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Translating research and into everyday clinical practice: Lessons learned from a USA national dental practice-based research network

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Abstract

Clinical studies are of paramount importance for testing and translation of the research findings to the community. Despite the existence of clinical studies, a significant delay exists between the generation of new knowledge and its application into the medical/dental community and their patients. One example is the repair of defective dental restorations. About 75% of practitioners in general dental practices do not consider the repair of dental restorations as a viable alternative to the replacement of defective restorations. Engaging and partnering with health practitioners in the field on studies addressing everyday clinical research questions may offer a solution to speed up the translation of the research findings. Practice-based research (PBR) offers a unique opportunity for practitioners to be involved in the research process, formulating clinical research questions. Additionally, PBR generates evidence-based knowledge with a broader spectrum that can be more readily generalized to the public. With PBR, clinicians are involved in the entire research process from its inception to its dissemination. Early practitioner interaction in the research process may result in ideas being more readily incorporated into practice. This paper discusses PBR as a mean to speed up the translation of research findings to clinical practice. It also reviews repair versus replacement of defective restorations as one example of the delay in the application of research findings to clinical practice.

> "If we want more evidence-based practice, we need more practice-based evidence."
>
> Lawrence W. Green, DrPH

Introduction

The latest announcements from the USA government clearly state that American taxpayers are highly interested in immediate results for the research taking place these days [1,2]. A significant delay exists between the generation of breakthroughs and their transfer through applications serving individual patients when science is not efficiently translated to daily clinical practice. Therefore, a substantial difference exists between the health care that patients may be eligible for and the health care that they actually receive [3-5]. Enhancing the delivery of established therapies would save more lives than pursuing additional innovations in therapy [6,3].

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The time lag between discovery and its generalized adoption by the medical/dental profession has ranged from 17 to 24 years depending on the study and subject area [5]. Part of the problem lies in the fact that most research is done in academic and industry environments and not directly by the end users. In the current research structure, many studies are so specific to certain areas that the results are not easily transferred into general practice. Whereas studies in academia are often narrowly focused and may apply to a limited subset of patients or circumstances, practice-based research involves a broad spectrum of patients and practitioners. One way to speed up the translation of the research findings is to promote the engagement and partnership between research professionals and practitioners on problems identified by practitioners. In other words, the translation of the research findings into clinical practice can be improved if practitioners are recruited and engaged in the research process. Practice-based research networks (PBRN) offer a unique opportunity for practitioners to be involved in the research process, formulating clinical research questions that may improve the oral health of the population. PBRNs also offer researchers the chance to learn more about everyday issues involving oral health and interact with practitioners in the dental field. Additionally, practice-based research (PBR) offers two very important points for the advancement of health care: (1) it generates evidence-based knowledge with a broader spectrum that can be more readily generalized to the public (i.e., the evidence comes directly from the end-user “the everyday patient”); and (2) it speeds up the translation of research findings as passive absorption of knowledge usually either does not work or is very slow. With PBR, clinicians are involved in the entire research process from its inception, asking the clinical questions, being involved in the gathering of the research findings, as well as in its dissemination. Early practitioner interaction in the research process may result in ideas being more readily incorporated into practice.

The obvious commitment from USA National Institute of Health to practice-based research [7,8] and translational research [9] shows where we are headed in response to the public's concern. On April 12, 2012, USA NIH/NIDCR announced the establishment of a National Dental Practice-based Research Network awarding a $66.8 million, seven-year grant to consolidate its national dental practice-based research network initiative [10]. The USA National Dental PBRN comprises 6 distinct regions throughout the United States and with administrative sites in Rochester, NY; Gainesville, FL; Birmingham, AL; Minneapolis, MN; San Antonio, TX; and Portland, OR.

One classic example: Repair versus replacement?

Replacement of defective restorations is one of the most frequent problems encountered by general practitioners today and accounts for over 50% of the work performed in general dental practice [11-13].

