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A bibliometric analysis of the 100 most influential papers in burns

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ABSTRACT

The importance of a published paper to a particular area is reflected in the quantity of citations obtained from peers. In burns, it is unknown which papers have been the most influential on this specialty. The purpose of our study was to identify the 100 most cited papers in burns and to analyze their characteristics. Twenty-seven journals were chosen for analysis. These included high impact factor scientific journals and journals dedicated to burns and trauma. Only twelve of these journals contributed to the 100 most cited papers in burns and we analyzed each paper individually looking at its subject matter, authorship, article type, institution, country and year of publication. Our citation analysis revealed an interesting mix of clinical and scientific papers that documents the key landmarks in burn care over the past 66 years.

1. Introduction

The area of burns has produced a large volume of important clinical and scientific papers over the years that can be found in prestigious high impact factor journals. These papers are spread over many different journals making it difficult to establish which of them has been the most influential in burns. The importance of a published body of work to a particular area is echoed in the quantity of citations obtained from peers. A citation can be described as an abbreviated alphanumeric expression contained in the body of an intellectual work that represents an entry in the references section of this work for the purpose of recognizing the contributions of the works of others to the topic of discussion in which the citation appears. The principle purpose of a citation is to acknowledge other authors for important valuable work that they have previously published. The reputation of an author can be proportional to the number of citations his or her published work receives. For scientific journals, the number of citations is hugely important too. The impact factor (IF) of a journal is based on the number of citations that its published articles obtain. The IF of an academic journal is a measure reflecting the average number of citations of recent articles published in the journal [1–3]. The impact factor is calculated annually and it is employed as a proxy for the relative importance of an academic journal within its field. The higher the impact factor the journal secures, the more important it is deemed. Despite several biases in utilizing the impact factor system, it is still viewed as the leading method for judging the merits of specific journals [4]. The impact factor is calculated for a given year, by finding the average number of citations received per article published in that journal during the two preceding years. Citation analysis is a bibliometric process that describes the means of analysing the citation history of published papers [5].

Several specialties have previously reported on the most cited papers relating to their specific area [6,7]. These include general surgery, plastic surgery, hand surgery, otolaryngology and orthopaedics [5,8–14]. These papers are useful in providing a better understanding of the important attributes that a piece of research requires for it to obtain enough citations for it

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to be perceived as a seminal paper. There has not been a bibliometric analysis of the most cited papers in burns published before. We have performed a citation analysis on the most influential papers to date in burns, based on the number of citations that they have received.

2. Materials and methods

Twenty-seven international journals were included in our bibliometric analysis (Table 1) but only 12 of these contributed to our top 100 list. The journals chosen were relatively high impact factor scientific journals that are well renowned internationally. We also included trauma and surgery journals for articles that dealt with burns. The two authors chose specialized burns journals and journals that dealt with emergency burn care as well as post-burn surgery. We felt that these would be the highest-yielding journals for burn articles and the ones most likely to produce the most cited papers in burns.

The database of the Science Citation Index (SCI) of the Institute for Scientific Information (ISI) was used to identify the most cited papers in burns from 1945 until 2013 in all of these publications [15]. The SCI is an index of citations produced by the ISI and is made available online through the Web of Science database, a part of the Web of Knowledge collection of databases.

By utilizing this electronic database, we were able to identify, by means of a customized filter, the most frequently cited papers in burns from 1945 until 2013 in all of our chosen publications. The specific terms in the customized filters included "burn", "thermal", "smoke inhalation", "electrical" and "chemical". The filtered articles were analyzed and any papers not pertaining to burn care were excluded from our study.

The 100 most cited papers were selected for further examination. Using a method previously described by Paladugu et al. [8], we analyzed each paper individually looking at its subject matter, authorship, article type, institution, country, level of evidence and year of publication. The level of evidence of each paper was sourced from the Oxford Centre for Evidence-based Medicine [16].

Table 1 – The journals and the number of papers each journal contributed to the top 100 papers.

