A probe into implant dentistry research: Past, present and future

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How to cite this article:
Hartshorne J. A probe into implant dentistry research – Past, present and future. Open J Implant Dent. 2013;1(1), Art. #4, 7 pages. http://dx.doi.org/10.4102/ojid.v1i1.4

Research aims and values

The ultimate purpose of research is to generate and make available accurate and reliable data that will illuminate and add value to evidence-based knowledge, with the aim of improving patient care, health and quality of life.

In scientific research this goal is achieved through seven key research processes:

- observing interventions and their outcomes and asking questions as to why they are happening
- describing who, what, why, when and where to get insight into or find answers to specific interventions or treatment modalities and outcomes in a population
- predicting the prognosis, survival or outcome of therapies or interventions
- determining the underlying causes and relationships between different biological processes that leading to the observed events, conditions or outcomes of interest
- finding possible explanations to why and how certain events or outcomes are happening
- debating the significance of the research or identifying gaps, which may direct research into new areas of interest
- synthesising and critically appraising a collective body of evidence on a specific research question to present evidence-based data that can facilitate clinical guidelines and recommendations.

These endeavours culminate in the scholarly activity of publishing research findings in peer-reviewed journals.

The value of research lies in its clinical and economic benefits to the individual and collective community. Research also has a scholarly benefit in that it contributes to developing science, technology and education and thus increasing the standing of the profession. However, research is meaningless if the results are not valid (i.e. inaccurate or unreliable), have no relevance to patients in real-world clinical situations, and are not easily accessible to the end users, namely clinicians, educators and researchers.[1]

The growth of implant dentistry research between 1960 and 2012

Research and scholarship has seen significant growth in all the research categories related to implant dentistry over the past 50 years (Table 1). One could say that implant dentistry was conceptualised in the early sixties, born in the seventies, experienced its infancy period during the eighties and entered adolescence in the nineties. The 21st century can be seen as the maturation period of implant dentistry research, with greater focus being placed on content, quality and consolidation. The significant growth is striking in all research categories.

A basic search of the MEDLINE database for the period 1960–2012, using search terms related to implant dentistry (dental implant surgery, oral implant surgery, oral implantology, dental implantology, implant dentistry, dental implants, and oral implants), yielded a total of 27 625 hits. The largest proportion of this body of scientific evidence (57.5%) was produced during the last decade.

Of this repository of research data, only 1282 (4.6%) studies are available to users as free full text. This indicates that clinical scientific data are not freely available to the general practitioner, who relies on the internet for online access to research. Researchers or clinicians who wish to access research publications have to subscribe to journals, have access to libraries at academic institutions or purchase articles online from publishing houses, all of which are costly.

The database search yielded a total of 22 091 hits in the clinical research categories and 5396 hits in the animal research categories (Table 1). The studies found describing laboratory or *in vitro* research are not a true reflection of research in this field because their scope differs significantly from that of clinical and animal research and a different set of keywords would be required to identify adequately representative studies.

A summary of the types of clinical research conducted during the past 50 years is presented in Table 2. Clinical research is dominated by case reports (19.2%). In comparison, only 4.2% randomised controlled trials (RCTs) and 0.6% systematic reviews were described. The search also yielded a meagre 95 hits for clinical guidelines, consensus reports or position papers, of which only two are available as free full text.

Current trends in implant dentistry research: 2011–2012

A bibliometrical analysis of 12 top-impact subject journals was also performed to establish current trends in implant dentistry research. The selected journals were:

- *Journal of Dental Research*
- *Journal of Clinical Periodontology*
- *Journal of Periodontology*
- *International Journal of Prosthodontics*
- *Journal of Prosthetic Dentistry*
- *International Journal of Periodontics and Restorative Dentistry*
- *International Journal of Oral and Maxillofacial Surgery*
- *The International Journal of Oral Maxillofacial Implants*
- *Clinical Implant Dentistry Related Research*
- *Clinical Oral Implants Research*
- *Journal of Oral Implantology*
- *Implant Dentistry.*

Abstracts of scientific publications from January 2011 to January 2012 were accessed online and analysed to gain information on research category, type of study and research design, research topic, interventions and outcome variables. A total of 747 abstracts were analysed. The results are summarised in Table 3, organised according to research category, study type and research design.

Research category and study type

The largest proportion (60%) of research during the assessed one-year period could be assigned to the clinical research category (research on humans). Other studies were approximately equally distributed between animal-based (18%) and laboratory (*in vitro*) research (21%).

