Top 100 cited manuscripts in aortic valve replacement: A bibliometric analysis

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Abstract

Background: This bibliometric analysis is used to identify publications and highlights the key areas that have significantly shaped modern clinical practice for aortic valve replacement (AVR), which is becoming increasingly relevant. The top 100 most cited manuscripts for AVR were analysed. Method: The Thomson Reuters Web of Science database was searched using the terms 'aortic valve replacement', 'replacement', 'aortic valve' and/or 'AVR' for full manuscripts in English Language. The results were ranked by citation number and the top 100 articles were further analysed by subject, author, journal, year of publication, institution and country of origin. Results: 26,782 eligible papers were returned and accumulated 76,680 citations in total, with a mean citation of 767 per manuscript (350-3667). The New England Journal of Medicine accumulated the most citations whereas Circulation published the most papers. Majority of manuscripts examined patients with aortic stenosis, of which half also included aortic regurgitation. The United States of America contributed 51 manuscripts, accumulating 43629 citations. Conclusion: The most cited manuscript, by Leon et al., assessed the outcomes of transcatheter aortic valve implantation in patients with severe aortic stenosis who were unfit for surgical replacement. By providing the most influential references this work serves as a guide to topics of interest in the field of AVR.

Introduction

The prevalence of aortic valve disease has been increasing due to the ageing population. A corresponding rise in published literature is seen. Hence, the identification of important works may become increasingly difficult. Citations are received when a publication is referenced by another peer-reviewed article and work with the greatest scientific impact and significance are likely to be cited more. Similarly, the citation counts of publications reflect its impact on scientific progress as well as the influence of its journal of publication.

Bibliometric Citation analysis is a method of identifying significant manuscripts amongst the plethora of publications whilst quantifying the importance of each paper. Citation analysis involves ranking and evaluating an article based on its number of citations, serving to rank the scientific impact of both the article itself and its journal of publication. Although there is no single best method of determining the importance of a scientific publication, the use of bibliometric analysis is generally accepted as an appropriate method. Many surgical specialities have employed citation rank analysis to identify their most influential papers, including paediatrics, general surgery and cardiothoracic surgery.[1–3]

To date, there has not been a study to determine the top 100 manuscripts on aortic valve replacement. Citation bibliometrics will provide insight into how our understanding of aortic valve replacement, and its uses, have evolved. Additionally, this paper will serve to reference the most impactful papers on AVR to help identify the most relevant materials for future authors.

Methods

A search was performed on the Thomson Reuters Web of Science citation indexing database using the following terms 'aortic valve replacement', 'replacement', 'aortic valve' and/or 'AVR'. The search was limited to full manuscripts in English Language and includes publications from 1970 to 2019. The returned list was sorted by the total number of citations. This method was initially developed by Paladugu *et al.* and replicated by O'Sullivan, Kavanagh and Chan in various surgical specialities. [2–5] The top 100 articles obtained were further reviewed and analysed according to journal, authorship, institution, country, year of publication, article type and topic. The generated total citation count was inclusive of articles indexed by Web of Science Core Collection, BIOSIS Citation Index, Chinese Science Citation Database, Russian Science Citation Index and SciELO Citation Index.

Results

The search terms yielded 26,782 manuscripts and were ranked in descending order of total citations. The 100 top-ranked manuscripts had a total of 76,680 citations and are shown in **Table 1** . The list of manuscripts is ordered from most to least cited on PubMed.gov.[6] The number of citations ranged from 3667 to 350, with a mean and median citation count of 767 and 533 respectively. The manuscripts were published across 16 journals shown in **Table 2** .

The journal *New England Journal of Medicine* (NEJM) had the highest impact factors and generated the highest number of citations, of 22,458 with 18 manuscripts. This is followed by Circulation with the highest number of manuscripts, of 24, generating 14,719 citations. The latest manuscript was on management guidelines for valvular heart diseases by the European Society of Cardiology published in 2017 issue of *European Heart Journal* . The oldest manuscript was published in Lancet in 1986 comparing percutaneous valvuloplasty against valve replacement in patients with aortic stenosis.

