D. B.	USA	1981–1991	Welte, E.	D	1965–1980
Pincirol, F.	I	1989–1999	Shortliffe, E. H.	USA	1986–2003	Westbrook, J.	AUS	since 2008
Pipberger, H. V.	USA	1962–1964 ^{R&A} 1983–1994	Sigulem, S.	BR	1992–199	Wigertz, O.	S	1981–1999
Polacsek, R. A.	USA	1981–1987	Sittig, D. F.	USA	2000–2006 and since 2011	Willems, J. L.	B	1989–1994
Pratt, A. W.	USA	1971–1991	Slack, W. V.	USA	1977–1991	Windeler, J.	D	2003–2005
Proppe, A.	D	1965–1988	Slee, V. N.	USA	1962–1980	Witte, H.	D	since 2003
Protti, D.	CDN	1992–2002	Southern, W. A.	USA	1962–1980	Wingert, F.	D	1977–1988
Quackenbush, J.	USA	2008–2010	Spencer, W. A.		1974–1991	Wolff-Terroine, M.	F	1971–1980
Rector, A. L.	GB	2000–2006	Stefanelli, M.	I	2000–2010	Wyatt, J. C.	GB	2000–2003
Reichert, P. L.	D	1970–1986 ^{EE}	Sweeney, J. W.	USA	1967–1976	Zajicec, G.	IL	1979–1999
Rienhoff, O.	D	1989–2002	Szolovits, P.	USA	1989–1999	Zhou, C.	USA	since 2010 ²
			Takabayashi, K.	J	since 200	Ziegler, A.	D	since 2006
			Takeda, H.	J	2000–2003	Zvárová, J.	CZ	since 2000
						Zywietz, C.	D	2000–2005

*: from 1962–1970 Editors, in 1971 Advisory Board, 1989–1991 Editorial Board and Advisory Board, in all other years Editorial Board; **: names taken from the volumes’ first issues – few exceptions are explicitly mentioned; AE: since then Associate Editor; AE11: since 2011 Associate Editor; AE&EIC: 1989–2001 Associate Editor since then Editor-in-Chief; AE&SE: since then Associate and later Senior Editor; AIE: before Abstracting and Indexing Editor; C&SE: since then Chief Editor and later Senior Editor; EE: in 1987 European Editor; EIC&SCE: since then Editor-in-Chief and later Senior Consulting Editor; Rn: from 1962 to 1964 (R1) resp. 1970 (R2) Redactor; R&AE: from 1965 to 1983 Redactor resp. Associate Editor; R&EIC&SE: 1962 Redactor, then 1965 Editor-in-Chief, then 1988–2006 Senior Editor; x: until 1999 “J. Möhr”; 2: since issue 2.

Table 3 Regional distribution of editorial board members and editors of *Methods of Information in Medicine* in the years 1962, 1970, 1980, 1990, 2000, and 2010. Definition of regions according to IMIA.

Region	Year											
	1962		1970		1980		1990		2000		2010	
	n	%	n	%	n	%	n	%	n	%	n	%
Asia-Pacific					1	2	2	3	3	6	6	10
Europe	6	40	15	45	35	56	34	55	28	58	36	58
from Germany	5	33	9	27	22	35	14	23	6	12	9	6
Latin America							2	3	1	2	1	2
North America	9	60	18	55	26	42	24	39	16	33	19	31
Σ	15	100	33	100	62	100	62	100	48	100	62	100

Table 4 List of those 20 persons with time periods, serving for the longest time periods in the Editorial Board ("■") and/or as Editor ("■") of *Methods of Information in Medicine*. Data have been taken from Tables 1 and 2. ">": still active.

Editorial Board Members and Editors	Years	1960	1970	1980	1990	2000	2010
G. Wagner (D) ^{R&EIC&EE&AE}	45	■					
D.A.B. Lindberg (USA) 1970–1982 ^{AE&SE}	>42	■ >					
H.V. Pipberger (USA) 1962–64 ^{R&AE} 83–94	33	■					
J.H. van Bommel (NL) 1981–1987 ^{C&SE}	>31	■ >					
F. Grémy (F) 1971–2001	31	■					
G.O. Barnett (USA) 1970–1999	30	■					
M.F. Collen (USA) 1970–1999	30	■					
S. Koller (D) 1962–1991	30	■					
L. Lasagna (USA) 1962–1991	30	■					
O. Nacke (D) 1966 ^{R1} –1991	30	■					
F.H. Roger France (B) 1981–2010	30	■					
B. Schneider (D) 1970–1999	30	■					
N. Victor (D) 1977–2006	30	■					
K. Überla (D) 1971–1999	29	■					
J. Moehr ^x (D since 87 CDN) 1981–2006	26	■					
P.A. Lachenbruch (USA) 1978–2002	25	■					
P. Hall (S) 1965–1988	24	■					
S. Kaihara (J) 1978–2001	24	■					
G. Oberhoffer (D) 1971 ^{R2} –1985	24	■					
A. Proppe (D) 1965–1988	24	■					

AE&SE: since then Associate and later Senior Editor; C&SE: since then Chief Editor and later Senior Editor; Rn: from 1962 to 1964(R1) resp. 1970(R2) Redactor; R&EIC&EE&AE: from 1962 to 2006 Redactor, then Editor-in-Chief, European Editor, then Senior Editor; R&AE: from 1965 to 1983 Redactor resp. Associate Editor.