Clinical research is generally classified into three main study types: systematic reviews, experimental studies and observational studies. Most of the research contributions (76.6%). could be classified as observational studies. Only 30 (6.7%) systematic reviews and 75 (16.7%) experimental studies were published during the assessed period.

TABLE 1: Summary of studies identified by database search, organised according to research categories and publication date.

Research category	1960–1969		1970–1979		1980–1989		1990–1999		2000–2012		Total	
	N	*n*	*N*	*n*	*N*	*n*	*N*	*n*	*N*	*n*	*N*	*n*
Clinical	126	5	810	15	2221	13	6199	148	12 744	731	22 100	912
Animal	32	3	295	20	631	29	1391	67	3047	238	5396	357
Laboratory	1	0	5	1	11	0	29	0	91	11	137	12

N, Total number of studies; *n*, number of publications available in free full text.

TABLE 2: Summary of some types of clinical research study in the field of implant dentistry conducted between 1960 and 2012, as found during a database (Medline) search.

Type of clinical research	1960–1969		1970–1979		1980–1989		1990–1999		2000–2012		Total	
	N	*n*	*N*	*n*	*N*	*n*	*N*	*n*	*N*	*n*	*N*	*n*
Systematic reviews/meta-analysis	0	0	0	0	0	0	10	0	115	6	125	6
Randomised controlled trials	0	0	0	0	12	0	159	9	749	37	920	47
Non-randomised clinical trials	0	0	14	0	75	0	462	24	1460	56	2011	81
Multicentre trials	0	0	0	0	5	0	114	1	271	10	390	11
Comparative (analytical) studies	1	0	25	2	124	2	827	27	1956	92	2933	123
Case reports	18	0	110	0	363	1	1144	8	2616	112	4251	131

N, Total number of studies; *n*, number of publications available in free full text.

TABLE 3: Analysis of studies conducted from January 2011 to January 2012.

Research category	Study type			Sub-study type			Research design			Total	
	Description	*n*	%	Description	*n*	%	Description	*n*	%	*N*	%
Clinical research	Systematic reviews	30	6.7				Quantitative meta-analysis	5	1.1	448	60.0
							Qualitative	25	5.6		
	Experimental	75	16.7				Randomised controlled trial	45	10.0		
							Non-randomised controlled trial	30	6.7		
	Observational	343	76.6	Analytical (with comparison group)	132	29.5	Prospective cohort	80	17.9		
							Retrospective cohort	45	10.0		
							Case–control	7	1.6		
				Descriptive (no comparison group)	210	47.0	Cross-sectional (prevalence)	63	14.0		
							Case series	54	12.0		
							Case reports	94	21.0		
Animal research										141	18.9
Laboratory (*in vitro*) research										158	21.0
Total abstracts										**747**	**100.0**

n, number of studies; *N*, Total number of studies.

Observational studies are divided into two subgroups: analytical studies, which have comparison groups, and descriptive studies, which do not have comparison groups. The core of published clinical research sorted within the latter group (47%).

Not all evidence is judged to be of equal value. The different hierarchies of research design provide information with different strengths and value in the decision-making process.[1,2] Levels of evidence are graded according to research design. Meta-analysis and systematic reviews represent the highest levels of evidence, whereas case reports are at the bottom of the evidence ladder. The classification of research designs as depicted in Table 3 is generally also considered to be the hierarchy of strength of evidence, with meta-analysis at the top and case reports at the bottom of the evidence ladder.[2]

Considering research design as an indicator of the quality of research produced in implant dentistry, the scale is tilted towards lower quality of evidence. Ideally one would like to see a shift away from descriptive studies towards core research, namely analytical and experimental research. Only 10% of studies identified by the database search were RCTs. Quality RCTs, the gold standard in clinical research, is the backbone of systematic reviews and evidence-based dentistry. The evidence gleaned from animal and laboratory research is generally considered to be lower along the evidence hierarchy than clinical research because it is indirect evidence. However, depending on the type of research question that is addressed, laboratory and animal research may have a great impact on driving clinical interventions. Laboratory and animal research is also the driving force behind new innovations and descriptions of biological processes.