The country with the most citations was the United States of America, with 43,629 citations across 51 manuscripts. This is followed by France and Canada, with 13,750 and 6579 citations respectively, generated by a total of 26 manuscripts. Citations counts by country are shown in**Figure 1** .

Of the top 10 authors, five have more than three authorships in the top 100 manuscripts (**Table 3**). 8 of the top 10 cited authors have multiple manuscripts and altogether generated a total of 36,578 citations. Nashimura had the most manuscripts in the top 100 (n=6), totalling 4,583 citations. Vahanian generated the highest citation count of 5,178 from four manuscripts in addition to being the senior author of two other manuscripts within the top 100.

Of the top 100 manuscripts, 33 investigated aortic valve replacement for both aortic regurgitation and stenosis whereas 32 were specific to aortic stenosis alone, accumulating 33,336 and 22,638 citations respectively. 29 manuscripts focussed specifically on the outcomes of percutaneous or transcatheter approach to aortic valve replacement, amounting to 20,702 citations. 18 of the top 100 were management guidelines involving aortic valve replacement, resulting in 17,585 citations. Topics by citation are shown in **Table 4** .

Discussion

Isolated aortic valve replacements comprised 10% of cardiothoracic operations in 2016, with 6% performed alongside coronary artery bypass grafting (CABG) and 1% alongside mitral valve replacement (MVR).[7] AVR surgery serves to provide symptomatic relief and improve prognosis in patients with severe valve obstruction.[8] Hence, most common indications for elective surgeries is aortic valve stenosis (AS) and aortic regurgitation (AR). [9] As a result of an ageing population, there has been an increasing incidence of AS and AR now with up to 275,000 to 370,000 per year who require AVR in the modern world. [10] Most AVR are elective surgeries and are performed for AS, in which the procedure currently provide a five-year survival rate of 78.4% and fifteen-year survival rate of 39.7%.[11] On the other hand, the most common indications for emergency AVR surgery are critical aortic stenosis and left ventricular failure, which typically presents as cardiogenic shock and multiple organ failure.[12] Advances in surgical techniques and understanding of the diseases produced notable improvements in treatment outcomes, lowering mortality rates in hospital from 6.4% overall in 2000, to 3.1% in 2015.[13,14]

The oldest manuscript was by Professor Alain Cribier who, in 1986, first trialled the use of percutaneous transluminal balloon catheter aortic valvuloplasty elderly patients with severe aortic valve stenosis in 1986.[15] This was introduced as an alternative intervention for those who are unfit for the traumatic surgical approach. While it was performed on only three patients and is too early to ascertain its efficacy, it laid the foundation for researchers to eventually develop the now widely used transcatheter aortic valve implantation (TAVI). This is reflected in the ever-increasing amount of literature investigating TAVI, with 29 of the top 100 specifically examining it alone. In comparison, only 8 manuscripts focused solely on surgical techniques. This increasing attention in AVR is reflected in the rising number of top manuscripts per year, from less than 5 per year before 2000 to peak in the 2010s, averaging more than 10 per year.

The most cited paper, by Leon *et al* ., investigated TAVI on high risk, severe aortic stenosis candidates who are not suitable for surgical replacement. This trial by PARTNER includes a specific cohort of patients taking place in a multi-centre, randomized clinical trial. Introduced in 1989 as a less invasive method of treatment for high-risk patients, transfemoral TAVI is found to significantly reduced 1-year mortality (30.7% vs 49.7%), cardiovascular-related mortality (19.6% vs 41.9%), repeat hospitalisation (22.3% vs 44.1%) and significant symptomatic relief [16]. However, the study also identified an increased number of severe stroke (7.8% vs 3.9%) and vascular events (32.4% vs 7.3%) in the 12 months following TAVI. Leon *et al.*concluded that such vascular complications may be attributed to large femoral access sheath insertions and so novel lower profile valves and support frames are being developed. This paper proposes TAVI as the best treatment for high risk severe aortic stenosis patients with complications unsuitable for standard surgery and identified the areas of improvement to help perfect TAVI.