It might be worth studying in detail the contents of ▶ Table 5, where the journal's titles, themes, aims and scope of the last five decades have been listed. All significant changes, either in the aims and scope texts

or in the layout are documented in this table.

We can e.g. recognize that it took about one decade for *Methods* to shift from a journal that published manuscripts in German

and English to a journal with English as the preferred language. One decade later the journal's German name disappeared from the title page. Until 1988 abstracts were written in both German and English. Start-

Table 5 Titles, themes, aims and scope of *Methods of Information in Medicine* from 1962 to 2011.

Volume (Issue)	Year	Title, Themes, Aims and Scope
1	1962	 <p>is a quarterly journal dealing with the general methodology of medical research. Contributions are accepted on the Theory and Mathematics of Medical Research, Methodology of Controlled Clinical Trials and of Etiological and Epidemiological Investigations, Problems of Nomenclature, Terminology and Classification, Mechanical Data Selection, Automatic Data Processing, and Literature Documentation.</p>
4	1965	 <p>•Methods of Information in Medicine — Methodik der Information in der Medizin« — Journal of Methodology in Medical Research, Information and Documentation — accepts papers in English or German.</p>
10	1971	  <p><i>Methods of Information in Medicine</i> — <i>Methodik der Information in der Medizin</i> publishes original papers, reports and bibliographies in the fields of methodology in medical research, data processing, documentation, information retrieval and clinical statistics.</p>
20	1981	  <p><i>Methods of Information in Medicine</i> publishes original papers, reports, and bibliographies in English in the fields of methodology in medical research, data processing, documentation, information retrieval and clinical statistics.</p>
28 29	1989 1990	 <p>Vol. 29, 1990</p>  <p>Vol. 28, 1989</p> <p><i>Methods of Information in Medicine</i> publishes original papers, reports, and reviews in the fields of methodology for medical research and clinical studies, dealing with documentation and data processing; information and communication systems; data, signal, and image interpretation; statistical studies; diagnosis and therapy in medicine and in health care; knowledge processing and expert systems; simulation and modelling. The Journal stresses the scientific foundations of medical informatics in medical research and applications.</p>
40 (4) 41	2001	 <p>Vol. 40, issue 4, 2001</p>  <p>Vol. 41, 2002</p> <p>Good medicine and good healthcare demand good information. <i>Methods of Information in Medicine</i> stresses the basic methodology and scientific fundamentals of processing data, information and knowledge in medicine and health care. It publishes original papers, reviews, reports, opinion papers, and editorials in medical informatics/health informatics and related disciplines such as medical biometry. Since the journal's foundation in 1962 progress in information processing methodology and in information and communication technology has significantly changed our societies. Medicine and health care have taken great advantage of this progress. <i>Methods of Information in Medicine</i> continues to publish papers in the whole range of processing data, information and knowledge in medicine and health care, including research in traditional as well as in new areas of this expanding field. It includes topics such as health information systems and patient records; diagnosis and therapy in health care; biomedical data, signal, and image interpretation; clinical bioinformatics; clinical data analysis and statistical studies; expert systems and knowledge representation; simulation and modelling.</p>
45 (3) 50	2006 2011	 <p>Vol. 45, issue 3, 2006</p>  <p>Vol. 50, 2011</p> <p>Good medicine and good healthcare demand good information. <i>Methods of Information in Medicine</i> stresses the basic methodology and scientific fundamentals of processing data, information and knowledge in medicine and health care. It publishes original papers, reviews, reports, opinion papers, and editorials in medical informatics/health informatics and related disciplines such as medical biometry. Since the journal's foundation in 1962 progress in information processing methodology and in information and communication technology has significantly changed our societies. Medicine and health care have taken great advantage of this progress. <i>Methods of Information in Medicine</i> continues to publish papers in the whole range of processing data, information and knowledge in medicine and health care, including research in traditional as well as in new areas of this expanding field.</p>

Table 6 Influential papers published in *Methods* identified by a citation analysis