Research topics, interventions and outcomes

Clinical research topics are dominated by surgical interventions (50.5%), followed by prosthetic (18.1%) and bioengineering interventions (16.3%) (Table 4). The clinical research topics studied most often were sinus augmentation (12.3%), guided bone regeneration (10.5%), overdentures (8.7%), implant design (8.0%) and host risk factors (8.0%).

Outcome criteria in clinical research focused mainly on prognosis (what is likely to happen?) (39.6%), and effectiveness (is it likely to help?) (28.7%). Etiology (what caused the problem?) (1.9%) and diagnosis (what is the problem?) (6.3%) were rarely regarded as outcome criteria.

The most common outcome variables measured were bone regeneration (13.6%), complications and adverse surgical effects (12.3%), prognosis or survival (10.6%), bone dimensional changes (8.7%), patient-centred outcomes (e.g. patient satisfaction) (7.3%), bone loss (5.4%) and bone healing (4.1%).

Animal research focused mostly on bioengineering (50.4%) and surgical interventions (34.7%), with the most interest being in implant surface modification (22.7%) and guided bone regeneration biomaterials and bone substitutes (19.9%) (Table 5).

TABLE 4: Clinical research topics and interventions in implant dentistry: January 2011 to January 2012.

Clinical research topic	*N* = 448	%
Surgical interventions	**226**	**50.5**
Sinus augmentation or lift or elevation	55	
Guided bone regeneration or bone augmentation	47	
Implant placement protocol	29	
Surgical techniques (harvesting, ridge expansion, etc.)	26	
Surgical guides or implant positioning	25	
Socket preservation	19	
Peri-implantitis	13	
Pharmacotherapeutic agents	7	
Reconstruction of jaw defects	5	
Prosthetic interventions	**81**	**18.1**
Overdentures	39	
Implant loading protocol	23	
Prostheses retention	7i	
Impression techniques	4	
Aesthetic considerations	3	
CAD or CAM applications	2	
Provisional restorations	2	
Crown biomaterials	1	
Bioengineering interventions	**73**	**16.3**
Implant design	36	
Implant surface topography	19	
Implant abutment design	17	
Biomaterials	1	
Diagnostic and treatment planning interventions	**60**	**13.4**
Host risk factors	36	
Cone beam computed tomography applications	23	
Ridge mapping	1	
Other interventions	**8**	**1.8**
Implant site development or orthodontics	3	
Implant maintenance	3	
Patient perceptions on cost	1	
Provider perceptions and behaviour on implants	1	

TABLE 5: Animal research topics and interventions in implant dentistry: January 2011 to January 2012.

Animal research topics and interventions	*N* = 141	%
Bioengineering interventions	**71**	**50.4**
Implant surface modification	32	
Guided bone regeneration biomaterials and bone substitutes	28	
Implant design	7	
Implant abutment interface	2	
Resonance frequency or implant stability	2	
Surgical interventions	**49**	**34.7**
GBR bone defect augmentation	12	
Sinus elevation techniques	10	
Surgical techniques or tissue expanders or flapless surgery	9	
Implant placement: 3D geometric position	7	
Implant placement: immediate, early or delayed	5	
Peri-implantitis therapy	2	
Socket preservation	2	
Soft tissue integration	1	
Torque or insertion or removal	1	
Other interventions	**21**	**14.9**
Host risk factors or bone characteristics	9	
Tissue engineering or stem cells	6	
Implant loading	3	
Pharmacotherapeutic agents	3	

Most animal research outcome variables were related to bone features, for example bone regeneration (24.4%), bone healing and remodelling (21.2%), osseointegration (19.2%) and bone dimensional changes (8.3%).

In the laboratory research category, studies on implant components (47.5%) and prosthetic superstructure interventions (19.6%) ranked highest (Table 6). Research topics that received the most attention were implant surface topography (20.9%) and implant abutment interface design (15.2%).

Cellular activity and response of osteoblasts (14.1%), fracture strength and strain levels (7.6%), retentive strength (7.6%) and prosthetic complications and adverse effects were common outcome measures in laboratory research.

Future directions in implant dentistry research

Improving the quality of research evidence

Clinicians and researchers need to be more mindful and critical in planning, conducting, reporting and assessing research to ensure that the results are valid, accurate and reliable. To achieve this goal, greater focus needs to be placed on research design and methodology.

