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Review article

Scoring of medical publications with SIGAPS software: Application to orthopedics

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ABSTRACT

SIGAPS is a bibliometric software tool developed in France to identify and analyze Medline-indexed publications that are produced by a researcher or research group. This measurement takes into account the author's ranking on the paper along with the journal's prestige according to its impact factor within the research field. However, use of this impact factor is the primary limitation of SIGAPS. SIGAPS analysis results are used to assign a financial value to hospital facilities. The impact of the journal *Revue de Chirurgie Orthopédique* and its successor–*Orthopaedics & Traumatology: Surgery & Research*–was compared using the Medline-based ISI (SIGAPS) and SCOPUS-based SCImago journal rankings.

For a long time, the research activity at French University Hospital Centers (CHU) has been funded at a fixed rate, typically 10.5% to 13% of the CHU's budget. In 2007, this system was replaced by MERRI funding (*Missions d'enseignement, de recherche, de référence, et d'innovation*) (French teaching, research and innovation mandate). Research-oriented university hospitals, non-university hospitals with significant research activity and the 20 cancer research centers–more than 150 facilities in all–are eligible for this funding. This model comprises a fixed part, a flexible part and a variable part. The flexible part is determined using four indicators: scientific publications, clinical trials, students and patents. The patents indicator was eliminated in the 2013 MERRI.

To calculate the "publications" indicator, the French Ministry of Health chose to use the bibliometric tool SIGAPS (*Système d'interrogation, de gestionet d'analyse des publications scientifiques*) (software to identify, manage and analyze scientific publications) that was developed by the Lille CHU in 2002 [1–3]. The principle behind this tool is that bibliographic references produced by an entity (faculty, center, department, individual) are automatically identified in the Medline database and analyzed. The primary objective was to make an inventory of the scientific production within a facility in a quantitative and qualitative manner, in real time. This tool can also be used for other purposes, such as analyzing collaborations and changes in production over time, which can provide a better handle on a facility's research activity and its reach (up-and-coming teams, collaborations).

1. How SIGAPS works

The SIGAPS software searches the Medline database of biomedical and life sciences journal citations via the PubMed server. Researchers are identified by their last name and initial of their first name (and alias for complex names). The software uses this information to download all of the publications associated with this name. The first validation step is automated: the software retains publications in which the author's address matches the facility's address, or indicates collaboration with other authors at the facility, or has a single name, which eliminates a certain number of unwanted publications upfront. The next validation step is carried out by each facility: every year, the system administrator reviews the list of automatically preselected publications. The final validation step is carried out by individual researchers through the SIGAPS website. This final review by the researcher ensures the highest possible reliability. The author will contact the facility's administrator if there are errors or an article was missed during the automatic selection step (article with uncommon collaboration, errors or change in author's name, etc.).

In the second phase, the SIGAPS software calculates a score for the facility, department or researcher. This score, which is updated annually, is based on the number and quality of the publications and the author's ranking on each paper. Quality is based on the

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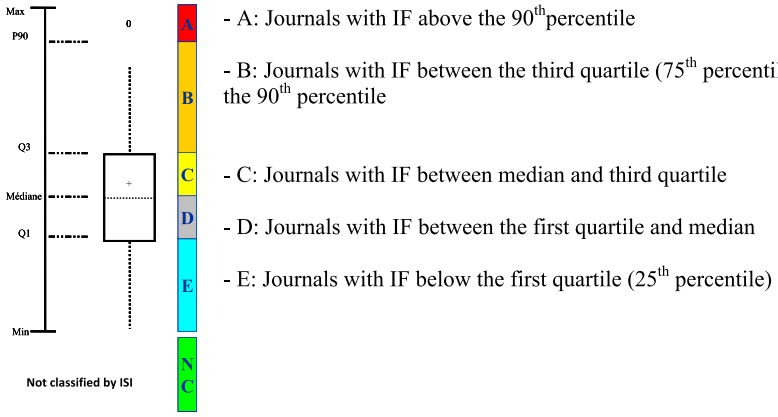

Fig. 1. Classification of journals according to the Thomson Institute for Scientific Information (ISI). Journals are classified from A to E according to the impact factor percentiles.

concept of the "relative" impact factor within the specialty or field. In each field (about 170 in all), the journals are ranked into five classes (A, B, C, D and E) according to their impact factor or listed as non-classified (NC). This classification is based on data from the Journal Citation Reports (JCR) of the Thomson Institute for Scientific Information (ISI). The A to E ranks are determined as a function of the impact factor percentiles (Fig. 1).