No.	Author(s)	Title	Bibliographic details	No. of cites	Proportion of cites from <i>Methods</i> (%)	No. of citing journals	Time pattern of citations*
1	Lindberg DAB, Humphreys BL, McCray AT	The Unified Medical Language System	1993;32(4):281–291	416	10.4	94	1998 (1993–2011)
2	Cimino JJ	Desiderata for controlled medical vocabularies in the twenty-first century	1998;37(4–5):394–403	207	10.5	48	2001 (1998–2011)
3	van Bommel JH, Kors JA, van Herpen G	Methodology of the modular ECG analysis system MEANS	1990;29(4):346–353	151	3.5	58	2006 (1990–2010)
4	Abt K	Descriptive data-analysis – a concept between confirmatory and exploratory data-analysis	1987;26(2):77–88	137	0	81	2001 (1987–2011)
5	D’Hoore W, Sicotte C, Tilquin C	Risk adjustment in outcome assessment – the Charlson comorbidity index	1993;32(5):382–387	124	0	81	2008 (1996–2011)
6	Heckerman DE, Horvitz EJ, Nathwani BN	Toward normative expert systems. 1. The Pathfinder project	1992;31(2):90–105	113	6.3	55	1996 (1993–2010)
7	Rector AL, Nowlan WA, Kay S	Foundations for an electronic medical record	1991;30(3):179–186	110	30.3	24	1996 (1992–2011)

*Year of highest number of citations (in brackets: interval during which the publication received citations)

ing in 1988 (Volume 27 of *Methods*), when Jan van Bommel became Editor-in-Chief, the German abstracts disappeared and *Methods* became a purely English language journal.

It may be of interest to look at the temporal shifts of the journal’s aims and scope statements. Starting with being a journal that dealt with the general methodology of medical research (Volume 1 in 1962), it gradually became a journal dealing with the basic methodology and scientific fundamentals of processing data, information and knowledge in medicine and health care (Volume 41 in 2002).

Methods never regarded itself as a journal devoted only to research or applications of computers, although information and communication technology tools were always considered as important counterparts to developments in methodology. Methodology of processing (and/or representing, organizing) data (and/or information, knowledge) and the intention to contribute to health care and progress in biomedicine and in the health sciences have always been its invariant priorities [32–34].

Also, *Methods* never regarded itself as a purely medical informatics journal (or, more broadly, a journal in biomedical and

health informatics), although the journal’s major focus is in this field. The beginning of this section may provide a historically rooted rationale and is also discussed in [36]. As mentioned in [36], the current editors still see the need to provide opportunities to communicate and discuss research covering more than one of the above-mentioned disciplines. In fact, it seems to us that this need has become even more urgent.

Like the founders and early editors, we are also convinced that our discipline in particular and science in general will benefit from continuing and even strengthening the broad scope of *Methods*, which has been a hallmark of the journal’s development over the last five decades.

5. Influential Papers in *Methods*

Approximately 2600 papers have been published in *Methods* during the last 50 years. In rapidly changing scientific disciplines such as the ones covered by *Methods*, it is sometimes the case that researchers focus more on recently published information, while assuming that almost everything

published several years or even decades ago is only of interest to historians. As a consequence, many carefully prepared and scholarly written papers are no longer cited some years after their publication. Some remain, however, in the collective memory of the discipline and, therefore, have an important impact on the field.

We tried to identify such influential papers in *Methods*. Since personal favorites vary and attempts to reach a consensus among scientists working on different topics are likely to fail, we approached the task through a formal citation analysis, using the database of the Institute of Scientific Information (ISI) as the primary source for our search and confirming the findings by an additional search in Elsevier’s Scopus databaseⁱ.

ⁱ As a consequence, all papers from the 60s had no chance of being selected, since the ISI coverage of *Methods* papers only began in 1970. We acknowledge also the limitations of a simple citation analysis that focuses only on those publications receiving the highest number of citations and ignores, for example, the changing citation behavior over time, the problem of self-citations and the length of the period between publication of the paper and this analysis which makes it difficult for papers published during recent years to appear in this list.

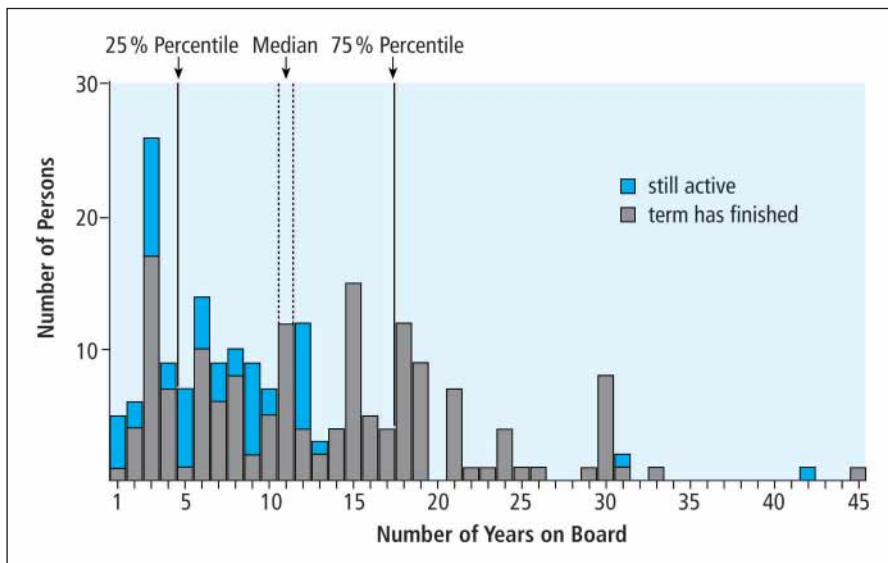


Fig. 4 Board membership participation of the 208 editorial board members and/or editors of *Methods of Information in Medicine* during the journal's first five decades. Data have been taken from Tables 1 and 2.

