The Department of Medicine comprehensive training program in Translational Medicine

Mission
“To train the next generation of effective translators of discovery to patients, populations and health services, improving the health and quality of life of patients”

Steering Committee
Evangelos Michelakis
Gavin Oudit
Atul Humar
Raj Padwal
Ross Tsuyuki

Administration: Eleni Karageorgos

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Overview

The Department of Medicine (DOM), in keeping with the current trends in modern medical research and education, recently made Translational Medicine (TM) its top priority. TM is a new discipline that facilitates translation of a molecular discovery to actual patients and populations. TM requires a different way of thinking at all stages of the journey from the discovery in an animal lab, to the point that the government approves and pays for the resulting therapy on humans (1, 2). Although all recognize the importance of TM there are surprisingly very few examples of training programs worldwide that aim to teach this new discipline to the future medical researchers and leaders. The DOM offers advanced graduate degrees (Masters) in “Experimental Medicine” based in part on three Department-based graduate courses (Med 671, 700, 701). We are integrating these 3 courses into a two-year program with a revised innovative curriculum that aims to effectively teach the principle and practice of TM. By attending the two-year program students can pursue their advanced DOM degrees on a TM-track. This will be the first program that will train students in TM not only in the UofA but in Canada as well. With its many innovative features this program could be a leading program in the country and attract students from the DOM, many other UofA Departments and potentially globally.

The changing landscape of Medicine and the need for training in TM: It can be argued that the greatest advances in medicine, i.e. antibiotics, anesthetics or transplantation, have all occurred more than 30 years ago. During the past 30 years, despite the explosion of efforts and funding in medical research, we have made great progress in molecular biology and in curing disease in animals but little progress in reversing disease in humans. For example, it is clear that we can “cure” cancer or heart disease in animals but we have made little progress on having a meaningful impact on reversing these top killers in humans. New discoveries in genetics suggest that it is possible that treatments can be customized for specific groups of patients as opposed to all patients with a disease. This “customized” approach is called Personalized Medicine (PM) and restricts the use of therapies only in sub-populations of patients that have the highest chance of positive response and the lowest chance for adverse effects (3). The way to reach the objectives of PM is through TM and efficient and “personalized” translation of basic research findings to patients and populations. This requires a new approach to research, clinical practice, health administration, regulatory processes and new partnerships between academia, industry and regulatory bodies. The medical community, governments, regulatory authorities and funding agencies agree that it should be Medicine’s highest priority (4-7). Unfortunately this realization has not reached medical education yet. At this point medical research is mostly done in silos of focused groups in narrow disciplines, missing the opportunity of harmonized and synergistic efforts to efficiently and effectively translate the research finding to treatment or policies for human disease. Unfortunately the same approach is currently practiced in medical education. While students may be exposed to breakthrough molecular biology findings in Alzheimer’s disease in one course, they may be exposed to the challenges of the management of Alzheimer’s disease in real patients in another course a year later or never. They may never be exposed to the challenges of conducting a large clinical trial or implementing a health system policy for Alzheimer’s disease.
Training in TM ensures that these silos are broken and students are exposed to the whole continuum of “molecule-animal-human-population-health services” (Figure), preparing them to excel in the new landscape of Medicine.

In the USA and Europe, there have been intense efforts over the last five years to build such programs. The Howard Hughes Institute (8) and Wellcome Trust (9) have launched specific competitions for the funding of training programs in TM. Specific programs in leading Universities have now started reporting their first experience, including Stanford (10), University of California Davis (11), University of North Carolina (12) or University of Edinburg (13). However, none of the existing programs world-wide aims to cover the whole continuum of TM all the way from genes to health services, although it has been recently advocated (14-18). The nature of the faculty of our DOM which includes basic scientists, clinician scientists, epidemiologists and health services researches in each of our four priority themes offers us the opportunity to conduct the first integrated TM training program in the world.