Each class is allocated a weighting coefficient. In 2013, this was 8 points for class A journals, 6 points for B journals, 4 points for C journals, 3 points for D journals, 2 points for E journals and 1 point for NC journal. A second weighting coefficient takes into account the author's ranking on a paper. In 2013, this was 4 points for first or last author, 3 points for second author, 2 points for third and second-to-last author and 1 point for another contributing author.

In 2008, the SIGAPS score was calculated by multiplying these two coefficients, which results in each article being given a score between 1 and 32. For example, a publication in an A journal by the first author will be assigned a score of 32 (8×4) and a publication in a NC journal by a fifth author will be assigned a score of 1 (1×1). A team's or researcher's score is the sum of the scores assigned to all their articles. If an article lists several authors from the same team, the score retained for the article corresponds to the score of the highest ranked author. This ensures that a paper is only counted once per entity (department, center or facility). Conversely, when two people who publish together belong to two different centers within a facility, this publication is counted once for each center, but only the best score is retained by the software for the facility score. As a consequence, the sum of the individual or center scores will be higher than the sum of the facility score. Since the method used to calculate the SIGAPS score has changed over time, the scores cannot be compared from year-to-year, especially before and after 2008.

For example, in the 2013 MERRI budget corresponding to the 2012 export (2008–2011 period), an article in an A journal scoring 32 SIGAPS points (for first or last author) corresponded to a grant of about €18,000, knowing that this same publication will be counted for 4 years. This is the facility score. But this same funding formula cannot be applied to individual researchers. Problems related to attributing scores to a certain center or department within a facility are hard to solve: a relative share has to be determined to distribute the score over the entire department or the highest ranked person (or center) on the article must be retained for each article and score.

2. Limitations of SIGAPS

The limitations of the SIGAPS scoring system revolve around its use of the impact factor (IF) for the score calculations [4–6]. A journal's impact factor for a given year is the average number of citations for each published article in that journal by journals indexed in the Thomson Reuters Science Citation Index (SCI) during the two previous years. For example, a journal will have an impact factor of 3 in 2013 if its 2011 and 2012 articles are cited an average of three times each in 2013 by all of the journals indexed in the SCI. This is the standard IF with self-citations, provided by Thomson Reuters in the Metrics File used for calculate the journal classes.

The impact factor has been used for a long time to evaluate the prestige of journals, but it is not without controversy. This classification system places non-English journals at a disadvantage. However, the IF continues to be the journal ranking system that corresponds approximately to the accepted hierarchy of journals and to the actual diffusion of research results. This is especially true in the SIGAPS because the IF is evaluated by groups of specialties, not overall (Table 1). In addition, the impact factor is an objective measure that is calculated in a transparent and known manner. Journals have the ability to increase their impact factor, for example by publishing reviews about trendy topics. The IF within a specialty can range from 0 to 153, as it does in Oncology (Electronic Appendix 1).

Orthopedics has a maximum impact factor of 4.439 and is ranked 127th out of 177 specialties. The *Revue de Chirurgie Orthopédique et de l'Appareil Locomoteur (RCO)* journal was indexed in French but had a low impact factor (maximum of 0.543) and was always considered a group E journal. As of 2009, the *Orthopaedics & Traumatology: Surgery & Research* (*OTSR*) journal is the indexed English version of *RCO*'s successor. The French journal *Revue de Chirurgie Orthopédique et Traumatologique* is no longer indexed in Medline. The impact factor of the old *RCO* in French never went above 0.54, but the English version (OTSR) surpassed 1.0 in 2012 and reached 1.168 in 2013 (Fig. 2).

Other methods to evaluate journals have been discussed, such as using the SCOPUS database to generate a SCImago ranking of 156 journals in the "Orthopedics and Sports Medicine" category (http://www.scimagojr.com) (Electronic Appendix 2) (Fig. 3). OTSR is ranked "Q2" on a 4-point scale, whereas it lies in the "D" class in the current SIGAPS ISI classification, which takes only 58 journals into consideration. Most of these journals are in English but they are not entirely in the "Orthopedics and Sports Medicine" field (Table 1).

Use of other bibliometric indicators such as the H-index to directly measure the impact of publications is being explored [7]. This index takes into account an author's productivity (how many papers an author publishes) and his or her impact (how many times the papers are cited in other journals). An H-index of 10 means that 10 of the researcher's papers have been cited at least 10 times each. Unfortunately, this index places younger researchers at a disadvantage. It is cumulative (annuity effect) and does not take

Table 1
ISI ranking used to calculate the SIGAPS score in the "Orthopedics and Sports Medicine" category.