► Table 6 shows the seven articles that were cited more than 100 times as of May 15, 2011, giving bibliographic details, citation frequencies, proportion of citations from other *Methods* papers, year of highest number of citations and interval during which the paper received citations. The highest number of citations is to a paper by Lindberg et al. from 1993 [40], which described the Unified Medical Language System (UMLS) and has attracted high interest over a long period of time. A closer look at the distribution of citations reveals that the year with the second-highest number of citations was in 2009, i.e., 16 years after the publication of the paper. Citations came from more than 90 journals. The second entry in the top seven, a paper by Cimino from 1998, addressed a related topic considering the broader issue of medical vocabularies [41]. Interest in this work was

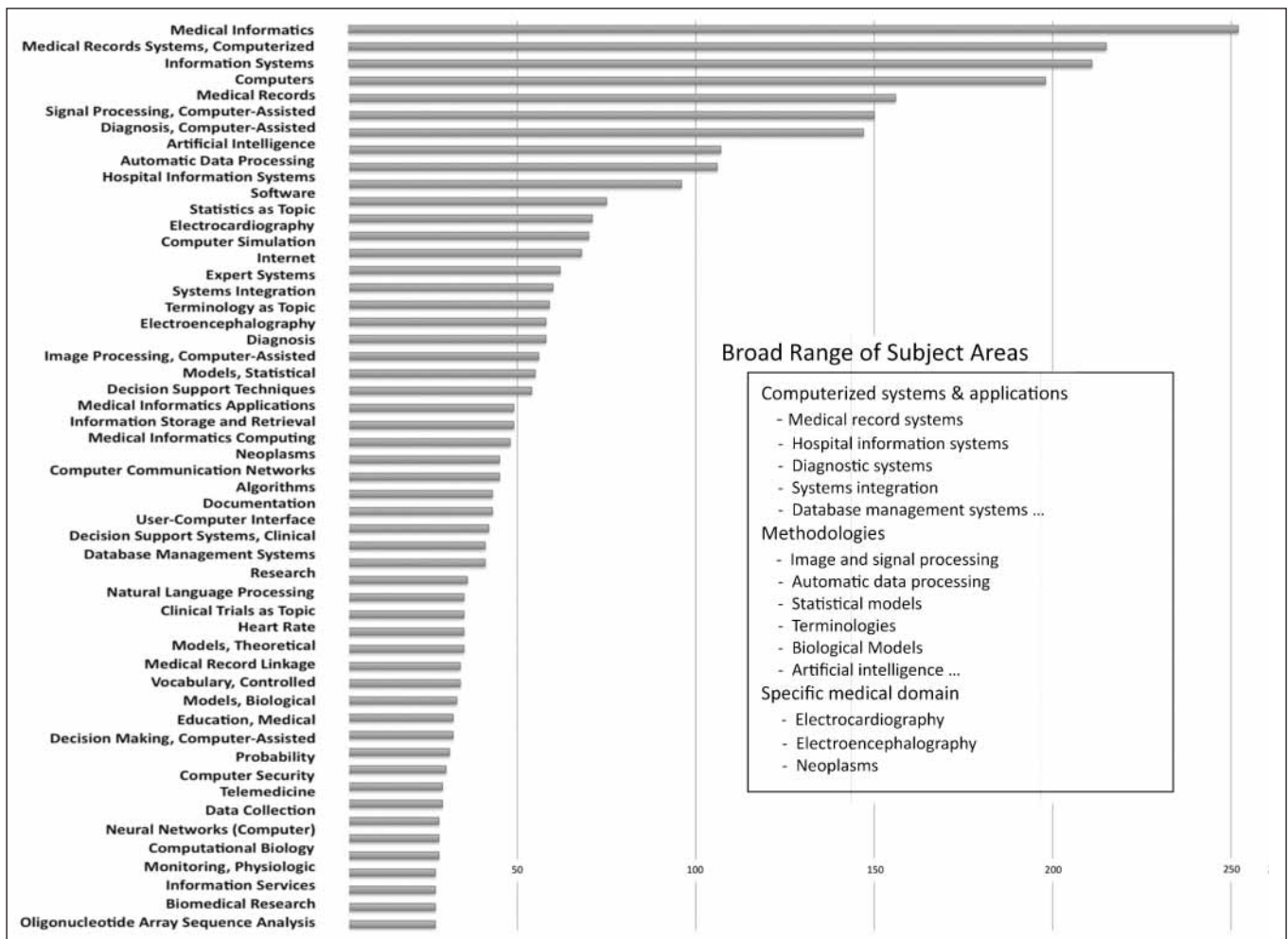


Fig. 5 Top 50 MeSH (U.S. National Library of Medicine Medical Subject Headings) topics discussed in *Methods* articles in the last 50 years.