Description of the Program: Over a 2-year cycle of weekly seminars and retreats the trainees will be exposed to comprehensive themes that cover the whole spectrum of TM. Some of the major themes include: a) chronic and degenerative diseases of aging, b) inflammatory, infectious and diseases of immunity, c) diseases of metabolism and obesity and d) vascular disease, reflecting our recently identified strengths and research priorities of the DOM. Rather than focusing on details of each of the components the TM continuum (Figure), each session will focus on the integration of all the pieces, its challenges of doing so and the innovative ways to overcome them:

- **Innovative “mix and match”, “modular” seminars**: A clinically-oriented, case-based approach will be followed. The seminars will consist of a 15-min presentation by faculty followed by 1-2 10-min presentations by trainees, leading to constructive and focused discussions around TM challenges and priorities. For example, in a single seminar on neurodegenerative diseases, the students will be expected to come prepared, having studied a package of a short case presentation of a patient with early onset dementia and articles on the pathogenesis, clinical management and impact of neurodegenerative disease. During the seminar a clinician scientist will present on “recent developments on applied research on humans with Alzheimer’s disease”, a graduate student from a basic science lab will discuss the “relevance of animal models to clinical priorities of Alzheimer’s disease” and a student from an outcomes lab will present the “importance of biomarkers for early detection of Alzheimer’s and their economic impact on health services”. The discussion will be based on pathways to allow early translation of preclinical work to humans, the role of integrative teams of research, regulatory and funding strategies and policies to optimize the cost effectiveness of interventions in prevention and treatment. The discussion will be followed among the students in the program’s dedicated “virtual café”.

- **“Real life skills retreats”**: These seminars will be supplemented by a series of retreats (3/year) focusing on “real life skills” required in modern TM; for example: challenges of early-phase or “first in human” clinical trials, Health Canada regulatory principles, strategies and principles of fundraising for investigator-driven trials, patent and commercialization laws.

- **“Crossing the fence” rotations**: Trainees will be offered direct exposure to the segments of the TM continuum that are “across the fence” and not covered by their traditional training environments. A “bench to bedside” as well as a “bedside to bench approach” will be followed in all of the themes. Assignment of a clinician scientist mentor for each student, in addition to their primary supervisor, will facilitate this training experience in a “customized manner”. For example, a graduate student working in a biochemistry laboratory using a worm model of neurodegeneration will attend selected Alzheimer clinics providing direct access to patients and their families. A student working in a pharmacology laboratory using a rat model of ischemia-
reperfusion and aiming to develop therapies for acute myocardial infarction, will spend time in the catheterization laboratory where patients undergo ischemia-reperfusion during the management of their myocardial infarct. Conversely, a student working on the role of health services regulating expensive biologics used in the treatment of arthritis, will spend time in a laboratory that studies in vivo models of inflammatory diseases and develops such therapies, in order to understand their mechanism and challenges in developing them.

Objectives: Our overall objective will be for the graduates to be effective “Translators of Discovery and Knowledge”. Although these skills and attitudes have not yet been clearly articulated in the literature, we will take this opportunity to prospectively develop and evaluate them as part of the educational research component of our program, as described below under “evaluation”. Our graduates will be able to:

• identify and effectively navigate through the regulatory and quality control steps from bench to bedside, including emerging ethics issues in both animal and clinical research.
• display skills and attitudes required for collaboration within multidisciplinary professional groups.
• analyze and use modern statistical methods commonly used in both basic and clinical research.
• determine the relative financial and social cost implications of new therapies from basic science to health policies and succeed in team grant writing as well as several forms of modern fundraising.
• design basic science experiments with a specific therapy in mind and execute animal experiments in a manner that will optimize their translational potential to early phase human clinical trials.
• master the general principles of molecular biology and genetics required to better design and execute health policies and select the most promising preclinical findings for advancement in the PM corridor.

