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A decade's trends in virology research

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Section 2:
Research Trends

A decade's trends in virology research

Matthew Richardson

One advantage bibliometric analysis brings is the ability to put a large quantity of research into perspective. Papers can of course be read individually, and the use of cited references in the literature allows an interested reader to get a wider background on the specific concepts found within, and how the understanding of these has changed over time. However, the sheer scale of work produced in a given field means that the only way to illustrate the broadest trends affecting an entire field is through analyzing the bibliographic data of these papers in bulk. In this article we illustrate the trends that have influenced the field of Virology, the study of viruses, over the past 10 years.

Visualizing the topics in Virology

In an earlier issue of Research Trends we introduced term maps as a method for exploring the topics published in a group of journals (1). These maps, developed in collaboration with the CWTS research group, present a two-dimensional view of the topical terms used in the titles and abstracts of a publication; when aggregated across a journal, or a large group of journals, you can then make use of the fact that a term is more likely to appear in the same paper as a related term to group together those which are most highly related. Using all of the textual data available in titles and abstracts, this allows you to produce a thorough view of which topics are researched and how they interact with one another to form the broader structure of a field.

In the term maps following, we use all journals that are categorized in Scopus within the Virology subject category. Although it is still possible that virology-related content is published outside these journals, for instance in a broad-based Medicine or Microbiology journal, this analysis catches the great majority of relevant research across a wider range of journals than a small selection would allow.

As we wish to compare the field at a gap of 10 years' time, we have used the two time periods 2000–02 and 2010–12. The use of three consecutive years of publications in each map allows us to obtain a more thorough view of what is being published, and so to use more accurate co-occurrence relationships between terms in the maps.

The term maps and selection of topics

Figure 1 shows a term map for Virology content published in the years 2000–02. This covers 14,158 articles, reviews and conference papers. This map is a co-occurrence cluster map, showing both the position of each term (the relative location is determined by their co-occurrence in title and abstracts, so that the closer the terms are positioned the more often they tend to co-occur) and the main cluster they belong to (distinguished by one of four colors). The final element of the data shown is the frequency with which a term is found in this field: the larger the term appears, the more papers contain that term within the title or abstract.

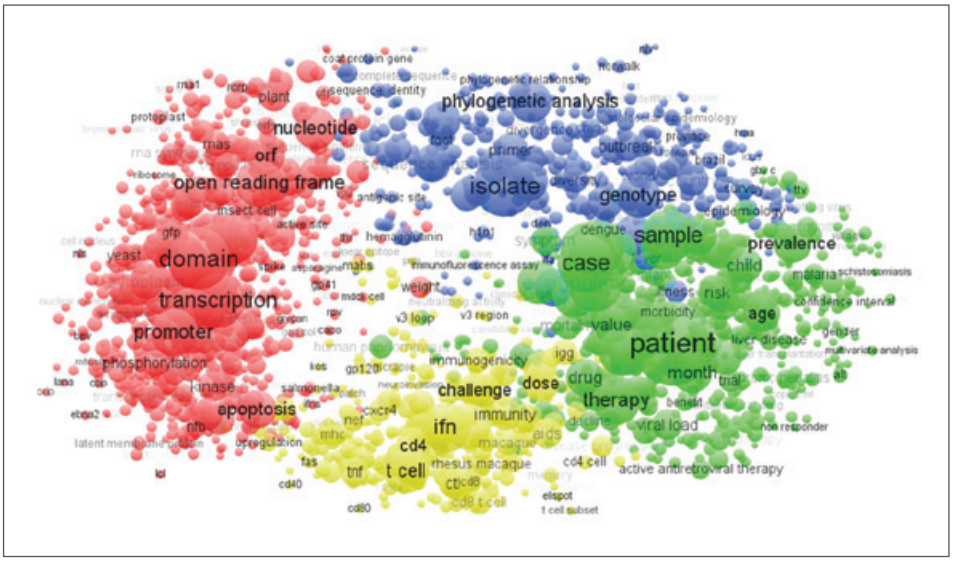

Figure 1: Journal term co-occurrence map for the field of Virology, using a set of 14,158 papers published from 2000 to 2002. Colors used to distinguish clusters of related terms. Data source: Scopus

This map forms a circular structure which is common to many such networks, and is composed of four main groupings of topics. The most common terms are those relating to primary care and clinical research in the green cluster ('patient', 'case', 'therapy'); epidemiology, outbreak investigation and phylogenetics in the blue cluster ('isolate', 'genotype', 'phylogenetic analysis', 'outbreak'); molecular biology and genetics in the red cluster ('transcription', 'open reading frame', 'nucleotide'), and cell biology of disease in the yellow cluster ('T cell', 'IFN', 'CD4').