Understanding what kind of research design is required or has been implemented is a prerequisite to thoughtful planning or critical appraisal of research. Selection of research design depends on the research question the investigator wants to pursue, the clinical setting, the time required to measure an expected outcome, data availability and the availability of resources. One of the fundamental skills required for research and for practising evidence-based dentistry is that of asking well-constructed clinical questions. These should include four critical elements, namely patient or problem (P), intervention or exposure (I), comparator or alternative (C), and outcome or effect (O).[3]

TABLE 6: Laboratory research topics and interventions in implant dentistry: January 2011 to January 2012.

Laboratory (*in vitro*) research topics	*N* = 158	%
Bioengineering implant component interventions	**75**	**47.5**
Implant surface topography	33	
Implant abutment interface design	24	
Implant geometry design	13	
Mini implants or short implants	5	
Bioengineering prosthetic interventions	**31**	**19.6**
Overdenture attachments	14	
Fixed prostheses frame or fit accuracy	10	
Cantilever load or stresses	4	
Abutment retentive design: cement or screw-retained	3	
Tissue engineering interventions	**17**	**10.8**
Cellular activity or response	13	
Peri-implant bone regeneration	2	
Gene expression or osteoblast response	1	
Stem cell modulation	1	
Biomaterial interventions	**15**	**9.5**
Graft biomaterials	7	
Superstructure or abutment or crown materials	6	
Implant material characteristics	1	
Retentive forces of luting agents	1	
Bioengineering surgical interventions	**11**	**6.9**
CAD or CAM guided surgery	6	
Instruments or piezo tips or torque drivers or implant drills	5	
Prosthetic techniques	**9**	**5.7**
Impression techniques	4	
Loading protocols	2	
Screw torque	2	
Cyclic loading	1	

An RCT is the best design to test effectiveness or efficacy of specific interventions or to establish causality. RCTs, when performed properly, are the gold standard for inclusion into systematic review studies and evidence-based dentistry. Properly performed RCTs can minimise bias effectively and eliminate confounding variables, such as age, sex, disease severity, periodontal biotype and bone density, and co-morbidities (smoking, bisphosphanates, diabetes and irradiation), which reduce the validity of the research.

Studies conducted with a high level of evidence (e.g. an RCT) but which lack rigorous methodology have the potential to generate evidence that is inaccurate or unreliable and could thus introduce significant potential harm to the patient.[4] Similarly, systematic reviews based on studies lacking rigorous methodology also carry a risk of producing evidence that is unreliable or of poor quality.

Vere and Joshi conducted a systematic review to assess the quality of RCTs of dental implant surgery and prosthodontics.[5] Their review identified important methodological flaws and inappropriate statistical analyses that compromised the quality of RCTs. They concluded that:

> '[*R*]andomised controlled trials of treatment interventions of dental implant surgery and prosthodontics published between 2004 and 2008 are poorly reported and, by themselves, provide little unbiased evidence to support the clinical decisions that we make'.

In another study, Pandis and co-workers investigated the quality of research published in six major clinical dental specialty journals.[6] They showed that the reporting on the key quality criteria (study type, randomisation, sample calculation, confounding concerns, statistical analysis, effect measurement and confidence intervals) was lacking, which could imply low research validity.

If we want to improve patient care through evidence-based dentistry, researchers will have to make concerted efforts to improve their methodological conduct and quality of research. Explicit guidance in this regard can be obtained from the CONSORT statement guidelines (for clinical trials) and the STROBE statement (for reporting observational studies). [7,8,9,10,11 12]

From an ethical point of view, authors need to be direct and disclose sufficient, relevant information to permit informed judgement of the internal (accuracy and reliability) and external (relevance in the real-world clinical situation) validity of clinical research.

Evidence-based dentistry: Bridging the gap between research and real-world dental practice

Together, the electronic database revolution, the significant growth in research and the demand for reliable and accurate information have allowed a paradigm shift towards evidence-based dentistry, aimed at reducing the gap between clinical research and real-world practice.

Evidence-based dentistry involves the integration of three key elements, namely best available research evidence, clinical expertise, and patient values and preferences, into treatment decision-making.[13]

Best available evidence implies using the highest quality evidence that is available. The highest quality evidence is derived from meta-analysis, systematic reviews and RCTs. Systematic reviews, which collect, appraise and combine all relevant clinical evidence, should therefore be used when available rather than an individual study, as observational studies provide less reliable data owing to their research designs being more prone to bias.[2] However, if high-quality studies are not available studies with lower levels of evidence can be considered.