The re-restoration cycle has been described for over 35 years [14-16] and since then innumerous in vitro [17,18] and clinical studies [19-21] have shown that removal of the existing restoration will significantly remove sound tooth structure resulting in subsequently larger dental restorations. The removal of existing restorations may also cause additional stress on the tooth with possible pulp and dentin reactions to thermal, chemical, bacterial, or mechanical stimuli [22,23], depending on the size and depth of the existing restored site. The first restoration placed in an unrestored tooth can affect the overall longevity of the tooth as proposed by the life-cycle of a tooth [24]. In this model the first restoration placed on a tooth is when the patient is around age six, and subsequent restoration replacements every eight to twelve years lead to progressively larger restorations and, ultimately, to tooth loss when patient reaches age 56. Another important inference from this model would be to delay or avoid the surgical intervention into the restored tooth as much as possible, since this

process will affect the remaining tooth structure and, consequently, reduce the survivability of the tooth.

Repair of defective restorations offers a less invasive and more conservative approach to restoration replacement and has the potential to delay the re-restoration cycle. Additionally, longitudinal cohort studies have demonstrated that the success rate of treatment for failed restorations not necessarily surpass the clinical performance of other alternative treatments such as repairing, sealing, or monitoring teeth at risk [25-32].

Another milestone study by Mertz-Fairhurst and colleagues [33] concluded in a long-term clinical study (over 10 years) that sealed restorations exhibited superior clinical performance and longevity compared with unsealed restorations. The study also concluded that sealed composite restorations placed over cavitated carious lesions arrested the clinical progress of the lesions [33].

Even though the results of these studies [25-33] have been published for several years, and schools have included the repair of dental restorations in their curriculum [34-37], clinicians still do not routinely consider the repair or sealing of restorations as a viable treatment option for the treatment of defective restorations [38-43]. Several reasons may account for this including, clinicians' tradition, lack of reimbursement for these procedures, professional community standards, and absence of baseline knowledge regarding the existing restoration.

What have we learned from dentists participating in practice-based research regarding repair versus replacement treatment? As reported in previous publications [19,44], close to 75 percent of clinicians participating in Dental PBRN also chose replacement more often than repair for the treatment of defective restorations [39,43,45].

Also consistent with previous findings [14,46-48], most of the dentists (75%) participating in a practice-based study [43] involving close to 10,000 restorations chose replacement over repair of defective restorations when they had not placed the original restoration ($p<0.001$). Another study [49], based on insurance claims, also suggests that patients who change dentists are far more likely to have restorations replaced and not necessarily repaired.

Restorations may become defective due to a number of reasons related to either clinician factors, patient factors, and/or material properties [50]. It is not always possible to single out factors and often a combination may be the cause of the defect or restoration failure. The reasons for restoration failure are not routinely recorded by practicing dentists and often only the end result is registered. Practicing dentists [43] reported the diagnosis of secondary caries as the main reason for restoration treatment, followed by restoration fracture, marginal degradation, and margin discoloration. These findings are consistent with others reported in the literature [51-54]. Although the study by Bogacki and colleagues [49] reported that changing dentist was the main reason for restoration replacement.

Even though secondary caries was identified as the primary cause for restoration treatment, it also leads to the highest number of repair treatments (30%). The clinical diagnosis of secondary caries is ill-defined [51-56] and marginal staining is often mistakenly diagnosed by clinicians as caries lesions [11,12,57,58]. Without objective criteria, it becomes challenging to correctly differentiate between secondary caries and staining or degradation of the restoration margin [59].

When assessing a restoration with a defect or discoloration at the margins, if the dentist is unable to clearly reject a secondary caries diagnosis, he or she will most likely choose replacement as opposed to other options of nonsurgical treatment, including systematic monitoring of the restored tooth. This continues to occur despite the fact that previous

studies [60-62] have shown no relationship between the development of secondary caries and the size of the leakage or gap, except in cases in which the crevice exceeds 250 μm[62] or 400 μm [63]. The criteria for the treatment of defective restorations should not be based solely on visual, tactile or radiographic examination, but primarily on the caries risk of the patients and caries activity of the site. Future research that focuses on biomarkers may identify and count the bacteria [64] present at the crevice (*i.e*, acid-producing versus alkali producing bacteria) have the potential to aid in the diagnosis of caries in the faulty margins of existing restorations.

