Translational Research in the Oral Health Sciences

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Abstract

From basic biomedical through implementation science, the goal of health research is ultimately to improve the health of populations. In this chapter, translational health research is defined and its rationale described. A variety of cross-disciplinary, or team science, approaches to study complex health issues are also described; these include multidisciplinary, interdisciplinary, and transdisciplinary collaborations. While there is a broad and general acceptance of team science, academic institutions and funding agencies are still in the process of developing appropriate benchmarks that will enable the assessment of the contributions of individual researchers involved in team science, as well as promoting initiatives to encourage and sustain these types of research teams.

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The primary aim of government funding for biomedical research is to improve the health of the population. While health research over the past decades has significantly increased life spans and improved population health, it is also recognized that scientific discoveries do not always translate to health [1]. Furthermore, those discoveries that do manage to reach clinical practice become obsolete relatively fast, since the length of time needed to move discoveries forward in the translation process is very long [2]. Thus, governments and funding agencies are encouraging scientists to take different approaches to research that will enhance and accelerate knowledge and product translation. The primary framework that has been proposed to accomplish this is through translational research [3, 4].

1.1 Definition of Translational Research in the Biomedical Sciences

The exact definition of biomedical translational research is still being debated [5]. However, to put it simply, *biomedical translational research* is the concept of "bench to bedside," a unidirectional view that has since been expanded to recognize the fact that translation can (and does) occur bidirectionally among the five steps of the continuum (Fig. 1.1) [6, 7]. In fact, the impetus for much of our basic research (apart from pure

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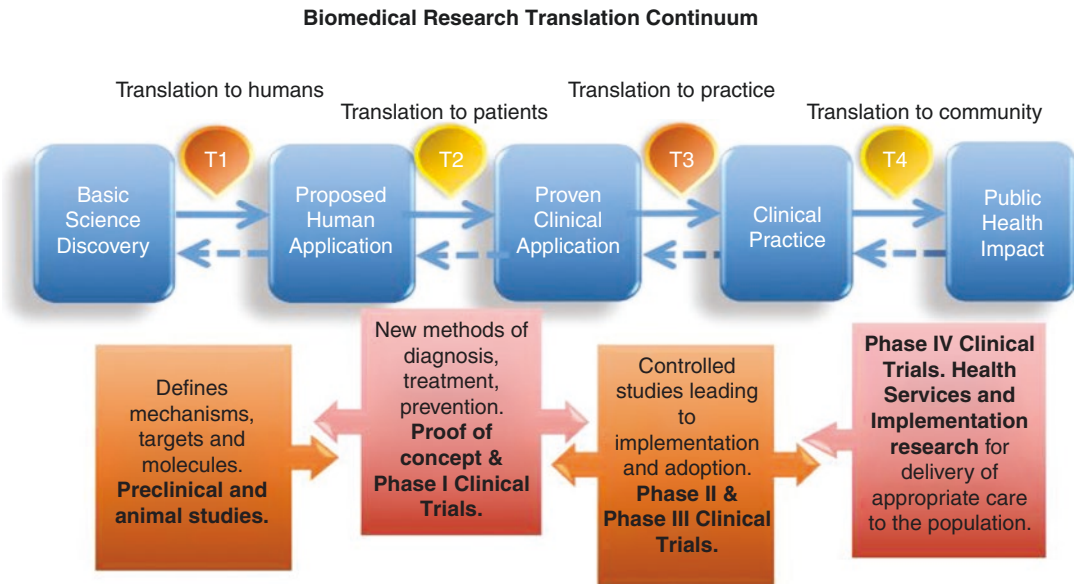

Adapted from Drolet & Lorenzi, 2011 and Fernandez-Moure, 2016

Fig. 1.1 This figure depicts the four translational phases in the biomedical research translation continuum (T1–T4) and provides examples of methodological approaches that are used within each phase

discovery research) is buttressed by clinical and epidemiologic evidence of the impact of various diseases on individuals and populations.