Clinical expertise is the ability of the clinician to use clinical skills and knowledge to identify a patient's unique situation and diagnosis, considering the individual risks and benefits of potential treatments. Patient values are the unique preferences, concerns and expectations that a patient adds to the clinical encounter.

If future clinical decisions in implant dentistry are to be evidence based, it is important that there should be an increase in the quantity as well as the quality of systematic reviews across all research areas in implant dentistry. The best available evidence is obtained through the process of qualitative and quantitative systematic review of published research findings. Researchers and clinicians should expand their ability to perform critical appraisal and synthesis of research and the associated quality before integrating research findings in clinical decision-making.

Reviews should address clinically relevant problems, include focused questions and follow a well-designed protocol to facilitate proper search strategies, quality assessment of primary research, pooling of data and testing of heterogeneity.

Grading of Recommendation Assessment, Development, and Evaluation (GRADE) is a system for rating the quality of evidence in systematic reviews and grading the strength of recommendations in clinical guidelines.[14] Research evidence, irrespective of the study design, does not necessarily imply that the quality of the evidence is high. Similarly, although the design of case–control studies is generally considered to yield lower-quality evidence, such studies do not necessarily have to be excluded from the clinical decision-making process.

Development and standardisation of patient-centred core outcome

Numerous problems exist with regard to the current state of outcome measures in implant dentistry research.[15] Future research should aim to focus on the identification, definition and quantification of patient-centred core outcomes. A core set of well-defined, validated and feasible outcome measures are recommended to promote improved quality in implant dentistry research. Standardised core outcome measures would permit researchers to combine data from multiple studies for meta-analysis, thus facilitating critical appraisal and development of appropriate clinical guidelines.[15]

Common outcomes of interest (end points) measured in clinical implant research include new bone formation, bone regeneration, bone dimensional changes, marginal bone loss, bone healing, and bone-to-implant contact. These are surrogate end points and are of limited relevance to patients.[16]

True end points, such as absence of pain, discomfort and complications, improved aesthetic and masticatory function and phonetics, simplicity and ease of maintenance, and implant survival are true, patient-centred end points and provide meaningful information to the clinician. Hujoel puts this in perspective: 'We must remember that research is conducted for the benefit of patients, not the convenience of researchers, and strive to use true end points wherever possible'.[16]

The Academy of Osseointegration recommends that a core set of outcome variables be gathered in all technology assessment research to combine and compare data from different studies.[15] It is agreed that outcome variables should be addressed in the following areas or domains:

- procedural – simplicity of technique, duration and adverse effects
- psychological – patient satisfaction, aesthetics, treatment preference and quality of life
- longevity – implant stability, prostheses stability, survival and/or success, biologic complications, mechanical complications and adverse effects
- physiological and functional – speech, mastication, nutritional needs, motor and sensory function, bone stability and soft tissue stability
- economic – initial cost of intervention and that of maintenance.

New frontiers in implant dentistry research

Bioengineering, tissue engineering and nanotechnology are expected to revolutionise implant dentistry in a dramatic way over the next two decades. The primary focus of these emerging research frontiers will be aimed at exploring innovative ways of enhancing bone regeneration and osseointegration, modulation of the host immune response, reducing healing time and preventing peri-implant disease.

Bioengineering is clearly setting the tone in innovative research. The arrival of nanotechnology has opened up new opportunities for the development and manipulation of

implant surface topography. Bio mimicking the nanopatterned surface topography of the extracellular matrix components of bone tissue could promote cell attachment, proliferation and differentiation, thereby significantly enhancing new bone formation and attachment to implant surfaces.

Multilayered biodegradable polypeptide nanofilms are currently being developed for surface coatings on implants or as scaffold material.[17] Nanofilms or coatings can be loaded and used as carriers of antibiotics or other biologically active therapeutic or modulating molecules such as interleukins, bone morphogenic proteins, growth factors, catabolic enzymes or matrix metallo-proteinases.

Tissue engineering, and in particular mesenchymal stem cell therapy, has the potential to offer enormous opportunities in the areas of alveolar bone and soft tissue regeneration and repair to deliver predictable implant site development and implant therapy to compromised patients.[15] In addition, stem cell therapy could reduce donor site morbidity because it would replace autogenous tissue harvesting.