There will be two major tracks that would prepare the trainees for TM careers in either the Academia or the Industry and Government: 1) Academic track: The students will be prepared for successful academic careers, pursuing postdoctoral fellowships and junior faculty appointments. The ideal graduate will eventually lead translational research programs, apply for large team and project grants focusing on TM, perform early phase investigator-driven trials, run biomarker discovery programs, direct PM clinical programs etc. 2) Industry (Biotech and Pharma) and Government track: As many of the components of the TM continuum are not taught in traditional training programs, the graduates of the programs will have a strong advantage when applying to such jobs, particularly in the Industry. Government agencies, like Health Canada that eventually drive all aspects of applied research and the resulting clinical products, are also in need of well-trained scientists. We plan to consult early on with Industry (with key CEOs of Biotech and Pharma companies through the FOMD office of Industry relations and TEC Edmonton) and Health Canada in order to get their advice on their ideal employee. In return, we will set up short internships (1-2 months) that selected trainees will be able to take in participating Biotech, Pharma or Health Canada. A successful bi-directional interaction may form the basis for these agencies to sponsor us financially as well.

Participating Faculty: The DOM is an ideal leader for this initiative that can eventually link to many other Departments and Faculties. The main mission of the DOM is to promote TM. The core faculty of the program, which will be supplemented by faculty from other Departments and Faculties, consists of 60 faculty members with expertise throughout the TM continuum in all of the themes described above. No other Department has this breadth of TM expertise waiting to be tapped. These professors were recently selected out of our >250 members, following a research exercise and applying strict criteria of successful mentoring and research and international recognition. Over the past 5 years, these 60 professors alone have published 3,019 papers, their work has been cited 28,992 times and they have raised 34.1 million from the CIHR alone, highest than any other Department at the U of A. A Steering Committee
composed of a multidisciplinary team of experts in translational medicine, education and education research will be responsible for the structure and curriculum.

Innovation

The **major innovations** of this program include:

- **A foundation of integrated seminars** covering the TM continuum in a single setting at a time.
- **“Across the fence”** rotations and targeted internships that along with the focused retreats, will teach real life skills and attitudes that are currently not offered in any of the existing traditional training programs. In addition, the program will also feature several **novel components**:
  - **A virtual digital environment** that will facilitate the use of multimedia teaching material, real-time testing as well as a discussion forum driven by the trainees, supported by the use of tablet computers.
  - **Lectures** by leading faculty from all over the world, either in person or via video-conference. Selected international TM leaders will be invited to give the seminar and spend the day with the students. Expenses for this will be covered by the DOM since these scientists will be asked to stay and deliver grand rounds the following day. Three times a year, we will invite a TM expert from Industry, Health Canada or leading academic programs already running and publishing their experience with TM training (like the TM program directors from Stanford, U of North Carolina etc). These experts, in addition to teaching at the seminar, will be meeting with the steering committee and consult on our evolving growth of the program. They will form a multidisciplinary dynamic **Advisory Board** which will advise us on keeping the program on track and evaluate us at 3 years on whether we are achieving our goals or not.
  - **Digital capture of all seminars** (pod casts of all sessions with synchronized multimedia slides and video recordings of selected seminars, particularly of the visiting speakers) that will form an archived package of the whole program available to all. This package can be sold to industry for the training of their employees in exchange of unrestricted funding of the program.
  - **An ongoing education research** program (as described in program evaluation below)

Sustainability

This program is not the effort of a single faculty member. Rather, it is the DOM’s major front in graduate medical education and it has the strongest possible support from its leadership. As we grow, we plan to also apply to every major source of relevant funding, provincially and nationally. Our plans include the formation of partnerships with Industry and Health Canada that could contribute with unrestricted funding. We will also look for contribution from the education budgets of other Departments and Faculties that will have access to our program whose students will benefit from training in TM, including the Nanomedicine Institute, Chemistry or Biomedical Engineering.