Journal	Number of papers in top 100
Annals of Surgery	34
Journal of Trauma, Injury, Infection and Critical Care	15
Lancet	11
Burns	9
New England Journal of Medicine	8
Archives of Surgery	8
Surgery	5
Critical Care Medicine	4
Journal of Burn Care and Research	2
British Journal of Surgery	2
Plastic and Reconstructive Surgery	1
British Journal of Plastic Surgery	1

These journals were included in our citation search but did not contribute to the top 100: *Journal of Plastic, Reconstructive and Aesthetic Surgery*, *American Journal of Surgery*, *Annals of Plastic Surgery*, *Injury; International Journal of the Care of the Injured*, *Journal of Burn Care Research*, *American Journal of the Medical Sciences*, *American Journal of Medicine*, *American Journal of Emergency Medicine*, *Annals of Internal Medicine*, *American Journal of Respiratory and Critical Care Medicine*, *Annals of Emergency Medicine*, *Intensive Care Medicine*, *Scandinavian Journal of Plastic and Reconstructive Surgery and Hand Surgery*, *American Journal of the Medical Sciences*, *Clinics in Plastic Surgery*.

3. Results

The 100 articles are listed in Table 2 and are in descending order, according to the number of citations that they have received. The number of total citations per article ranged from 746 to 104. The mean number of citations per paper was 178. The most cited paper, by Gallico et al., had a total of 746 citations whereas the 100th paper had 104 citations [17,18]. The most recent paper came from 2007 and it was cited 201 times [19]. The oldest paper included in the top 100 was from 1947 and has been cited 151 times to date [20]. The 1980s contributed the most papers of any decade to the top 100 burns papers (Table 3) followed by the 1990s.

Eighty-eight of the top 100 papers were clinical papers and 12 were experimental. The type of clinical study and level of evidence can be seen in Table 4. Level 2 prognostic studies contributed the most to our most cited list of papers in burns.

Of the 27 international journals included in our bibliometric search, only 12 provided papers to our top 100. These included high impact factor journals such as the New England Journal of Medicine and Lancet as well as specialty journals such as Burns and Plastic and Reconstructive Surgery. The Annals of Surgery contributed the most number of papers to our top 100 list with 37 (Table 1).

Nine countries were responsible for producing all of the 100 papers in our citation analysis (Table 5). The United States produced the vast majority of papers (78%) followed by the United Kingdom (10%). The University of Texas Galveston, Texas is the institution that produced the most number of papers to our top 100 list (Table 6). Massachusetts General Hospital in Boston and the Institute of Surgical Research, Fort Sam, Houston, Texas also contributed considerably. Of the 100 articles, 54 reported clinical experience, 37 reported basic science and 9 were clinical reviews. Twenty-three papers focused on infections post-burns. Seventeen papers were dedicated to nutrition and fluids after burn injury whilst 15 papers described the coverage of burn wounds with autologous epithelium or artificial skin. The use of silver on burn wounds was the subject of seven papers in the top 100.

Fifteen authors were first-named authors on more than one paper in the most-cited papers (Table 7). Doctor Herndon wrote four papers [21–24] whilst Doctors Alexander [25–27], Burke [28–30] and Deitch [31–33] were the first name authors on three papers each. A further eight authors wrote two papers each.

The most cited paper [17] in the top 100 describes the coverage of burn wounds with an autologous cultured human epithelium. This paper from 1984 was cited 746 times. The

Table 2 – The 100 most cited papers in burns.

