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Original Article

Trends in paediatric, neonatal, and adult cardiology publications over the past 10 years

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Abstract *Objective:* Medline classifies publications as clinical trials, randomised control trials, meta-analyses, practice guidelines, reviews, case reports, editorials, and letters. We tested the hypothesis that cardiology-related publications have increased with a shift in the type of publications over the past 10 years by age category. *Methods:* To retrieve from Medline the cardiology articles, we used the keyword "heart disease", but limited the search to articles in English from 2000 to 2009. We repeated the search using one limit according to the publication type and using age tags. We used regression analysis to determine the effect of the year of publication on the number of publications of each type. *Results:* During the 10-year period, Medline registered 152,849 cardiology articles, doubling from 10,452 in 2000 to 20,841 in 2009, of which 8.5% were tagged as both paediatric and adult. There was a linear increase in the number over the study period in the total number of publications and in all categories, except for practice guidelines. There was almost a twofold increase in adult and neonatal articles, but ~70% in paediatric articles. The rate of increase was 66% for randomised control trials, 73% for clinical trials, 124% for meta-analyses, 117% for editorials, 36% for reviews, and 103% for case reports. Practice guidelines remained very low, increasing significantly for paediatric and neonatal articles. *Conclusions:* There was a substantial increase in cardiology articles over the past 10 years, being greater for adult and neonatal articles compared with paediatric articles. The increase varied according to the type of article.

Keywords: Neonatal; paediatric; adult; cardiology; publications

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THE FIELD OF CLINICAL CARDIOLOGY IS EVER expanding in the light of the critical importance of cardiac health in the maintenance of general health. As stated recently by a president of the American College of Cardiology, "We must put a greater emphasis on attempts to prevent, slow, or ideally halt the progression of heart disease. Our focus should be to develop and help caregivers to implement prevention strategies for every individual at risk for cardiovascular disease, as well as to redefine what is meant by prevention".[1]

In view of this requirement for better evidence-based means of treatment and prevention of heart disease, it should not be surprising that the practising cardiologist faces the daunting challenge of keeping abreast with developments of his/her field of expertise, as the number of new medical publications continues to grow.[2] There is also a steady increase in medical journals, in particular the open-access ones, readily and freely accesible on the Internet. In 2010, Fraser et al[3] stated that: "There are now

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25,400 journals in science, technology, and medicine, and their number is increasing by 3.5% a year. In 2009, they published 1.5 million articles. PubMed now cites more than 20 million papers". Many of them are registered on the Medline, a free service of the National library of Medicine. The Medline classifies publications as clinical trials, editorials, case reports, meta-analyses, practice guidelines, randomised controlled trials, reviews, or others – such as letters, etc.

The aim of this study was to test the hypothesis that the number of publications in the field of cardiology has increased over time to determine whether there has been a temporal shift in the type of publications – such as reviews or clinical trials – over the past 10 years, and whether the specific fields of paediatric and neonatal cardiology were subject to temporal trends similar or different from the adult field. In particular, we aimed to verify whether the rate of increase in articles that carry a high level of evidence – such as randomised clinical trials or meta-analyses – was similar in the paediatric/neonatal as compared with the adult fields.

Methods

We used the following Internet address: http://www.ncbi.nlm.nih.gov/entrez in order to evaluate all Medline articles registered from 1/1/2000 until 12/31/2009. We focused on the field of cardiology. In order to do so, we searched for the following keyword: "heart disease". We limited the search to all articles in English and in humans. We repeated the search each time using one limit according to publication type as classified by the Medline, and collected the total number of publications per year for the 10 years of the specified period. We also repeated the search by using age limits that would enable us to retrieve articles related to neonates (0–1 month), to children inclusive of neonates (0–18 years), or to adults (19 years and above), or to the general population (no age limit). We used regression analysis to determine the effect of year of publication on the number of publications of each type. As mentioned in the introduction, we used Medline's own classification of articles as clinical trials, randomised control trials, meta-analyses, editorials, letters, practice guidelines, reviews, and case reports. In order to verify that the categorisation and tagging offered automatically by PubMed was accurate, we used a random sample of 10 studies each year. The PubMed's categorisation was found to be accurate. There were, however, obvious overlaps: for instance, all randomised control trials are also listed as clinical trials; some papers, based on a case report and a review of the literature, are listed both among reviews and case reports, whereas studies may overlap the age groups, see below.