more focused on a smaller number of journals and citing authors were primarily affiliated with US institutions. The third article in the list, published in 1990, came from the discipline of biomedical signal processing. Van Bommel et al. explained the methodology and implementation of a system termed MEANS to analyse ECG signals followed by a diagnostic classification [42]. The citation pattern shows a late peak in 2006 and a strong bias with respect to the country of origin of researchers citing this work. Obviously, this Dutch group had a strong local influence as nearly 90% of the citations came from authors with a Dutch affiliation.

A similar phenomenon can be observed for the fourth most highly cited paper, the biostatistical paper by Abt [43]. This is also the oldest publication on the list, having been published in 1987. In this case 85% of the citations came from authors of German speaking countries (Germany, Switzerland, and Austria). None of the citations came from another paper in *Methods*, instead articles from more than 80 clinical journals referenced Abt's work. The same citation pattern with respect to the broad range of more than 80 journals excluding *Methods* can be observed for the paper by D'Hoore et al., the next entry on the list [44]. Their article on the so-called Charlson index as a tool in clinical epidemiology to measure comorbidity is also bibliometrically interesting for another reason. The pattern of temporal occurrence of citations fulfils the characteristics of what has been termed a "sleeping beauty". During the first years after its publication in 1993 no reference was made to it; interest in this work started late and slowly. The highest yearly number of citations was observed in 2008, i.e., 15 years after its publication.

The high interest in artificial intelligence and practical implementations of expert systems during the 1990's is reflected in the sixth entry in the list. Heckerman et al. presented the Pathfinder project, an expert system for surgical pathologists for the diagnosis of lymph-node diseases, in their paper published in 1992 [45]. The topic of electronic medical records can be viewed as a long-standing one for *Methods*. Its importance is also reflected in the list of influential *Methods* publications and represented by the final entry, an article by

All Time 1962-2011 (2,465 articles total)		1962-1971 (270 articles total)		1972-1981 (342 articles total)	
MeSH Topic	No. of Articles	MeSH Topic	No. of Articles	MeSH Topic	No. of Articles
Medical Informatics	252	Medical Records	77	Computers	95
Medical Records Systems, Computerized	215	Computers	66	Information Systems	70
Information Systems	211	Automatic Data Processing	62	Medical Records	51
Computers	198	Information Systems	41	Diagnosis, Computer-Assisted	45
Medical Records	156	Diagnosis	28	Automatic Data Processing	20
Signal Processing, Computer-Assisted	150	Statistics as Topic	28	Statistics as Topic	17
Diagnosis, Computer-Assisted	147	Punched-Card Systems	23	Probability	16
Artificial Intelligence	107	Research	17	Diagnosis	15
Automatic Data Processing	106	Documentation	16	Decision Making	14
Hospital Information Systems	96	Drug Therapy	11	Electroencephalography	12
1982-1991 (373 articles total)		1992-2001 (662 articles total)		2002-2011 (818 articles total)	
Diagnosis, Computer-Assisted	46	Medical Records Systems, Computerized	111	Medical Informatics	154
Information Systems	44	Artificial Intelligence	74	Medical Records Systems, Computerized	100
Software	37	Medical Informatics	68	Signal Processing, Computer-Assisted	64
Computers	36	Signal Processing, Computer-Assisted	68	Hospital Information Systems	57
Medical Informatics	30	Diagnosis, Computer-Assisted	48	Systems Integration	54
Electrocardiography	22	Medical Informatics Computing	40	Internet	53
Expert Systems	22	Computer Simulation	39	Image Processing, Computer-Assisted	46
Signal Processing, Computer-Assisted	18	Expert Systems	32	Decision Support Systems, Clinical	33
Medical Records	17	Decision Support Techniques	29	Algorithms	30
Artificial Intelligence	16	Terminology as Topic	28	Information Systems	30

Fig. 6 Top 10 MeSH topics in each of the five decades that *Methods* has been in existence.