ISSN	Title	2008 IF	Class	2009 IF	Class	2010 IF	Class	2011 IF	Class	2012 IF	Class	Field(s)
0363–5465	Am J Sports Med	3.646	A	3.605	A	3.821	A	3.792	A	4.439	A	TC XW
0749–8063	Arthroscopy	2.503	B	2.608	B	3.317	A	3.024	B	3.103	A	TC YA
0021–9355	J Bone Joint Surg Am	3.313	A	3.427	A	2.967	B	3.272	A	3.234	A	TC YA
0736–0266	J Orthop Res	2.963	A	3.112	A	2.976	A	2.811	B	2.875	A	TC
0190–6011	J Orthop Sports Phys Ther	1.895	C	2.482	B	2.538	B	3	B	2.947	A	TC WC XW
1063–4584	Osteoarthr Cartil	4.082	B	3.888	A	3.953	B	3.904	B	4.262	A	TC WH
0031–9023	Phys Ther	2.19	B	2.082	B	2.645	A	3.113	A	2.778	A	TC WC
1745–3674	Acta Orthop	1.762	C	1.909	C	1.897	C	2.168	B	2.736	B	TC
0009–921X	Clin Orthop Relat Res	1.893	C	2.065	C	2.116	C	2.533	B	2.787	B	TC YA
0341–2695	Int Orthop	1.235	D	1.825	C	1.561	C	2.025	C	2.319	B	TC
1067–151X	J Am Acad Orthop Surg	2.25	B	1.58	C	2.547	B	2.662	B	2.455	B	TC YA
1836–9553	J Physiother		NC		NC		NC	1.917	C	2.255	B	TC WC
1058–2746	J Shoulder Elbow Surg	1.827	C	1.934	C	2.311	B	2.747	B	2.319	B	TC YA XW
0942–2056	Knee Surg Sports Traumatol Arthrosc	1.696	C	1.674	C	1.857	C	2.209	B	2.676	B	TC YA XW
1529–9430	Spine J	2.902	C	2.902	C	3.024	B	3.29	B	3.355	B	TC RT
1471–2474	BMC Musculoskelet Disord	1.987	C	1.88	C	1.941	C	1.577	C	1.875	C	TC WH
0268–0033	Clin Biomech (Bristol, Avon)	2	C	1.759	C	2.036	C	2.071	C	1.869	C	TC IG XW
1050–642X	Clin J Sport Med	1.595	D	1.5	D	2.11	C	2.119	C	1.6	C	UM TC XW
0940–6719	Eur Spine J	2.396	C	1.956	C	1.994	C	1.965	D	2.133	C	TC RT
1071–1007	Foot Ankle Int	1.061	D	1.101	D	1.092	D	1.218	D	1.474	C	TC
0020–1383	Injury	1.946	C	2.383	B	2.269	C	1.975	C	1.931	C	FF TC YA DS
0883–5403	J Arthroplasty	1.556	C	1.787	C	2.207	B	2.384	B	2.11	C	TC
0363–5023	J Hand Surg Am	1.447	C	1.326	C	1.439	C	1.354	C	1.572	C	TC YA
0890–5339	J Orthop Trauma	1.877	C	1.777	C	1.792	C	2.135	B	1.751	C	TC XW
0968–0160	Knee	1.49	C	1.126	D	1.403	C	1.736	C	2.01	C	TC YA XW
0091–3847	Phys Sportsmed		NC		NC	1.023	D	1.023	D	1.344	C	ML TC XW
0362–2436	Spine	2.793	C	2.624	C	2.51	C	2.078	C	2.159	C	TC RT
0936–8051	Arch Orthop Trauma Surg	0.965	D	1.117	D	1.196	D	1.369	C	1.358	D	TC YA
1413–3555	Braz J Phys Ther		NC	0.338	E	0.368	E	0.444	E	1	D	TC