Statistical analyses: the Minitab version 15.0 (State College, Pennsylvania, United States of America) was used for statistical analyses. We used regression analysis to determine the effect of advancing year of publication on the number of publications of each type. A p-value <0.05 was considered significant.

Results

During the 10-year evaluation period, Medline registered 152,849 medical articles tagged as related to heart disease, which nearly doubled from 10,452 in 2000 to 20,841 in 2009. Table 1 depicts year after year the number of each type of publications retrieved using the keyword selected. As can be seen from the table, the sum of all paediatric and adult articles ($n = 165,901$) exceeded the total number of papers (152,849) over the 10-year period, indicating an overlap of 8.5% of articles that were tagged by the Medline as both paediatric and adult articles, as their patient population included both children and adults. This overlap was also true for every single category of articles.

When all articles were considered, regardless of the patients' age, there was a significant linear increase in the number of publications over the study period both in the total number of publications and in all the categories of articles examined, except for practice guidelines. There was a near doubling in the total number of papers from 10,452 papers in 2000 to 20,841 papers in 2009. During the same period, the number of adult papers also doubled, from 9332 to 18,822 articles, as well as the number of neonatal articles, from 492 to 868. In contrast, the number of paediatric articles went up by just ~70% from 2199 to 3740.

When different categories of articles were considered regardless of the patients' age, the rate of yearly increase was not uniform. Indeed, during the 10-year period under consideration, the number of randomised control trials increased ~66% from 838 to 1393, the number of clinical trials increased 73% from 1710 to 2953, the number of meta-analyses increased 124% from 38 to 85, the number of editorials increased 117% from 71 to 154, the number of reviews increased 36% from 448 to 608, and the number of case reports increased 103% from 2966 to 6020; the number of practice guidelines remained very small, an increase from 5 to 17.

When the age of the patients was taken into consideration, and articles analysed as either adult, paediatric, or neonatal, the adult articles followed the general trend of all articles collated. The trends for paediatric articles were also similar, but for two exceptions the number of practice guidelines, although small, increased significantly over time,

Table 1. Publication types by year.

Cardiology papers	Total	Clinical trials	Editorials	Meta-analyses	Practice guidelines	Randomised controlled trials	Reviews	Case reports
2000 total	10452	1710	71	38	5	838	448	2966
Adult	9332	1629	622	38 (0%)	5	805	377	2393
Paediatric	2199	223	17	3	1	80	135	702
Neonatal	492	36	5	0	0	17	53	175
2001 total	11076	1648	50	41	8	836	444	3006
Adult	9875	1571	42	41	6	807	378	2465
Paediatric	2247	212	12	2	4	75	130	691
Neonatal	548	30 (2)	4	0	0	7	49	192
2002 total	11388	1712	59	33	13	884	511	4923
Adult	10218	1663	54	32	12	857	435	4240
Paediatric	2242	170	8	6	1	53	147	926
Neonatal	516	23 (6)	3 (2)	1	0 (0)	8	47	218
2003 total	12583	2106	56	39	11	1053	528	3403
Adult	11270	2005	51	36	10	1012	436	2714
Paediatric	2464	5 (9)	12	3	5	89	153	790
Neonatal	535	1	4	2	1	15	54	200
2004 total	13864	2211	58	52	7	1147	659	3753
Adult	12521	2107	55	50	7	1102	545	3060
Paediatric	2540	273	13	3	1	108	187	808
Neonatal	568	34	4	1	0 (0)	10	74	223
2005 total	15765	2426	61	61	6	1181	537	4363
Adult	14183	2324	56	56	6	1139	433	3510
Paediatric	3014	280	13	9	3	107	156	983
Neonatal	666	38	3	0	0	15	71	263
2006 total	17202	2479	78	64	7	1163	495	5211
Adult	15505	2387	72	63	7	1135	432	4285
Paediatric	3149	257	9	5	3	79	119	1070
Neonatal	706	41	1	1	1	13	40	264
2007 total	19308	2809	99	79	10	1327	549	8651
Adult	17347	2703	92	75	9	1291	469	7514
Paediatric	3537	283	18	11	4	98	153	1489
Neonatal	842	52	7	2	1	15	59	359
2008 total	20370	2874	121	83	7	1343	581	6048
Adult	18248	2752	111	81	6	1301	500	4989
Paediatric	3748	291	25	9	4	105	152	1211
Neonatal	914	68	8	1	1	26	50	287
2009 total	20841	2953	154	85	17	1393	608	6020
Adult	18822	2819	140	84	13	1345	535	5929
Paediatric	3740	349	27	9	9	123	144	140
Neonatal	868	73	7	0	3	23	53	269

