Tackling Scientific Frontiers During Undergraduate Medical Education: Thinking Outside the Steps

TEXAS TECH UNIVERSITY HEALTH SCIENCES CENTER EL PASO
Paul L. Foster School of Medicine

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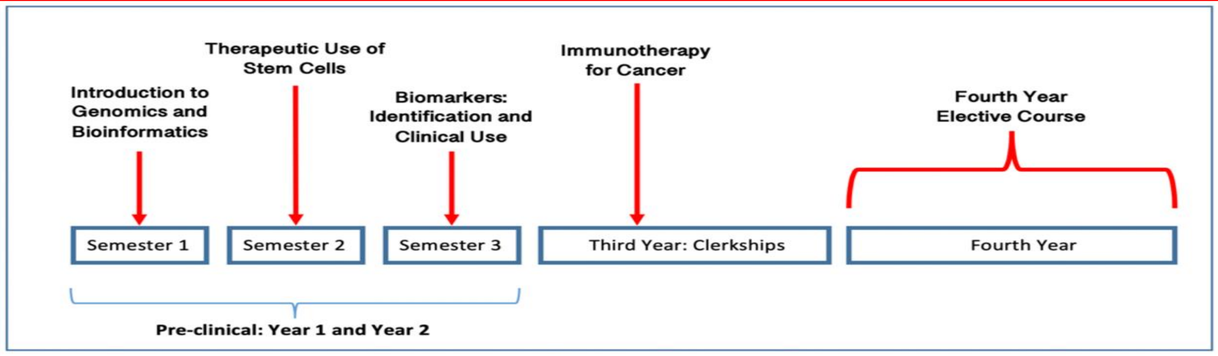
BACKGROUND

Despite efforts to introduce cutting-edge biomedical advances into undergraduate medical curricula, only a small percentage of medical students feel that their education has prepared them for an era of personalized medicine (1). While the majority of undergraduate programs include genomic topics in the first two years of medical school, personalized medicine is included as a topic in only 21% of medical school curricula (2). In addition, many physicians feel unprepared and are reluctant to apply scientific advances to everyday practice (3, 4). Further, integration of basic science and emerging research at multiple levels of the undergraduate medical curriculum continues to be a strategic priority. However, barriers to provide such content include the heavy academic workload and insufficient instruction regarding scientific research (5, 6). One approach to increase student exposure to personalized medicine is to design a curriculum thread that spans the 4 years of undergraduate medical education (UME) (7). Here, we describe the design of a novel spiral curricular approach to incorporate such content into the curriculum at The Paul L. Foster School of Medicine (PLFSOM), and present results of two pilot sessions.

METHODS and RESULTS

- We sought to evaluate the outcomes of a new session "*Hot Topics in Cancer Precision Medicine*" using a one-group pre-test and post-test observational analysis. An anonymous course evaluation questionnaire was completed at the beginning and end of the session using the Poll Everywhere (PollEv) software.
- We used the McNemar statistical test to determine improvement in students' abilities based on the pre- and post-survey responses. There was a significant statistical difference between the numbers of participants moving from Disagree to Agree, compared to those who moved in the other direction (**Table 1**).
- Feedback from "Hot Topics in Cancer Precision Medicine" session was well received (**Table 1**). The majority of the students (55 out of 66 students, 83%) found the session to be useful. Approximately 90% of the student-respondents would seek additional opportunities to learn about precision medicine, and implement related technologies for the benefit of their patients. In the pre- and post-surveys, the students were asked to evaluate their ability to explain to others the clinical uses of: 1) Next Generation Sequencing; 2) Dendritic Cell therapy; and 3) Chimeric Antigen Receptors. Answer selections were "Agree" or "Disagree."