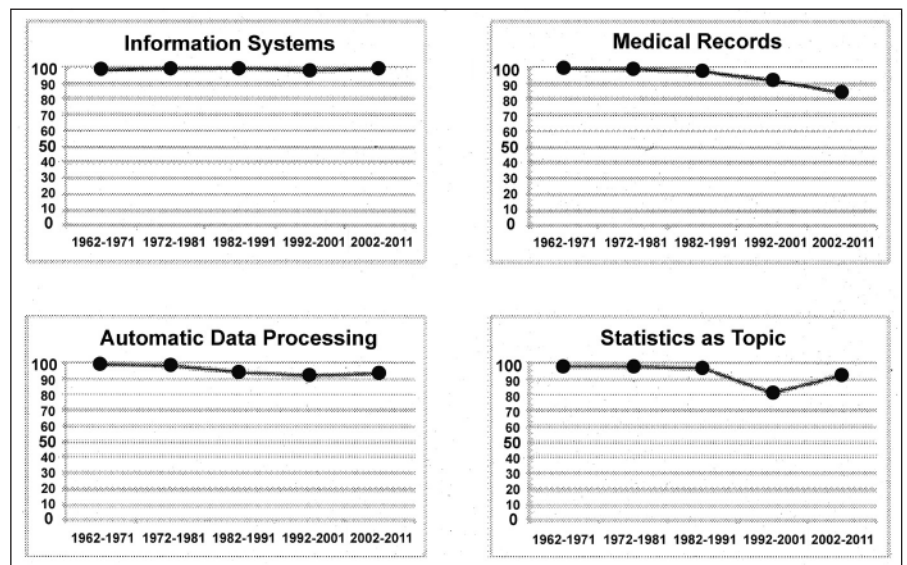


Fig. 7 Highly frequent (percentile rank) MeSH topics: Topics appear regularly across time (percentile rank distribution).

Rector et al. published in 1991 [46]. Here fundamental principles that should underlie electronic medical records are discussed from a practical perspective. This paper received a high number of citations in *Methods* demonstrating that this is one of the journal's central topics.

Even this collection of only seven papers reflects the broad range of disciplines and topics covered by *Methods*.

6. Trends in Major Topics over Time

An analysis of the 2,456 *Methods* articles, being indexed in May 2011 in the U.S. National Library of Medicine's MEDLINE database with MeSH (Medical Subject Headings), indicates that *Methods* articles, consistent with the broad scope of the jour-

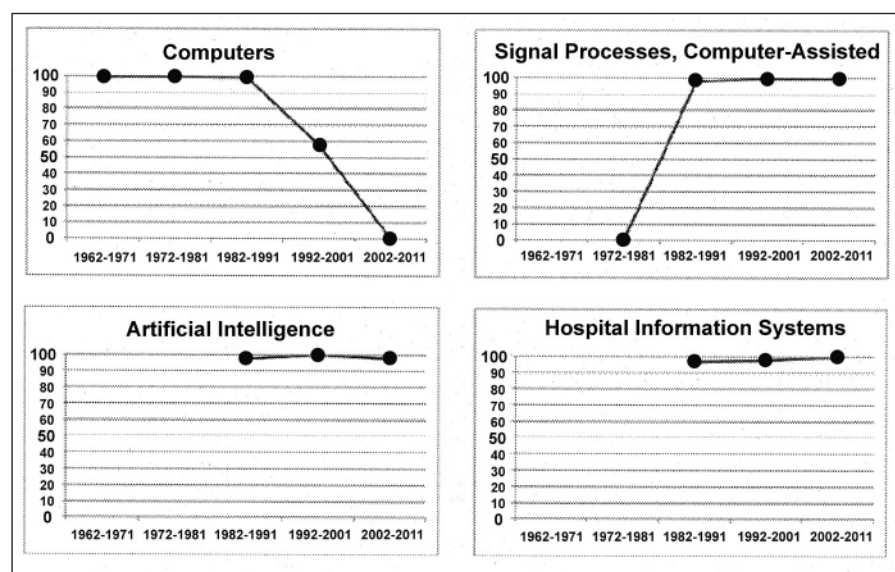


Fig. 8 Highly frequent (percentile rank) MeSH topics: Topics peak in certain decades (percentile rank distribution).