Figure 2 shows a term map based on the same selection of journals, 10 years later: this includes 24,691 Virology papers published in 2010–12. This represents a huge increase in content over the earlier time period, with more than 10,000 additional papers. As might be expected, similar phrases appear as common terms: for instance, 'patient', 'domain', 'case', 'isolate'. More interesting are the broader changes in the structure of the field, and changing trends in the less frequent, more specific topics. Topics such as HCV (hepatitis C virus) and HPV (human papillomavirus) are far more visible in the center of the map, pointing to the increasing quantity but also interdisciplinarity of this research.

While the main clusters remain present and intact in this later map, the circular structure is not as contained; the green cluster relating to primary care and clinical research, and the yellow cluster relating to cell biology of disease, no longer link together quite so closely as in the 2000–02 period. This finding is surprising, given that in recent years we have seen a strong focus on interdisciplinary research, translational medicine and closing the loop between 'bench' research and 'bedside' care.

In Figure 3, selected virus-related terms have been identified and annotated on the 2010–12 Virology map. Rather than being confined to any particular cluster, these virus topics are scattered throughout the map according to the types of papers they occur in most frequently. This finding illustrates the fact that different virus families are predominantly used in very different kinds of studies, relating to the different clusters of the map. Related terms appear close to one another, as expected: for instance, hepatitis B and hepatitis C are close to one another, in the green (clinical) cluster, while influenza A is towards the top of the map along with the subtypes H5N1 and H1N1.

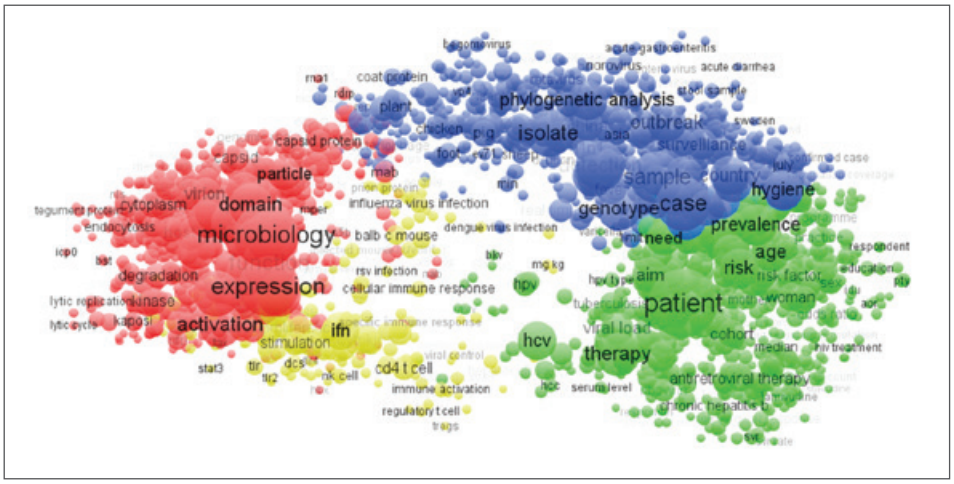

Figure 2: Journal term co-occurrence map for the field of Virology, using a set of 24,691 papers published from 2010 to 2012. Colors used to distinguish clusters of related terms. Data source: Scopus