Rank	Author	No. of citations	Rank	Author	No. of citations	Rank	Author	No. of citations
1	Gallico, GG [17]	746	34	Till, GO [65]	174	67	Madden, MR [93]	130
2	Burke, JF [28]	568	35	Hefton, JM [66]	172	68	Cannon, JG [94]	129
3	Sevitt, S [47]	563	36	Wilmore, DW [67]	166	69	Drost, AC [95]	129
4	O' Connor, NE [48]	435	37	Hinton, P [68]	166	70	Sakurai, Y [96]	127
5	Moyer, CA [34]	317	38	Mawjima, K [69]	166	71	Goodall, M [97]	126
6	Heimbach, D [49]	311	39	Wolfe, RR [70]	161	72	Rodriguez, JL [98]	122
7	Wainwright, DJ [36]	295	40	Gore, DC [71]	160	73	Loirat, P [99]	122
8	Mochizuki, H [35]	283	41	Alexander, JW [26]	158	74	Tompkins, RG [100]	122
9	Wolfe, RR [50]	279	42	Arons, MS [40]	161	75	Boyce, ST [101]	122
10	Alexander, JW [25]	192	43	Herndon, DN [23]	156	76	Bull, JP [102]	121
11	Fox, CL [51]	272	44	Wilmore, DW [72]	156	77	McHugh, GL [103]	120
12	Shirani, KZ [52]	260	45	Lanser, ME [73]	151	78	Yin, HQ [104]	120
13	Herndon, DN [21]	255	46	Cope, O [20]	151	79	Jones, WG [105]	118
14	Ryan, CM [53]	252	47	Burke, JF [30]	151	80	Becker, RA [106]	118
15	Parrybillings, M [54]	249	48	Wischmeyer, PE [74]	151	81	Winchurch, RA [107]	116
16	Burke, JF [29]	240	49	Hart, DW [75]	149	82	Moyer, CA [108]	114
17	Cuono, C [39]	239	50	Thompson, PB [76]	148	83	Smith, DL [41]	112
18	Klasen, HJ [55]	230	51	Goldhill, DR [77]	147	84	Curreri, PW [109]	112
19	Jackson, DM [37]	229	52	Wolf, SE [78]	146	85	Deitch, EA [33]	111
20	Ziegler, TR [56]	222	53	Demling, RH [79]	142	86	Herndon, DN [24]	111
21	Deitch, EA [31]	221	54	Poon, VKM [80]	141	87	Ferrando, AA [110]	111
22	Wood, JJ [57]	215	55	Saito, H [81]	141	88	Gilpin, DA [111]	111
23	Deitch, EA [32]	209	56	Moncrief, JA [82]	140	89	Nguyen, TT [112]	110
24	Allison, SP [58]	208	57	Jones, I [83]	140	90	Arturson, G [113]	110
25	Gore, DC [59]	202	58	Vaughan, GM [84]	136	91	Zawacki, BE [114]	110
26	Atiyeh, BS [19]	201	59	Ivy, ME [85]	135	92	Alexander, JW [27]	109
27	Cuono, CB [60]	197	60	Bull, JP [86]	135	93	Bruck, HM [115]	109
28	Herndon, DN [22]	192	61	Engrav, LH [87]	134	94	Boyce, ST [116]	108
29	Klasen, HJ [61]	190	62	Novick, M [88]	134	95	Pietsch, J [117]	108
30	Deluca, M [62]	187	63	Kien, CL [89]	132	96	Hart, DW [118]	107
31	Halebian, PH [63]	185	64	Germain, L [90]	131	97	Drost, AC [119]	107
32	Evans, EI [38]	175	65	Schwacha, MG [91]	130	98	Ninnemann, JL [120]	106
33	Baud, FJ [64]	175	66	Aulick, JLH [92]	130	99	Niazi, ZBM [121]	105
						100	Nijsten, MWN [18]	104

second most cited paper by Burke et al. received 568 citations and describes the successful use of an artificial skin for burn wound coverage [28]. The landmark 1965 paper from Moyer et al. describing the treatment of burns with 0.5% silver nitrate was cited 317 times and was the fifth most referenced paper [34]. This is Doctor Moyers first of two appearances in the top 100. An important paper detailing the prevention of the catabolic response to burns by early enteral feeding also featured in the top 10 [35]. The first article from the journal Burns to appear in the top 100 was written by Wainwright, and it detailed the use of Alloderm in the treatment of full thickness burns [36]. A landmark paper on ascertaining the depth of a burn was described by Jackson in 1953 and this paper was 19th in the top 100 [37]. At 22, Deitch et al. analyzed the variables of hypertrophic scar formation post burns and at 32, a 1952 paper by Evans et al. looked at the fluid and electrolyte requirements in severe burns [31,38]. The only paper from Plastic and Reconstructive Surgery was at 27 and it outlined a composite autologous-allogeneic skin replacement for burn wounds [39]. The relationship between burn scars and malignant change was described by Arons et al. at number 42 and the importance of early excision and skin grafting was put forward by Burke et al. at 47 [30,40]. A large retrospective study looking at the effect of inhalational injury, burn size and age on mortality in burns featured at 78 in the top 100 [41]. The last paper on the most cited list by Nijsten et al. from 1991 focused on interleukin-6 and how it related to the humoral immune response and clinical parameters in burned patients [18].

Table 3 – The decades where the top 100 papers originated from.