Data are expressed as n

from 1 to 9 a year ($p = 0.05$), and the number of reviews remained nearly unchanged, ~150/year during the whole period. The trend for neonatal articles also was for a general increase, but with the following exceptions: there was no significant change in the number of reviews (~55 a year on average), in meta-analyses (varying from 0 to 2 a year), and in editorials (~5 a year on average); there was a statistically significant increase in practice guidelines, although the numbers were small, from 0 in the early years to 3 in 2009.

Discussion

This study confirms that as hypothesised, cardiologists willing to keep abreast of the developments in their field of expertise are faced with the exceptionally difficult challenge of reading and evaluating an ever-increasing number of medical articles. Indeed, we found a linear increase (twofold in 10 years) in the number of yearly publications related to the field of cardiology. This phenomenon is not unique to this specific field of medicine, as the total number of clinical English articles reported in Medline had increased from 301,305 in 2000 to 503,245 in 2009.

When analysed for type of publication and without tagging for age, there was a steady, linear increase in the number of publications of nearly every type, except for clinical guidelines, which did not change significantly. However, the slope of the rise was not similar for each type of publication. On the background of a twofold increase in the total number of articles, the rate of increase in clinical trials over the 10-year period was only 73% for clinical trials and 66% for randomised control trials. Publications of "lesser evidence" such as editorials increased by 117%, and case reports by 103%. In contrast, reviews increased at the lowest rate, only 36%, whereas the highest rate was for meta-analyses, an increase of 124%.

These differences among the different types of publications merit a few comments. Meta-analyses, believed to represent one of the highest levels of evidence in medicine,[4,5] were nearly unknown before 1990. We speculate that, in view of the rising number of randomised control trials published every year, we may expect a further increase in the number of meta-analyses in the years to come. The rate of increase in the number of clinical trials was greater than that of randomised control trials. It is noticeable that in Medline all randomised control trials are included among clinical trials. Thus, we speculate that the slower rate of increase in randomised control trials even blunts further the faster rate of increase in non-randomised clinical trials. The level of evidence provided by a randomised clinical trial is usually considered higher than that of a non-randomised or non-controlled clinical trials.[4] We therefore speculate that the field of cardiology still heavily relies upon the "lesser quality" of clinical trials. Reviews, considered as a much less powerful tool of research assessment than meta-analyses in terms of hierarchy of evidence,[4–6] decreased over time, a finding unique to this type of publication. We have no explanation for this phenomenon, and may only suggest that journal editors feel that reviews are less and less necessary. It is also possible that reviews, which do not bring much academic credit to their authors, and which may be very lengthy and time-consuming to produce, are of a lesser appeal to potential writers.

The overall number of practice guidelines did not change significantly over the years. However, paediatric and neonatal guidelines increased significantly over the years, although their numbers remained very small (<10 per year). We can only speculate about this finding, which was unique to this specific category of articles. We may regret the fact that clinical guidelines, published usually by a committee of experts, and based upon all available evidence, are not published more consistently possibly owing to the considerable effort and time involved.[6] Indeed, there are many conditions in cardiology where there is very little strong scientific evidence, where serious controversies exist, and where clinical guidelines would be helpful. For instance, some experts suggest supportive (compassionate) treatment of infants with hypoplastic left heart syndrome.[7] Most centres would recommend intervention either primary neonatal transplant if available,[8] or the Norwood pathway[9] with or without the Sano modification,[10] with advocates now suggesting the newer hybrid procedure.[11] In view of the fact that the number of available patients is too few to easily allow for a randomised clinical trial comparing the outcomes of these various strategies, though that is now being addressed in some major centres, probably illustrates why a consensus statement expressed as clinical guidelines cannot yet be reached. In addition, whenever clinical guidelines are written, they usually are binding medicolegally. The fear of malpractice suits might be a deterrent for professional associations to publish such guidelines.