Most models of the biomedical translational research continuum illustrate a path for product development. The model shown in Fig. 1.1 depicts five steps (in blue) that range from "Basic Science Discovery" to "Public Health Impact." Translation occurs between each of these and can move in both directions. The boxes below the blue steps are descriptions of some of the types of research approaches that are used in each step.

Following this model, let's consider the example of a vaccine to prevent dental caries:

Basic science research uses a variety of laboratory methods to test various component(s) in the development of a vaccine product. This product is then tested in animals to determine whether it works in the intended manner, what concentration appears to be effective, and what, if any, side effects occur.

If it appears that the product is safe and effective in an animal model, then T1 (translation to humans) occurs. The product is tested in a few humans in Phase I clinical trials to determine safety, maximum tolerated dose (MTD), pharmacokinetics (what the body does to the product, e.g., absorption, distribution, metabolism, and excretion), and pharmacodynamics (what the product does to the body, e.g., biochemical and physiological effects).

Provided the Phase I testing is positive, Phase II clinical trials are undertaken to further determine safety and effectiveness. These involve very small groups of the vulnerable population(s); in the example of a caries vaccine, this population could be made up of those who are at a high risk for caries, i.e., young children or older people.

Following this, T2 can begin, involving translation to Phase III randomized clinical trials. In these studies, the vaccine is tested in a larger group of vulnerable people who are randomly assigned to either the experimental or to a control group (placebo or a standard treatment).

If the experimental treatment (vaccine) is shown to be superior to the control, then the T3 translation to clinical practice can be initiated. This is when knowledge translation becomes highly important, because changing clinical practice is an enormous undertaking. Thus, efforts in

training dental students and the development of technologies/methodologies that can assist dentists in successfully carrying out evidence-based practice are crucial to this translational process.

Once the new vaccine is accepted and used by dentists, then T4 (from clinical practice to the community) is initiated. Efforts aimed at implementation of programs to deliver the vaccine can be developed and tested; furthermore, the effects of the vaccine on the incidence and prevalence of caries in large populations can be determined, including economic analyses for the most cost-effective preventive programs.

1.2 What Is Needed to Carry Out Biomedical Translational Research?

The most viable way to facilitate research translation is through research collaborations with those in other disciplines who are interested in investigating the same topic [8]. "*Collaborative methods for scientific research are increasing in importance as scientists are tasked with researching the world's most complex problems. The complexity of these issues requires scientists to transcend their own disciplinary boundaries and create teams to assess the interconnected network of systems associated with the problem*" [9]. Known as "cross-disciplinary" or "team science," these collaborative approaches can be multidisciplinary, interdisciplinary, and transdisciplinary [10]. The terms are distinct from one another in the following ways:

Multidisciplinary—This is team science research in which a health condition is studied by experts within their own discrete disciplines, individually following separate protocols either independently or sequentially. Although these researchers meet together in order to redefine problems and develop more comprehensive assessments of the health condition, each remains fully entrenched in his/her own disciplinary approach [11].

Interdisciplinary—This is also team science research in which a health condition is examined by experts in discrete disciplines. However, these experts work together to develop and carry out protocols that incorporate the conceptual and methodological approaches inherent to each of their respective fields [11].

Transdisciplinary—Transdisciplinary research is posited to be the highest level of collaboration among scientists [9]. "*It is an integrative process in which researchers work jointly to develop and use a shared conceptual framework that synthesizes and extends discipline-specific theories, concepts, methods, or all three to create new models and language to address a common research problem*" [8].

For expert scientists to succeed in translating their research, it is important for them to understand the translational research process, in addition to having a general understanding of other research approaches along the translation continuum [12]. One can easily begin the process by asking a colleague from a different discipline how she/he thinks about a particular oral health condition. Conversations like these can inspire ideas for team research projects.