Decade	Number of papers
1940s	2
1950s	4
1960s	7
1970s	14
1980s	34
1990s	26
2000s	13

4. Discussion

Over the last 60 years, the specialty of burn management has grown from simple burn excisions to a comprehensive mult disciplinary approach to target all sequelae of the injury, promptly and expectantly. This is reflected in the growing body of scientific literature relating to burns.

Table 4 – The type and level of evidence of the clinical studies (n = 88) in the top 100.

Clinical study type	Number of studies
Diagnostic	**4**
Level 2	3
Level 4	1
Prognostic	**40**
Level 1	1
Level 2	30
Level 3	6
Level 4	2
Level 5	1
Therapeutic	**44**
Level 1	6
Level 2	5
Level 3	12
Level 4	11
Level 5	10

By reading through the 100 most-cited papers, it is hard not to appreciate the seminal papers that are present on the list. These are representative of the many landmarks that have occurred in burn management and burns research over the past 66 years. However, many important papers relating to burns are not found on this top 100 list and this is a limitation of this type of study. The Journal of Burn Care Research has made significant contributions to burns yet no papers from this journal made it into the top 100. The phenomenon of ''obliteration by incorporation'' may account partly for this, as over time, many ''classic papers'' may have become such common knowledge that they are deemed not necessary to cite [3]. This indicates that the number of citations a paper has received may not reflect its overall importance to burn care historically. An example of an important paper that failed to qualify into the top 100 is the 2007 paper from Greenhalgh et al. in which the findings of American Burn Association conference to define sepsis and infection in burns were discussed [42]. This paper has been cited 96 times to date and narrowly missed out in being included in the top 100. Other seminal papers that did not make the most cited list were Saffle's paper on fluid creep in burn resuscitation and the review of skin substitutes by Balasubrami et al. published in Burns in 2001 [43,44].

It has been proposed that the most important landmark papers burns may be located in the reference list of the most-cited papers [8,45]. In contrast, it has been reported that the older articles are, the greater the likelihood they have attained more citations purely because their citable period was longer [9].

Table 5 – The countries of origin of the top 100 papers in burns.

Nation	Number of papers
USA	78
United Kingdom	10
The Netherlands	3
Canada	3
France	2
China	1
Sweden	1
Australia	1
Lebanon	1

Table 6 – The institutions which contributed the most papers to the 100 most cited papers in burns.

Rank	Institution	Number of papers
1	University of Texas/Shriners Hospital, Galveston, TX	16
2	Massachusetts General Hospital, Boston, MA	9
3	US Army, Institute of Surgical Research, Houston, TX	8
4	University of Cincinnati, OH	7
5	Birmingham Accident Hospital, UK	6
6	Cornell University, NY	5

Browsing through the list of the top 100 papers gives an interesting insight into the history and development in burns over the last six decades. We have identified the key papers that have had the most momentous impact in the field of burns. The vast majority of papers originated from the United States which is not surprising as according to the Institute of Scientific Information, they also lead the rankings in all 20 scientific disciplines [5,15]. Nonetheless, it has been established that American reviewers have a bias towards American papers [46]. Interestingly, nine papers in the top 100 originated from countries where English is not the first language (The Netherlands, France, China, Sweden, Peru and Lebanon). The remaining 91 papers came from English speaking countries (United States, Canada, Australia and the United Kingdom).

It is important to recognize the limitations with this type of study. 'Incomplete citing' is a phenomenon that occurs when citations are made with the intention to persuade the reader rather than to give credit to those who most influenced their work. Other common biases that can occur include journal bias, self-citation, in-house bias, language bias towards the English language, and omission bias by purposely failing to cite competitors [6]. Notwithstanding these biases, the top 100 most cited papers in burns is a fine representation of many of the most significant works over the last 66 years and each individual paper should be looked at as having acquired 'classic' status based on the large number of citations it has obtained. The top 100 list is helpful for many reasons, as it identifies the seminal papers that have greatly enriched the specialty of burns and permits us to identify which institutions and authors have contributed to them and therefore led the way in burns research. Furthermore, for budding researchers and authors, it provides useful information as to what it entails to write a 'classic paper'. In order to produce such a body of work, a novel idea, innovation or observation must be found that has an abiding effect on the way we treat burns. We have observed that for a piece of work to attain 'classic' status, it should originate from an English speaking country and be published in English in a high impact factor journal. We also found that it was more likely to be published if it originated from the United States.