0300–8207	Connect. Tissue Res	1.113	E	1.552	D	2.093	D	1.198	E	1.788	D	DR TC
1083–7515	Foot Ankle Clin	0.709	D	0.709	D	0.709	D	0.709	D	0.899	D	TC
0966–6362	Gait Posture	2.743	C	2.576	C	2.313	C	2.123	D	1.969	D	RU TC XW
0749–0712	Hand Clin	0.681	D	0.687	D	0.802	D	0.717	D	0.946	D	TC
8750–7315	J Am Podiatr Med Assoc	0.586	E	0.598	D	0.523	D	0.567	D	0.768	D	TC
1067–2516	J Foot Ankle Surg	0.76	D	0.76	D	0.76	D	0.516	E	0.86	D	TC YA
1753–1934	J Hand Surg Eur Vol	0.7	E	0,044	E	0.87	D	1.171	D	1.223	D	TC YA
0894–1130	J Hand Ther	0.933	D	0.612	E	1.164	D	1.556	C	1.169	D	TC WC YA
0949–2658	J Orthop Sci	0.94	D	1.027	D	0.839	D	0.843	D	0.96	D	TC
1749–799X	J Orthop Surg Res	1.013	D	1.013	D	1.013	D	1.013	D	1.013	D	TC
0271–6798	J Pediatr Orthop	1.569	C	1.226	D	1.153	D	1.156	D	1.163	D	TQ TC
1536–0652	J Spinal Disord Tech	1.365	D	1.206	D	1.333	D	1.503	D	1.767	D	TC RT
0147–7447	Orthopedics	0.588	D	0.594	D	1.098	D	2.664	B	1.054	D	TC
0744–6020	Orthop Nurs	0.548	E	0.573	E	0.304	E	0.471	E	0.688	D	RZ TC
1877–0568	**Orthop Traumatol Surg Res**		**NC**	**0.52**	**E**	**0.52**	**E**	**0.943**	**D**	**1.061**	**D**	**TC YA**
0001–6462	Acta Orthop Belg	0.403	E	0.403	E	0.392	E	0.401	E	0.629	E	TC
1017–995X	Acta Orthop Traumatol Turc		NC		NC	0.309	E	0.337	E	0.597	E	TC
1305–8282	Eklem Hastalik Cerrahisi		NC	0.25	E	0.404	E	0.708	D	0.656	E	TC YA
1633–8065	Eur J Orthop Surg Traumatol		NC	0.105	E	0.146	E	0.097	E	0.181	E	TC YA
1053–8127	J Back Musculoskelet Rehabil	0.196	E	0.172	E	0.292	E	0.587	E	0.613	E	TC WC XW
1060–152X	J Pediatr Orthop B	0.742	E	0.66	E	0.421	E	0.467	E	0.532	E	TQ TC
2000–656X	J Plast Surg Hand Surg		NC		NC		NC	0.017	E	0.078	E	TC YA
0934–6694	Oper Orthop Traumatol		NC		NC	0.433	E	0.459	E	0.474	E	TC
0085–4530	Orthopade	0.573	E	0.543	E	0.583	D	0.51	E	0.506	E	TC
0309–3646	Prosthet Orthot Int	0.377	E	0.563	D	0.634	D	0.95	D	0.624	E	TC WC
0932–0555	Sportverletz Sportschaden	0.325	E	0.415	E	0.521	E	0.612	D	0.458	E	TC XW
1864–6697	Z Orthop Unfall	0.178	E	0.313	E	0.343	E	0.522	E	0.652	E	TC
0001–5415	Acta Chir Orthop Traumatol Cech	1.628	C	1.628	C	1.628	C		NC		NC	TC
1120–7000	Hip Int	0.215	E	0.343	E	0.792	D	0.763	D		NC	TC
0030–5898	Orthop Clin. North Am	1.431	D	1.245	C	1.398	C	1.398	C		NC	TC