1.2.1 Graduate Student Training

A key ingredient to successful change in research practice is through graduate training. Potential graduate trainees should be screened to determine whether they have the necessary personality characteristics for translational research; this includes having the ability to communicate and collaborate with others.

Disis has described the qualities of graduate trainees who would be successful in transdisciplinary research. "Future translational researchers of all ages must be adaptable, life-long learners. They have to be highly curious about a lot of different things, collecting data and ideas from the basic literature and creatively applying these to disease solutions. This means being outside your comfort zone, reading literature that is way outside your field" [13].

What skills do we need to instill in our graduate students that will encourage and prepare them for translational research success? The first step is to give graduate trainees a solid understanding

of their own and other disciplines, along with the vocabulary used in the language of these disciplines. Since mastering one discipline is very time-intensive and is still the primary goal in our present models of graduate training, we need to develop teaching paradigms that will provide our graduate trainees with a comprehensive knowledge of other disciplines in an efficient manner. This will enable our new researchers to communicate effectively with researchers from many different disciplines in order to enable them to successfully lead or participate in team science groups.

For example, a team science course can be designed in which researchers from a variety of disciplines will describe the theoretical underpinnings, including how each of their disciplines develops hypotheses, the ethical issues specific to each, methodological approaches, analytic techniques, interpretation of findings, knowledge translation, etc.

Along with associated readings and group assignments, the student will be better equipped to expand his/her thinking about specific health issues and to better determine how to address those issues through appropriate research approaches.

Some groups have published competencies and ideas for translational biomedical graduate research training programs that provide knowledge and skills to graduate trainees [14–17]; furthermore, while there are still relatively few active training programs, some have already been assessed for success [16].

1.2.2 Publication of Translational Team Science Research

Health research journals need to be prepared to publish multiauthored translational research reports. Adequate space for these complex reports should also be made available. Editors should understand that a greater number of reviewers in the assessment of translational research reports may be needed. If a series of reports are written from one translational research project, the authors may wish to publish their work in a series. Journal editors should be open to considering a variety of publication options for these authors. Publication of translational research is a topic of interest for editors of journals in health research.

The relatively new IADR/AADR publication, the JDR Clinical and Translational Research (CTR), provides a platform in which oral health translational research reports can be published. The journal was designed specifically to allow for multiple authorships and longer reports that will serve the specific publication requirements for this type of research.

1.2.3 The Role of the Institution

Universities and funders that are interested in promoting translational research must consider and act on a variety of issues. The process of creating and sustaining translational research teams requires more than merely the desire of researchers [18]. Universities and funding agencies will need to provide reasonable, but wholehearted, financial and infrastructure support to make team sciences initiatives successful.

University promotion and tenure committees have traditionally judged the productivity of researchers through the number and quality of journal publications, order of authorship, and funding, in addition to administrative and teaching contributions. Team science research necessarily involves teamwork in which authorship order and contributions to protocol development are not clearly obvious. This means that the documentation required to support an individual team member's tenure/promotion must include descriptions of the team member's role (in relation to others in the team) for every aspect of his/her work. Universities must put effort into developing appropriate criteria and ensuring that their committee members understand how cross-disciplinary research teams function. Committee members should be trained in the best ways to judge the productivity of an investigator who carries out team research. The criteria presently used for an independent researcher who follows a traditional discipline-specific path cannot be used for team science investigators [19, 20].

Conclusion

Translational team science research has begun. While there remain many issues that must be resolved, it is imperative that we begin to think about complex oral health conditions beyond our individual disciplinary lenses.

An understanding of the biomedical translational research framework is fundamental for the effective investigation, development, and uptake of new preventive strategies and therapies to cure or mitigate disease symptoms. Translational research offers a platform for the use of team science research approaches to complex health problems in which a variety of relevant disciplinary lenses are focused on one particular condition.

> Science is a collaborative effort. The combined results of several people working together is often much more effective than could be that of an individual scientist working alone (John Bardeen [21]).

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