Nanotechnology will have an impact across the entire practice of implant dentistry. A new generation of 'bio-active' implants are capable of modulating cellular responses at the molecular level. Beside the advances to implant surface topography itself, nanotechnology offers useful possibilities with regard to diagnostic imaging methodologies, implant site preparation, restoration and aesthetics, wound healing, delivery of modulating therapeutic molecules and drugs, management of peri-implant disease and surgical and restorative techniques. As nanotechnologies mature, they will become more customised, allowing them to be guided towards specific patients, treatment sites or clinical indications.[15]

The Academy of Osseointegration further cites vertical ridge augmentation and the prevention and treatment of peri-implantitis as the two most challenging issues that should be prioritised as a future research focus in implant dentistry therapy. [15]

There should be an increased quest for basic experimental research (i.e. laboratory or bench research, materials research and animal studies) to characterise and develop new materials and fundamental biological principles, and to understand biological mechanisms at cellular and molecular level. These studies should be conducted according to the same rigorous methodologies as applied in controlled experimental clinical research to improve the quality of evidence.[4]

Open access to peer-reviewed research articles

It is imperative that the wealth of research information be used and integrated into mainstream clinical practice in a more efficient and accessible manner. Open access to peer-reviewed research articles will undoubtedly be the future platform for authors' scholarly reporting and provide access to research for readers.[18] The aim of an open-access journal is to provide wider and easier access to readers and a larger audience and impact for authors by removing price barriers such as subscriptions, licensing fees or pay-per-view fees, and permission barriers associated with copyright and licensing restrictions, thus allowing 'free availability and unrestricted use' of peer-reviewed research.[18] The only constraint on the reproduction and distribution is that the authors are appropriately acknowledged and cited for their work.

According to Suber:[18]

> 'We have already reached the point at which even affluent research institutions cannot afford access to the full range of research literature. Priced access to journal articles would not scale down with continuing, explosive growth of knowledge even if prices were low today and guaranteed to remain low forever'.

Open access to peer-reviewed articles provides authors with an audience larger than that of any subscription-based journal, no matter how prestigious or popular, and undeniably increases the visibility and impact of the work.[18]

For readers, open access provides barrier-free access to literature needed for research or clinical purposes, without any constraints of access to or budgets of academic libraries. For those involved in post-graduate clinical education, open access eliminates the need for payment or permissions to reproduce and distribute content to students or participants in clinical training. For academic institutions, open access thus increases visibility of their faculty and research, reduces their expenses with regard to journal subscriptions and, most importantly, advances their mission to share knowledge.[18]

According to Suber:[18]

> 'The most important 'royalty-free literature' for open access purposes is the body of peer-reviewed scientific and scholarly research articles and their preprints. Scholars write journal articles because advancing knowledge in their fields advances their careers. They write for impact, not for money. It takes nothing away from a disinterested desire to advance knowledge to note that it is accompanied by a strong self-interest in career-building'.

Open access increases the return on investment in research, making the results of funded research more widely available, retrievable and useful to authors, readers and the public at large.

Conclusion

The ultimate goal of future research initiatives is to produce biomaterials and therapies that will improve current standards of care, customised to patients' preferences and specific needs and improve quality of life. This will require greater integrated and interdisciplinary team work between the fields of bioengineering, tissue engineering, material sciences, biology and clinical sciences.

Research in implant dentistry is not without problems and challenges. Studies in dental implantology are expensive to conduct, difficult to blind, require prolonged follow-up and frequently impossible to undertake owing to ethical constraints. Limited available space in journals also often results in a long publication lag time. Funding for research will increasingly become a major challenge for researchers.

Pooling resources through multicentre trials and collaborative efforts are some of the innovative methods of addressing this challenge.

Research should go the full circle: identification of patient-centred clinical problems, posing focused research questions, proper planning and execution of research, ethical and adequate reporting of findings, synthesising pooled evidence in systematic reviews, and critical appraisal of systematic reviews and evidence-based clinical recommendations, to culminate in the implementation of evidence-based recommendations in practice in an affordable and accessible manner. As members of a profession we have the responsibility to question the value and validity of each of these processes to ensure both that the patient will benefit and that implant dentistry will develop in stature. Research achieves its true value only when quality evidence is available, integrated with clinical expertise and patient preferences to produce clinical guidelines or recommendations that are freely available to clinicians for making clinical decisions about patient care.

Acknowledgments

AOSIS is thanked for the copyediting and carrying the cost of publishing this paper.

Competing interests

The author declare that he has no financial or personal relationship(s) that may have inappropriately influenced him in writing this article.