the author ranking into consideration. In addition, it considerably favors popular specialties with high citation rates versus specialties with narrow readership, where the impact factor and number of citations will never attain those of well-known internal medicine journals (*NEJM, Lancet, JAMA*) or those in immunology, genetics or oncology.

Another limitation of SIGAPS is the lack of correspondence between the ISI scientific fields and the sub-sections of the French National Council of Universities (CNU). If a journal is multidisciplinary, the SIGAPS category is calculated as a function of the various fields in which the journal is allocated to. This calculation can have an impact on the final category, which may not realistically reflect on how prestigious a journal is in the eyes of the scientists in that field. The "old" *RCO* was considered the top journal in the French orthopedics community, but had a low impact factor.

If the goal was only to accumulate points, it would be more effective for an author to send a short-format paper (case report) to a French journal that is easy to access and indexed in Medline, but this would be contrary to the research excellence objective [8,9]. This is the main reason that a cumulative score was replaced in

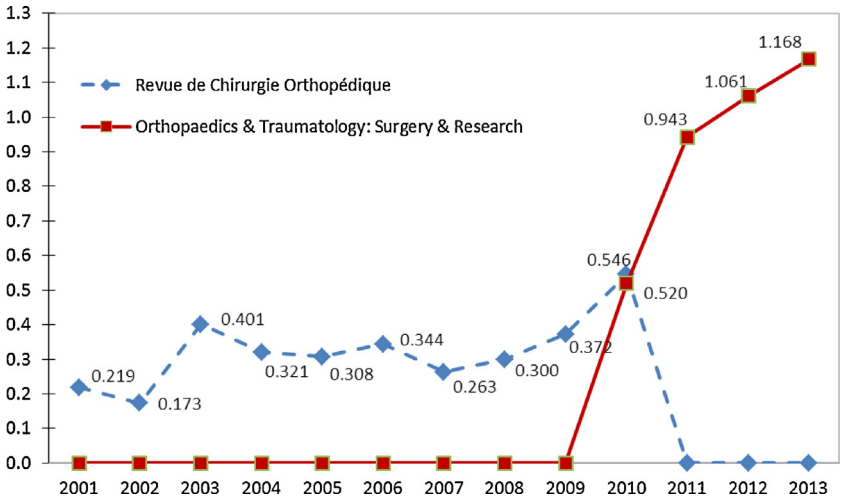

Fig. 2. Change in the impact factor (IF) for the "old" *Revue de Chirurgie Orthopédique (RCO)* journal and its successor, *Orthopaedics & Traumatology: Surgery & Research (OTSR)*.

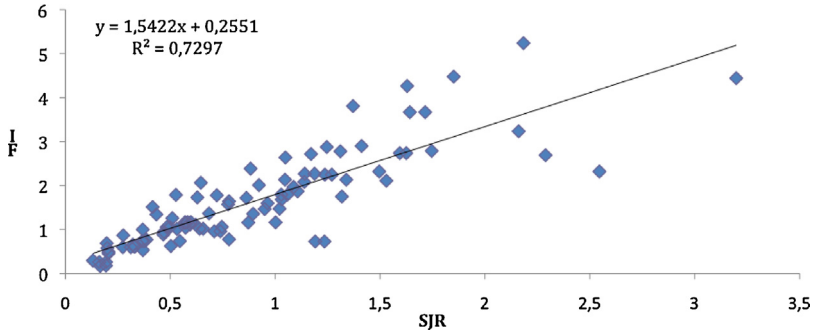

Fig. 3. Relationship between the impact factor (IF) and the SCImago Journal Rank (SJR) for the first 95 journals listed in the SCOPUS classification.

2008 by a multiplicative score, which encourages researchers to publish in journals with a high impact factor in their specialty area, instead of French journals with a narrow readership. A recent study has shown an inverse correlation between the SIGAPS score and the proportion of articles published in French at the Rouen university hospital [10]. This will get worse because fewer and fewer French medical research journals are indexed in Medline. The "old" *Revue de Chirurgie Orthopédique* journal is no longer indexed in Medline because it no longer exists. It was replaced by the OTSR, which published articles online in English and by the *Revue de Chirurgie Orthopédique et Traumatologique (RCOT)*, which is not indexed in Medline but is still listed in SCOPUS (Electronic Appendix 2). All the articles published in the latter journal are in French, including French translations of the OTSR articles.

Multicenter publications are, in the end, more expensive for the collectivity because each facility is funded based on the best rank of its authors, which brings an author's relative position on a paper into play. This calculation method could be a barrier to interfacility collaborations and even intercenter collaboration within a facility because SIGAPS is a financial distribution tool used for an overall budget that is set annually. Because of how SIGAPS is currently used in France, attributing value to publications is only effective for health facilities that have access to the variable MERRI financing (more than 150 facilities in 2013). This financing is dependent on a minimal output threshold of €200,000 in 2012, reviewed annually. This threshold concept, stemming from a French policy and desire not to spread research funding too thinly, is still under discussion.

Despite these limitations, SIGAPS is an original, reproducible tool developed to estimate the quantity and quality of Medline-indexed publications produced in France [11]. It has multiple applications, beyond distributing MERRI funds. It is also used for overall evaluation of hospitals or specialties. It has been adopted by most of the sub-sections of the French National Council of Universities to evaluate candidates for tenure at universities (full University Professor). But this use has been controversial since it is not what SIGAPS was created for [12–15]. The application period must be well defined: a SIGAPS score cannot be interpreted unless the period over which it was calculated is specified. The software calculates the score over a 10 year period; the Ministry of Health (DGOS) uses the last four years and the evaluations are done with the last five years. For researchers, the score's variation over time, instead of the cumulative or absolute score, will likely provide the best view of past research activity, once the SIGAPS calculation method has stabilized.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.otsr.2014.06.020.

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