Collaborations and Timeline

**Year One** will focus on effective engagement with faculty and students from other Departments within the FOMD. Although the core faculty will consist of the 60 professors that we describe above, at least 30% of the teaching faculty will come from other Departments, including Biochemistry, Pharmacology or the Institute of Personalized Medicine. **Year Two** will focus on integration with other Faculties and local agencies, including the Institute of Nanotechnology (Nanomedicine is a new principle that although it is playing a critical role in modern PM, both in diagnostics and therapeutics, it remains relatively unengaged to the efforts of the DOM both at the faculty collaborations and training levels; this could evolve to be a major strategic partnership). **Year Three** will focus on reaching out to external
programs, as our own program will be maturing. These include strategic partnerships with Stanford’s “MOM program”, Health Canada and Industry. **Year 4+** will focus on the outcomes of our evaluation procedures and **Dissemination** of our experience and findings. The experience of the first 3 years of this new program will be published as well as the results of our prospective evaluation projects, discussed below. At this point the program may become open to all UofA students, as well as to Industry, including an online track. Our digital Education Product will be offered to Canadian Universities for free and sold to non-Canadian Universities or Industry, under the appropriate IP protection through TEC Edmonton.

**Evaluation**

Via interviews with industry, government and research training leaders (our Advisory Board), we shall use qualitative methods to develop a draft list of what best predicts these skills and attitudes that are expected to help promote successful TM efforts. To develop specific learning objectives and evaluation tools, we will follow the classic Context, Input, Process, Product (CIPP) model (20). There are currently no published accepted measurable skills that predict success in TM; thus this effort will be “a first” and testing these skills prospectively, a major research project with a significant potential impact in the field.

1) We will develop assessments that best predict these skills and attitudes and test the trainees at the time of entry and exit from the program. We will collaborate with the FGSR and offer the same assessments to a similar group of biomedical trainees that do not enter our program, at their entry and exit. We will also collaborate with a matched program from an American University with a TM program. Assessments will be designed to determine the degree that our graduates have achieved these objectives and will be applied to the other groups for comparison and evaluation.

2) Over a longer period of time, we shall track our graduates as well as graduates of the UofA students in biomedical training outside our program and record their successes or failures in terms of securing TM-focused jobs and tri-council grants during their training and the first 3 years of their first academic job.

3) Assess the satisfaction of students at the end of each year in terms of their assessment of reaching the programmatic and individual goals. A student representative will be in the steering committee and programmatic adjustments will be made to better accommodate constructive student suggestions.

**Interactions/Collaborations in Research and Training between the DoM and the U of A**

Interactions and collaborations among our members but also between us and the rest of the UofA campus are critical for our success and visibility, in both research and education. We systematically tracked for the first time the interactions of our members within the U of A community and we are proud to show how interactive our DoM is. For example, in the last 5 years, 44 DoM faculty members have established at least 60 active collaborative projects involving 97 interactions with non-FOMD faculty across the UofA campus. In the last 5 years, 89 DoM faculty members have served on Graduate Committees for 497 students from 25 Faculties outside of the FOMD. Collaboration is a core value of the DOM and we are very open to partnering our education and training efforts with those from other departments and faculties such as Pharmacy, School of Public Health, Nursing, Surgery and Biomedical Engineering. As such, this program will be open to students from these Departments (our biggest collaborators).

**Summary:** the DOM TM training program will allow graduate students in the DOM that pursue our already approved Master and PhD degrees in “Experimental Medicine” to follow a TM track that would give them a tremendous advantage in either Academia or Industry/Government careers. **No such program currently exists in the UofA.** This 2 year program has several innovative features and will be the first in Canada, with a potential to develop leadership in TM training world-wide. This program will also be open to many other Departments that share interests with us in TM. Despite being one of the
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biggest and most research-intensive Department in the UofA, the DOM does not receive as much support for our graduate programs as other Departments do (for example, we have no teaching assistanships available to our students). We hope to receive the support we need as we believe this program could become a jewel in the UofA that could attract students globally.

References

10. Stanford University: Master of Medicine (MOM) degree: http://msm.stanford.edu/