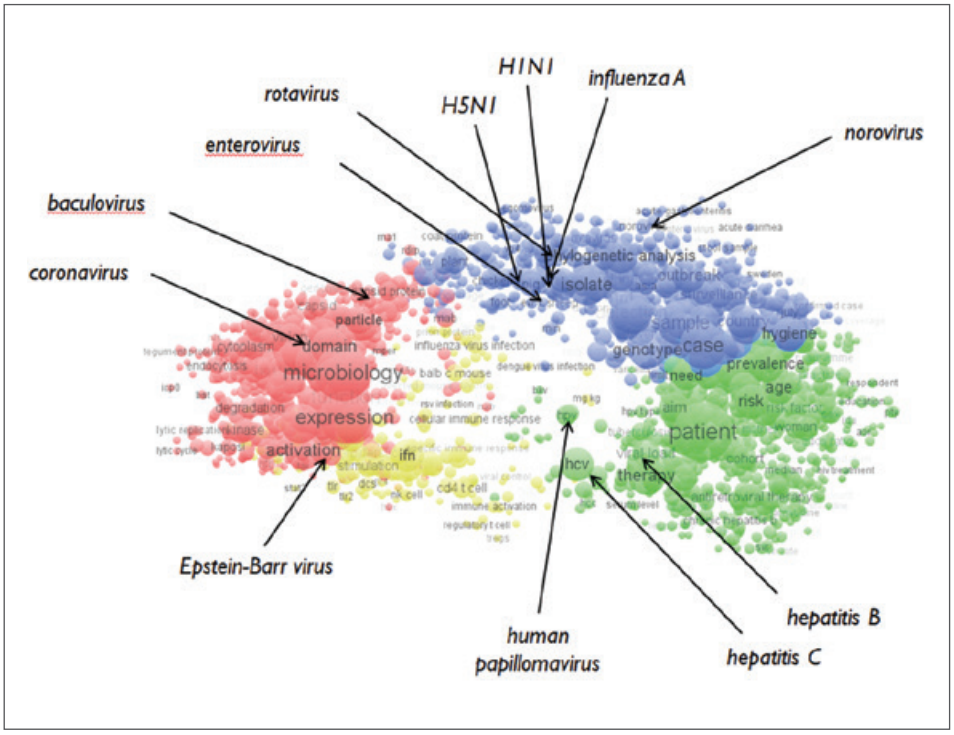

Figure 3: Journal term co-occurrence map for the field of Virology, using a set of 24,691 papers published from 2010 to 2012. Colors used to distinguish clusters of related terms and annotations provided for selected virus-related terms. Data source: Scopus

As demonstrated here, term maps provide a useful overview of a field and allow you to examine the broader structural changes that affect it over time. In contrast, in the analysis that follows SciVal is used for more detailed analysis of individual topics with various metrics.

Research trends in the past decade

Taking some of the virus terms identified from our term map, it is possible to construct research areas in SciVal based around these topics and then compare them to one another by a variety of measures. One example is provided in Figure 4: here we see trends in scholarly output from 2004 to 2013 for five different research areas, covering research on hepatitis B and C, human papillomavirus, the H1N1 strain of influenza A, and coronavirus. The first three were included as they show high quantities of research but also extremely strong growth throughout the decade. H1N1 on the other hand starts with minimal activity but then grows quickly to a peak of 568 papers in 2011. This growth in activity follows the 2009-10 H1N1 (swine flu) pandemic (2). Coronavirus research follows a different trend: while it starts relatively high in 2004 with more than 600 papers, it then declines steadily until there were fewer than 300 papers published in 2011. After this point there is another increase in activity, with 395 papers in 2013. The two different periods of higher interest in coronaviruses seem likely to be related to two distinct viruses: first SARS-CoV, a global epidemic which occurred in 2002–03; and towards the end of the period MERS-CoV, which was first identified in 2012 (3, 4).

Field-weighted citation impact (FWCI) is a citation metric showing the citation activity around a group of papers, taking into account subject field, article type and year of publication, and so offering a robust comparison to the expected level of citation impact (which is assigned a level of 1.0). Looking across the full set of virus topics highlighted in Figure 3, three in particular stand out as having extremely strong spikes of citation impact in the past decade: the influenza A subtypes H5N1 and H1N1, and coronavirus. These times of activity coincide with the timing of public outbreaks even more closely than the publication trends shown in Figure 4. The year 2004, in which H5N1 research has an FWCI of over 10 times the expected level, saw major outbreaks of the virus strain across Asia (e.g. 5, 6); 2009, in which H1N1 research reached an FWCI of 9.33 times the expected value, saw cases of the virus affecting people in the US and around the world (2); and the coronavirus MERS-CoV was first identified in 2012, coinciding with an upturn in impact continuing into 2013 and 2014 (which shows early signs of a similarly high FWCI but is not shown here due to the incompleteness of the data) (4).