It is recognized that the measurement of scientific quality is not based on citation analysis. Nevertheless, the more times a paper has been referenced reflects the importance and influence it has had on the scientific community as a whole.

Table 7 – The authors who contributed more than one article to the top 100 papers.

Author	Number of citation classics	Position on author list
Herndon DN	16	First author – 4, second – 2, third – 1, fourth – 1, fifth – 3, last 5
Wolfe RR	9	First author – 2, second – 1, fourth – 1, eighth – 1, tenth – 1, last – 3
Burke JF	8	First author – 3, second – 1, third – 2 fifth – 1, last – 1
Pruitt BA Jr	8	Second author – 1, fifth – 2, eighth – 1, last – 4
Chinkes DL	6	Second author – 2, third – 1 fourth – 3
Wolf SE	6	First author – 1, second – 2, third – 2, fifth – 1
Mason AD Jr	6	Third author – 1, fourth – 1, fifth – 1, last – 3
Shires GT	5	Last author – 5
Alexander JW	5	First author – 3, last – 2
Barrow RE	4	Second author – 3, fifth – 1
Deitch EA	4	First author – 3, second – 1
Tompkins RG	4	First author – 1,fourth – 1, last – 2
Wilmore DW	4	First author – 2, second – 1, last – 1
Bondoc CC	3	Second author – 1, fourth – 2
Desai MH	3	Third author – 1, fifth – 1, last – 1
Finkelstein JL	3	Second author – 1, third – 1, fourth – 1
Gore DC	3	First author – 2, fourth – 1
Hart DW	3	First author – 2, second – 1
Klasen HJ	3	First author – 2, fifth – 1
Madden MR	3	First author – 1, second – 1, third – 1
Rutan RL	3	Third author – 2, last – 1
Quinby WC Jr	3	Third author – 1, fifth – 1, last – 1
Abston S	2	Last author – 2
Allison SP	2	First author – 1, second – 1
Aulick LH	2	First author – 1, second – 1
Becker RA	2	First author – 1, second – 1
Berg RD	2	Last author – 2
Boyce ST	2	First author – 2
Broemeling L	2	Fourth author – 2
Bull JP	2	First author – 2
Burleson DG	2	Second author – 2
Cioffi WG Jr	2	Third author – 2
Cuono CB	2	First author – 2
Demling RH	2	First author – 1, fourth – 1
Drost AC	2	First author – 2
Evans JH	2	Second author – 2
Ferrando AA	2	First author – 1, seventh – 1
Gilpin DA	2	First author – 1, second – 1
Goodwin CW Jr	2	Fourth author – 2
Green H	2	Last author – 2
Hefton JM	2	First author – 1, last – 1
Heimbach DM	2	First author – 1, second – 1
Hinton P	2	First author – 1, second – 1
Jahoor F	2	Third author – 2
Kehinde O	2	Fourth author – 2
Kunkel KR	2	Third author – 1, fifth – 1
Langdon R	2	Second author – 2
Luterman A	2	Second author – 2
Lynch JB	2	Second author – 2
Margraf HW	2	Second author – 1, fourth – 1
McGuire J	2	Last author – 2
McManus, WF	2	Seventh author – 1, eighth – 1
Mlcak RP	2	Third author – 1, fifth – 1
Monafo WW Jr	2	Last author – 2
Moyer CA	2	First author – 2
Nguyen TT	2	First author – 1, sixth – 1
Obeng MK	2	Sixth author – 1, seventh – 1
O'Connor NE	2	First author – 1, second – 1
Ogle CK	2	Fourth author – 1, last – 1
Schoenfeld DA	2	Second author – 1, third – 1
Till GO	2	First author – 1, fourth – 1
Trocki O	2	Second author – 1, third – 1
Vaughan GM	2	First author – 1, second – 1
Warden GD	2	Tenth author – 1, last – 1
Wolfe MH	2	Last author – 2

The top 100 'classic' papers that we observed in this study are the ones that have had the greatest impact on the field of burn care and research and are more than likely the ones that will be remembered most.

Conflicts of interest

All named authors hereby declare that they have no conflicts of interest to disclose.

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