In addition, there are special issues related to the field of paediatric cardiology. Apart from the third world, the vast majority of affected neonates and children have congenital – rather than acquired – heart disease,[12] the management of which is still in its infancy as compared with the long history of adult cardiology.[6] In contrast with adults with heart disease, generally acquired, the overall numbers of

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children with heart disease is small. In addition, the development of foetal cardiac imaging and foetal cardiology in the developed world has led to a major increase in the number of pregnancy terminations if the foetus is affected by significant heart malformation despite significant improvements in neonatal cardiac surgery and non-surgical invasive cardiology.[13] There is now a developing field of adult cardiology that relates to the many survivors of congenital heart disease.[14,15] These changes in patient populations are expected to influence the way disease-specific type of literature will evolve. It is also likely that the literature may not necessarily reflect the patient population worldwide, but rather that seen in the very few selective and eclectic academic centres of excellence distributed unevenly around the world leading to guidelines from the relevant professional associations.[16,17]

One limitation of our study is that we cannot claim that our search allowed us to access ALL papers published in the field of cardiology. The inclusion of additional keywords or that of additional languages may have added a substantial number of publications. However, we do not believe that accessing those articles would have modified our findings and conclusions significantly, in view of the very large number of publications (152,849) that we were able to retrieve.

Another limitation of our study is that the categorisation and tagging that is offered automatically by PubMed might not be 100% accurate. This applies mostly to the type of study. Misclassification errors are possible. However, a random sample of the retrieved articles revealed an excellent degree of agreement with the PubMed categorisation. In addition, as noted earlier, there were obvious overlaps. For instance, randomised control trials are all included in clinical trials as well, and all neonatal literature is included in the paediatric literature. Similarly, more than 8% of articles were tagged as both adult and paediatric.

Although we showed a very significant increase in the number of cardiology publications, we did not attempt to determine whether the general quality of these papers also increased. Many factors contribute to the rising number of publications: scientific curiosity is an important one together with an exchange of knowledge in the hope of improving clinical care. However, academic ambition may also be influential. The need for more publications in order to achieve academic promotions, although an incentive to publish, may actually harm the quality of the research published.[18]

In conclusion, over the past 10 years the field of cardiology has seen a twofold increase in yearly published articles. Meta-analyses appear to have the fastest rate of increase. Guidelines are seldom issued, and increased in number only in the paediatric and neonatal fields. We speculate that the Internet "revolution", with the electronic resources available to readers (in particular the plethora of open-access journals), might create additional striking changes in the trends that we currently report. Moreover, secular changes in funding priorities might also influence the future of the cardiology literature. For instance, new drug development that requires expensive resources has been and is more likely to be carried out in the treatment of adults with ischaemic heart disease – a major human health issue – than in neonatal cardiomyopathies, which affect so few patients. However, the Orphan Drug Act enacted by the US Federal Administration tries precisely to alleviate this difficulty.[19]

Finally, more articles published does not necessarily equate with improved outcomes. To help busy clinicians, both national and international meetings tend to allocate less time to presentations of scientific works and increasingly more time for "experts" to summarise, update, and editorialise the literature. "Designer journals" are replacing textbooks in writing up summaries of the current knowledge on a particular subject but in a more timely manner. The clinician may not have the time, inclination, or skill to analyse the information provided. Editorial comments in reputable journals may serve a similar purpose, if done without political or evangelical overtones.

This paper highlights the problems, but has few answers for the practising clinician. Others who have tried to keep up with the literature may have suggestions to make,[20] although further study as to how to deal with the issue is essential as published papers and journals continue to multiply.

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