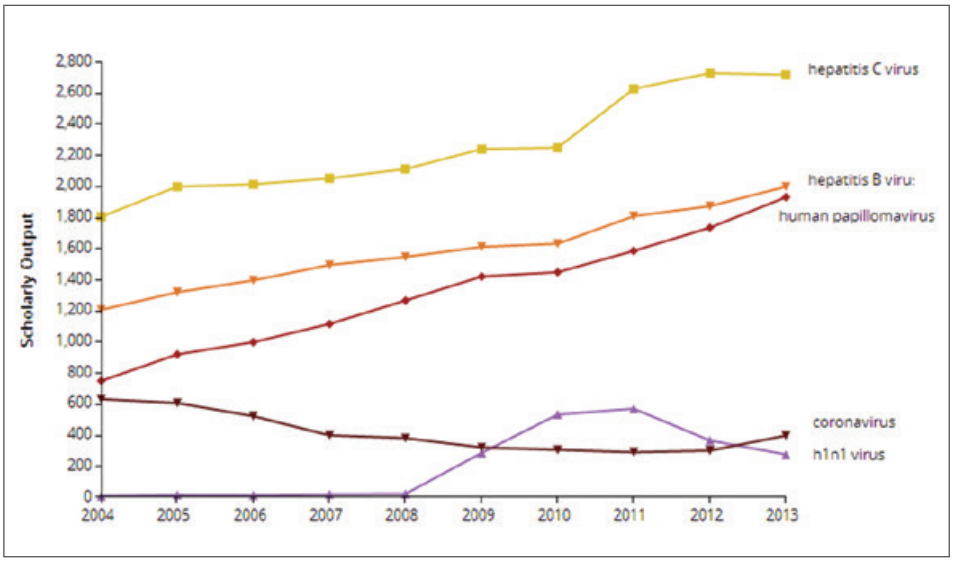

Figure 4: Trends in scholarly output for a selection of virus-related topics, counting articles, reviews and conference papers published per year. Source: SciVal

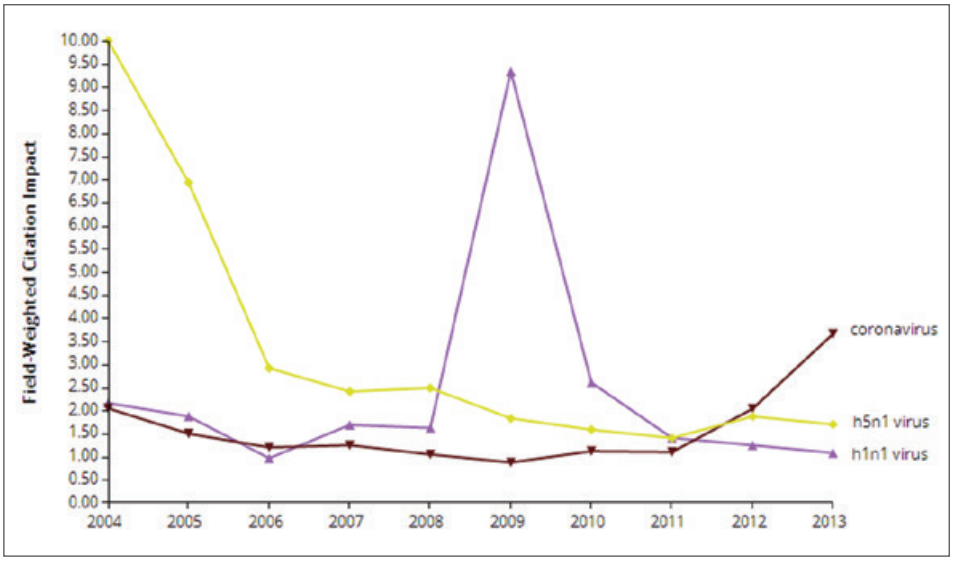

Figure 5: Trends in field-weighted citation impact for a selection of virus-related topics. Source: SciVal

Conclusion

While the publication and citation trends shown for specific virus topics reflect wider public interest at times of virus outbreaks, bibliometric analysis such as shown in this article allows for detailed comparison of the amount of research in different areas but also the way it is carried out. The insights available through term maps are even more difficult to draw from mainstream media or individual scholarly papers; using these visualizations we can view the full structure of a subject area and see how this has changed over time. Virology, a fast-moving field with topics that naturally rise and fall in interest as outbreaks occur, is particularly apt for this kind of illustration of hot topics over time.

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