References

1. Sutherland SE. Evidence-based dentistry: Part IV. Research Design and Levels of Evidence. J Can Dent Assoc. 2001;67:375–378. PMid:11468093
2. The Oxford Centre for Evidence-Based Medicine. The Oxford 2011 Levels of Evidence. University of Oxford 2011. [updated 2012 May 29; cited 2012 June 20]. Available from http://www.cebm.net/index.aspx?o=5653.
3. The Oxford Centre for Evidence-Based Medicine. Asking focused questions. Oxford University. [Updated 2012 May 29; cited 2012 June 20]. Available from http://www.cebm.net/index.aspx?o=1036.
4. Chiapelli F, Avila J, Chai DY et al. Evidence dentistry in the XXI century: Towards clinically relevant complex systematic reviews. Open Dent L. 2010;4:48–50.
5. Vere J, Joshi R. Quality assessment of randomized controlled trials of dental implant surgery and prosthodontics published from 2004 to 2008: a systematic review. Clin Oral Impl Res. 2011;22:1338–1345. http://dx.doi.org/10.1111/j.1600-0501.2010.02124.x, PMid:21418331
6. Pandis N, Polychronopoupou A, Midianos P, Mkou M, Eliades T. Reporting of research quality characteristics of studies published in 6 major clinical dental specialty journals. J Evid Base Dent Pract. 2011;11:75–83.
7. Moher D, Hopewell S, Schulz KF et al. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomized trials. Br Med J. 2010;340:c869. http://dx.doi.org/10.1136/bmj.c869, PMid:20332511 PMCid:2844943
8. Cambell MK, Elbourne DR, Altman DG. CONSORT statement: extension to cluster randomized trials. Br Med J. 2004;328:702–708. http://dx.doi.org/10.1136/bmj.328.7441.702, PMid:15031246 PMCid:381234
9. Ioannidis JP, Evans SJ, Gøtzsche PC et al. Better reporting of harms in randomized trials: an extension of the CONSORT statement. Ann Intern Med. 2004;141:781–788. PMid:15545678
10. Bourton, I, Moher D, Altman DG, Schulz KF, Ravaud P, the CONSORT 51 Group. Extending the CONSORT statement to trials reporting nonpharmacological treatments: extension and elaboration. Ann Intern Med. 2008;148:295–309.
11. Piaggio G, Elbourne DR, Altman DG, Pocock SJ, Evans SJ. Reporting of non-inferiority and equivalence randomized trials: an extension of the CONSORT statement. J Am Med Assoc. 2006;295:1152–1160. http://dx.doi.org/10.1001/jama.295.10.1152, PMid:16522836
12. Von Elm E, Altman DG, Eger M, Pocock SJ, Gøtzsche PC, Vandenbrouck JE. The strengthening of the reporting of observational studies in epidemiology. (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008;370(9596):344–349. http://dx.doi.org/10.1016/j.jclinepi.2007.11.008, PMid:18313558
13. Sackett DL, Straus SE, Richardson WS, Rosenberg W, Haynes RB. Evidence-based medicine: How to practice and teach EBM. Edinburgh: Churchill Livingstone; 2000.
14. Guyatt G, Oxman AD, Akl EA et al. Grade guidelines: 1. Introduction – GRADE evidence profiles and summary of findings tables. J Clin Epidemiol. 2011;64:383–394. http://dx.doi.org/10.1016/j.jclinepi.2010.04.026, PMid:21195583
15. The Academy of Osseointegration. Impact of biological and technological advances on impant dentistry. Int J Oral Maxillofac Implants. 2011;26(Suppl):7–10
16. Hujoel P. Endpoints in periodontal trials: the need for an evidence-based research approach. Periodontology. 2000. 2004;36:196–204. http://dx.doi.org/10.1111/j.1600-0757.2004.03681.x, PMid:15330950
17. Jiang B, Li B. Polypeptide nanocoatings for preventing dental and orthopaedic device-associated infection: pH-induced antibiotic capture, release, and antibiotic efficacy. J Biomed Mater Res Part B: Appl Biomater. 2009;88B:332–338. http://dx.doi.org/10.1002/jbm.b.31021, PMid:18161817
18. Suber P. Open access overview – Focusing on open access to peer reviewed research articles and their preprints. 2011. c.2004 [updated 2012 December 16; cited 2013 February 21]. Available from http://www.earlham.edu/~peters/fos/overview.htm