Even though studies report a decline in the use of dental amalgam, because of its inferior esthetic appearance, alleged adverse health effects, and environmental concerns [65-69], many of existing restorations are still amalgam [45]. The PBR study showed that most of the restorations that were treated in the study were amalgam (56%), which were replaced primarily (56% of cases) with direct tooth-colored restorative materials. The restorative material was five times more likely to be changed when the original restoration was amalgam. The probability of changing from amalgam to another restorative material varied according to several characteristics of the original restoration. The change was most likely to take place when (1) the treatment was a replacement; (2) the tooth was not a molar; (3) the tooth was in the maxillary arch; and (4) the original restoration involved a single surface [45].

The choice of repair over replacement of defective restorations differs among dentists according to certain dentist's characteristics. Dentists who placed the original restoration, dentists who graduated from dental school within the last 15 years, and dentists who work in large group practices (3 or more practitioners) repaired defective restorations more often than they replaced the restorations [43]. Some patients' characteristics were also associated with a greater likelihood of repair versus replacement, such as older patient age, original restorative material different than amalgam, restorations in molar teeth, and fewer surfaces in the original restoration [43].

How can we speed up the translation of research findings?

Clinicians are bombarded by vast amounts of information from manufacturers, in dental journals, and in continuing education courses. What evidence do clinicians use to make drastic improvements in preventive and restorative care? How can clinicians accept and translate the evidence into practice?

Traditionally, journal articles, workshops, academic classes, and conferences have been the usual mode of educating practitioners. Patient education and financial incentives have also been used, with all methods showing small to modest effects [6,70]. Research has shown that new methods and materials will have better acceptance if transmitted by leaders in the field. This is not necessarily an individual with the highest degree or visibility, but is someone trusted as an opinion leader or mentor [6,71]. A goal of PBRNs is to share results and possible solutions to certain problems by promoting the networking and collegiality among practitioners and participants about their daily work and practicing environment [72]. PBRN practitioners are offered several venues to interact with each other through annual and training meetings, study clubs, participating in webinars, as well as other means of interaction through virtual communication such as chat rooms, Facebook, Twitter, and Linked-in. Besides the above mentioned means, dissemination of information also happens through monthly electronic publications and quarterly newsletter which highlights various activities and study results.

Participating in PBRN activities may create openness to change and the practitioner-investigators act as agents for change [73]. Additionally, presentations on study results given

by fellow practitioner-investigators, rather than academicians, seem to have a greater influence on practitioners as opposed to clinical faculty presentations [6].

We also learned that bringing the evidence into the dental office through PBR may efficiently change dentists' attitudes and daily practice. In one PBR study, 998 clinicians participated in a baseline questionnaire with clinical case scenarios about the diagnosis and treatment of dental caries. From the 998 clinicians, 133 were asked to participate in a nationwide meeting. Those participating in the meeting were mailed their results from the baseline questionnaire 45 days prior to the meeting, were asked to complete a new questionnaire at the meeting's registration desk; and another questionnaire upon leaving the meeting. During the meeting, clinicians had the opportunity to participate in panel discussions with question-and-answer sessions, as well as in informal gatherings and formal breakout sessions in which clinicians discussed pre-assigned topics at assigned tables. At the end of the meeting one third of clinicians actually changed, in the second questionnaire, how they responded to the clinical case scenario questions. The improvement was towards using more prevention and delaying the treatment process in certain instances, according to the latest evidence-based research results. Clinicians were receptive to changing how they treat patients as a result of being engaged in the scientific process with their fellow clinicians [73].