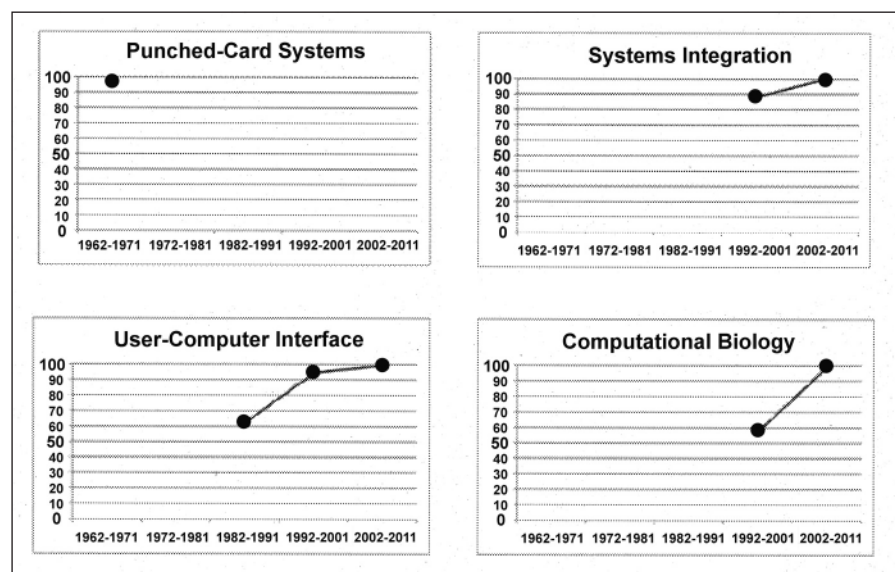


Fig. 9 Highly frequent (percentile rank) MeSH topics: Topics appear in certain decades only (percentile rank distribution).

nal, indeed cover a wide range of topics.

► Figure 5 shows the 50 most frequent topics discussed by authors contributing to *Methods* since 1962. Topics range from computerized systems of various types, including medical record systems, hospital information systems, database management systems and other types of computerized applications, to methodologies, including image and signal processing, automatic data processing, statistical models,

and artificial intelligence (including the closely related expert systems, natural language processing, and neural networks), and finally, topics related to a particular medical domain, electrocardiography, electroencephalography, and neoplasms. Note that “Medical Informatics” as a major topic is the most frequent topic discussed, with over 250 articles having been indexed with that term. In most cases, this means that the article focuses on the field as a whole. For

example, an article that discusses the educational requirements and curriculum for the field of Medical Informatics would receive that index term.

► Figure 6 shows the 10 top topics of all time and then in each of the five decades that *Methods* has been in existence. Notice that some topics are heavily and regularly represented in each of the decades, while others may be important in a particular decade, but not in other decades. For example, “Punched-Card Systems” was an important topic in the 1960’s, but not in subsequent decades. Some topics, such as “Internet” and “Systems Integration” appear in the top 10 in only the most recent decade, 2002–2011. On the other hand, “Information Systems” appears in the top 10 of each of the decades, with the exception of 1992–2001 (where, it is, however, ranked as the 12th most frequent topic). Some topics that appear with high frequency in the list of top 10 topics of all time, do not appear in the top ten of most decades. For example, “Artificial Intelligence” is in the top 10 topics of all time with a total of 107 articles, but the majority of those (74) appeared in the 1992–2001 time period, and the closely related topic “Expert Systems” appeared in the top 10 (22 articles) in the previous decade.

► Figures 7–9 illustrate the different patterns exhibited by topics discussed in *Methods* organized according to decades. ► Figure 7 shows some examples of high frequency topics that have appeared with regularity over time. Information systems, the third most frequent topic (211 articles) of all time; medical records, the fifth most frequent topic (156 articles); and the closely related topic of automatic data processing, the 9th most frequent topic (106 articles); for example, were of interest early in the field, and they continue to be of interest. Statistics, the 12th most frequent topic (71 articles), shows only a slight dip in the 1992–2001 decade, but overall it has been a regularly discussed topic in *Methods*.

► Figure 8 illustrates some of the topics that are represented with high frequency in *Methods*, but which have peaks only in certain decades. Computers, the 4th most frequent topic of all time, is at its peak in the 1972–1981 time period, begins to drop off as an index term during 1992–2001, and is