The second most cited study was a similar study by Smith *et al.* , a randomised control trial comparing TAVI and standard approach but on high-risk patients who are suitable for surgery. High risk severe aortic stenosis patients showed similar 1-year mortality between standard surgical replacement and TAVI. TAVI cohort had shorter ICU stays (3 vs 5 days) and as well as hospital stay (8 days vs 12 days). Major bleeding was also less common in TAVI, with 14.7% vs 25.7%. However, neurological events such as stroke and/or transient ischemic attacks are nearly doubled in TAVI (8.3% vs 4.3%). This study also associated TAVI with more procedural complications compared to normal surgery, with increased vascular complications (18% vs 4.8%). The authors concluded that the outcome of TAVI for male patients was similar to the surgical approach but offers survival mortality benefits in women or patients with a coronary bypass graft.

The third most cited study was by Birkmeyer *et al.* , which investigated the relationship between hospital volume, and the number of procedures performed and their effects on postoperative mortality. Analysis of 2.5 million procedures, including 6 types of cardiovascular surgeries, revealed hospitals with larger volumes had lower mortality rates. With higher hospital volumes, observed mortality rates of AVR decreased: hospitals with very low, low, medium, high and very high volume shown a decreasing mortality rate from 9.9% to 7.6%. Similar trends can be seen in mitral valve replacements and carotid endarterectomies. This

study only included patients on Medicare within the USA and the majority were above 65 years old. The authors concluded that the apparent mortality reduction in specialised procedures may be resultant of more specialised and experienced healthcare professions who are equipped with greater resources.

Apart from the number of citations and manuscripts published under each journal, the impact factor of the journals themselves also helps us understand the quality and significance of the papers. The impact factor is based on the citations of published articles in each journal, specifically the average amount of citation by a journal's publications. As such, journals with higher impact factor tends to publish work of higher quality and importance which is cited more often. Hence, journals with an impact factor above 45 (*JAMA, Lancet* and *NEJM*) accounted with over a third of the total citation counts with 25 manuscripts. Furthermore, only 7% and 16% of articles from the list were from journals with impact factors less than 5 and 10, respectively. This demonstrates that research in aortic valve replacement is largely dominated by publications in journals with high to very high impact factors. However, it would be useful for future research to be able to assess the clinical significance of these articles to determine the correlation between citation count and clinical applicability.

Limitations

Citation analyses are prone to certain types of biases. Across many institutions, particularly in the USA, some articles may receive additional citations due to self-citations. This phenomenon has also been noted in other citation analyses and was attributed to preferential citation of 'local research' and tendency to integrate research in clinical practice.[1] Similarly, by limiting the scope of our search to the English language alone may further affect the self-citation phenomenon.

Additionally, the earliest assessed manuscript dates back to 1982; older publications would have had a longer duration to accumulate citations and it may take a certain amount of time for an influential manuscript to accrue citations due to lead time. However, given that the top 10 cited manuscripts were all published between 2002 and 2015, publication time bias might not be a significant limitation. Finally, certain authors may be under-represented as only first and the senior author is assessed despite most manuscripts being authored by multiple researchers.

Conclusion

The most cited manuscript by Leon *et al.* highlighted the treatment and outcomes of transcatheter aortic valve implantation for aortic stenosis patients who were not suitable for AVR surgery. The majority of the manuscripts used were presented in acclaimed, high-impact journals, and this particular work provided a reference for the most influential papers in AVR surgery. Indeed it reflected quality and significance as well as served as a marker for what makes a paper 'citable'. Conducting this investigation, it was made clear that the ongoing research into surgical techniques proves that this top 100 most cited papers list will likely change in the coming years, warranting future analyses.

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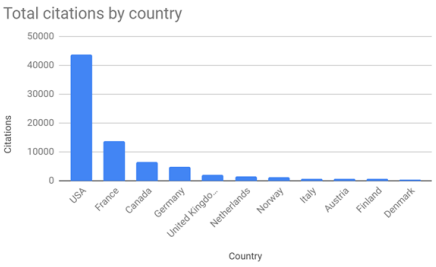

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