Informal reports provided by clinicians also confirmed that collegial interaction has an important role in changing clinicians' approaches in clinical practice. The initial responses from clinicians prior to the meeting reported that less than one-third of respondents had any intention of changing diagnosis or treatment approaches to caries management. However, at the end of the meeting, these clinicians reported their intention to change their approach towards diagnosis and treatment of dental caries, thus taking the next step toward implementing change and translating the latest scientific evidence into regular clinical practice. This "change in intention" is consistent with the health change theory, which suggests that this step is a prelude to the subsequent "next step" of actually implementing change [74,75].

Acquiring new information is necessary, but not enough for a change in behavior [76]. This is why passive dissemination of knowledge, guidelines, and attendance at meetings are not necessarily effective for the translation of research into practice [77].

In addition to participating in annual meetings, one powerful tool for translation of the study findings is to create opportunities for practitioners to reflect on their own decision-making process and quality of care. At the end of each PBRN study, clinicians are provided a summary of their results in a simple and visual format (e.g., tables and/or colorful bar graphs) and the results of others in their region and network-wide. This approach discusses how PBRNs can have a direct impact on the translation of research into routine clinical care. Clinicians are given the chance to reflect upon their daily clinical practice and their choices in the delivery of dental care while comparing them to those from their fellow clinicians in a non-threatening manner. Therefore, they feel free to change as they learn from each other's results and taking their experience into account.

One of the reasons clinicians have reported joining the network is to have the opportunity to answer questions related to routine dental care. A significant amount of information offered to dentists seems to be manufacturer-driven, so there is a concern for bias. The desire to be a part of a community that has the possibility to generate research questions and to answer them with new knowledge is the main reason that clinicians join the network [78,79]. Other reasons for joining a PBRN are: (1) to provide a focus for clinical excellence by devoting increased short-term attention to one particular area of clinical practice at a time; (2) to

improve the logistics of daily clinical operations as they need to plan ahead of time when studies are taking place; (3) to serve as a team-building experience for practice staff, engaging the entire staff in the excitement of discovery and quality improvement; (4) to distinguish the practice from other practices, acting as a practice promoter or practice builder; and (5) to enhance communication with patients by showing that the practitioner-investigator cares about the scientific basis of clinical practice.

In PBRN research, practitioners are given the personal experience of exploring a question from its concept to the final stage of data analysis. PBRNs have the ability to use a variety of research methodologies including randomized clinical trials, observational and retrospective studies. Each of these different study designs have their own potential of resulting in greater impact on daily practice by being more easily adapted to the research environment. Not all methods of transmitting results have equal success in incorporating these results. Naik and Petersen [4] highlights the importance of developing connections between researchers and practitioners in dissemination of information and Innvaer and colleagues [80] conclude that increasing personal contacts and relationships between researchers and care leaders is an important facilitator of using evidence in making policy decisions.

Concluding remarks

Even though several long-term prospective studies have supported the repair versus replacement of restorations, these studies did not randomly assign the treatment ([81-83]. The results of the studies serve now as basis to obtain institutional review board approval for conducting randomized, controlled clinical trials which provide the highest level of evidence. Additionally, in order for these studies to be generalizable to most patients, they would be conducted in a general practice setting. The research conclusion of these studies will enable dentists and their patients to make educated decisions based on evidence.

Traditional federally-funded or corporate-funded research in academic institution has significant value that can complement the studies that are conducted in PBRNs.

Academic research addresses different questions that can provide more rapid answers to clinician's questions and lead to follow-up by PBRNs. In a controlled setting, researchers can undergo calibration exercises and the risk factors of study populations can also be more carefully controlled. Results from pilot and preliminary studies can then lead to relevant questions for PBRNs to pursue.

The results from PBR can be more generalizable to the public at large, therefore it facilitates the application of the findings for policy changes and the establishment of standard of care.

PBRNs can be an effective venue for translation of research findings as participants serve as change agents.

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