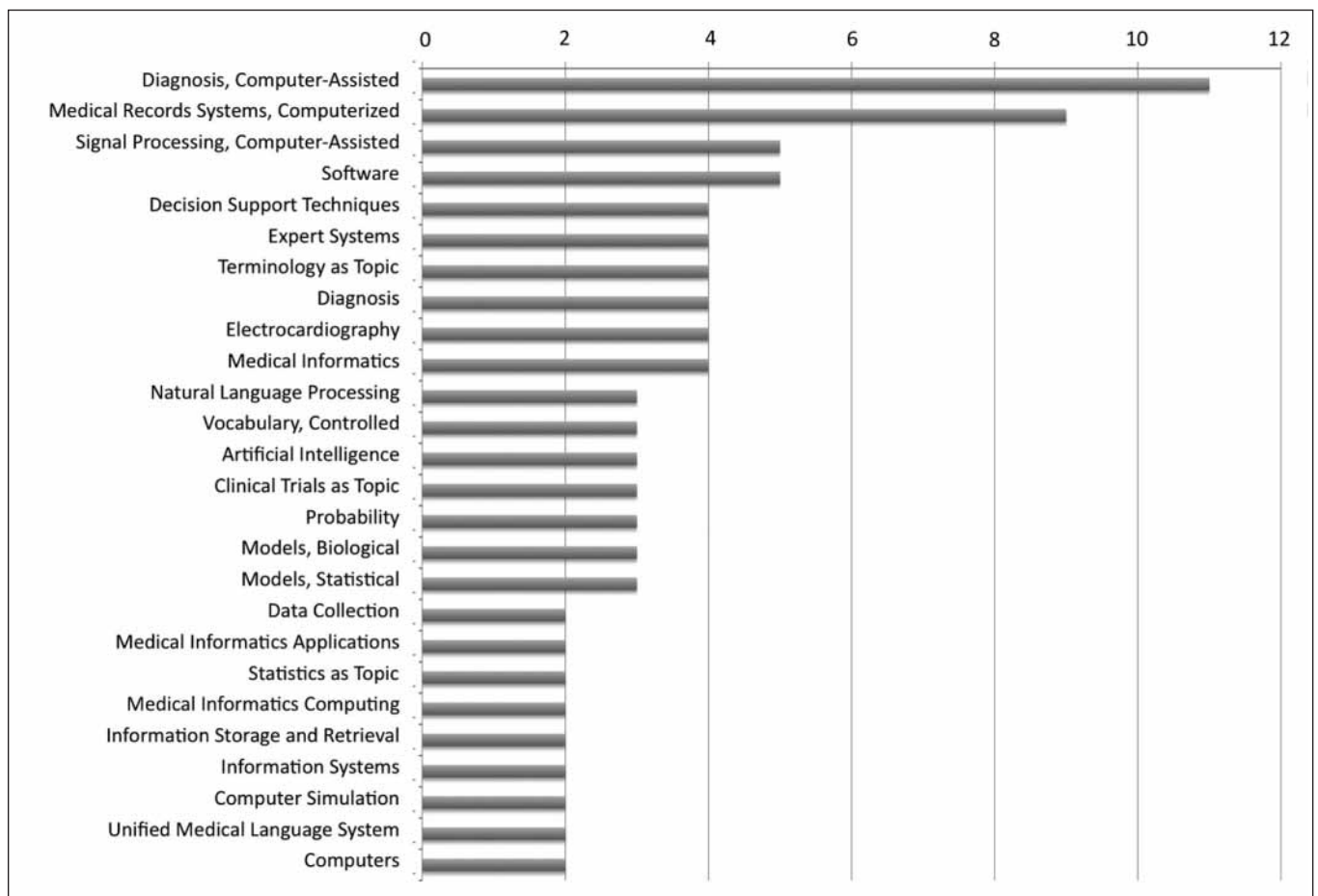


Fig. 10 MeSH topics discussed in at least two of the 50 most highly cited *Methods* articles.

rarely used in the current decade. On the other hand, computer-assisted signal processing, which is the 6th most frequent topic, does not appear in the earliest decade, begins to appear in 1972–1981, and then is highly frequent since then. Artificial intelligence, the 8th most frequent topic does not appear at all until the 1982–1991 time period, peaks during 1992–2001, where it is the 2nd most frequent topic, and then begins to drop off in the current decade. Finally, hospital information systems, which is the 10th most frequent topic, appears with some frequency starting in the 1982–1991 time period, and peaks as the fourth most frequent topic in the current decade.

► Figure 9 illustrates topics that are not in the most highly frequent category overall, but that are highly frequent in one or more decades. Punched-card systems were discussed with some frequency in the first decade, but not at all since then. The inverse

is true for systems integration and computational biology, which are relatively frequent topics in the last two decades but do not appear at all before then. User-computer interfaces as a topic began to appear in 1982–1991, increased in prominence in the next decade, and is the 11th most frequent topic in the current decade.

The discussion above shows the broad scope of *Methods* topics, as well as the relative frequency of those topics. It may be of further interest to consider and compare the topics covered in the most heavily cited papers in *Methods* to see whether the topics that are of interest to and within the scope of *Methods* are also of interest to the broader community. To that end, we analyzed the MeSH topics in the top 50 most heavily cited papers [40–89]. ► Figure 10 shows those topics that appeared in at least two of the papers in this group. There is significant overlap between these topics and the top

topics of all time (► Fig. 6), though the relative frequencies are somewhat different. Computer-assisted diagnosis is ranked highest among the most highly cited papers, being a topic of 11 of the 50 papers, while it is ranked 7th in the full set of *Methods* papers. Decision support techniques is ranked 5th among the most highly cited papers, while it is ranked 23rd in the full set of *Methods* papers. Automatic data processing and hospital information systems, which are highly ranked topics overall, are not frequent topics in the highly cited papers.

7. Conclusions

Methods of Information in Medicine is the oldest and one of the leading international journals in biomedical informatics. The journal's development over the last 50 years correlates with the formation of this new

discipline. In stressing the basic methodology and scientific fundamentals of organizing, representing and analysing data, information and knowledge in biomedicine and health care, it has and continues to stimulate multidisciplinary communication on research that is devoted to high-quality, efficient health care, to quality of life and to the progress of biomedicine and the health sciences.

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