ACTIVITY



	Semester 1	*Semester 2*	*Semester 3*	*Third Year*	*Fourth Year Elective*
Session Prep Materials	**Introduction to Genomics and Bioinformatics** o High-throughput biology o Next Generation Sequence Data o Eukaryotic chromosome o Human genome	**Therapeutic Use of Stem Cells** o Stem cell biology o Induced pluripotent stem cells o Therapeutic strategies	**Biomarkers: Identification and Clinical Use** o Molecular biomarkers o Imaging biomarkers	**Immunotherapy for Cancer** o CRISPR o CAR-T therapy o Dendritic cell therapy	**Clinical Pathology Technology** o Microscopy / Immunohistochemistry; o RT-PCR o GC-MS and MS/MS (tandem mass spectroscopy).
Session Format	**Case presentations** Discussion with audience response questions (PollEv)	**Case presentations** Discussion with audience response questions (PollEv)	**Case presentations** Discussion with audience response questions (PollEv)	**Case presentations** Discussion with audience response questions (PollEv)	**Wet lab simulation stations** o Immunofluorescence detection of cancer biomarkers o RT- PCR detection of viral genomes o Proteomic detection of endometrial cancer biomarkers

Fig.1 Chronology and outline of Personalized Medicine Modules. (A) Three sessions are embedded within the preclinical Years 1 and 2, with an additional session in the third year and an elective course offered in the fourth year. (B) Learning materials and format are indicated for the 4 single sessions and the elective course.

A) Ability to explain clinical uses of Next Generation Sequencing in cancer to others

		Post-Survey: *Agree*	Post-Survey: *Disagree*
Pre-Survey	*Agree*	15	1
	Disagree	27	7

*p < 0.0001 [McNemar's Test]

B) Ability to explain clinical uses of Dendritic Cell Immunotherapy to others

		Post-Survey: *Agree*	Post-Survey: *Disagree*
Pre-Survey	*Agree*	16	1
	Disagree	29	2

*p < 0.0001 [McNemar's Test]

C) Ability to explain clinical uses of Chimeric Antigen Receptor T Cell Immunotherapy to others

		Post-Survey: *Agree*	Post-Survey: *Disagree*
Pre-Survey	*Agree*	11	0
	Disagree	29	10

*p < 0.005 [McNemar's Test]

Table 1: Ability for students to explain clinical uses of Next Generation Sequencing (**A**), Dendritic Cell Immunotherapy (**B**), and Chimeric Antigen Receptor T cell therapy (**C**).

Currently implemented Sessions

Therapeutic Use of Stem Cells:
A 2-hour session was presented to 1st year medical students entitled "Introduction to Translational Research: *Therapeutic Use of Stem Cells*." This introduced students to basic stem cell biology and the ongoing efforts to use stem cells in regenerative therapies. The session included an introduction to existing types of stem cells, related terminology, biological characteristics and potential therapeutic applications. Pulling current clinical research scenarios (including renal, cardiac and pulmonary cases), students discussed in small groups the potential challenges and possible solutions utilizing stem cells and presented their approaches to the class for further discussion.

Hot Topics in Cancer Precision Medicine:
A 2-hour session entitled "Hot Topics in Cancer Precision Medicine," was given as a bridge between various clerkships in the third year. The session included introductions to: 1) cancer genomics; 2) cancer immunotherapy using dendritic cells and Chimeric Antigen Receptor (CAR) T cells; and 3) clinical uses of clustered regularly interspaced short palindromic repeats (CRISPR) technology. The content of the session was based on literature review and included scientific topics that are also covered in the lay press.

SIGNIFICANCE

- Outcomes from this intervention demonstrated student interest in learning about and applying advances in personalized medicine to their future practice. There was an increase in medical students' comfort in explaining current biomedical advances to others and a positive outlook regarding the activities.
- Our initial implementation of this initiative had some overall limitations including the need to phase the sessions into the curriculum across several academic years rather than all at once. Due to this phased-approach, we were unable to uniformly assess the impact of the innovative sessions. As we move forward, we will develop an appropriate umbrella evaluation to determine the overall impact and learner satisfaction of our longitudinal spiral learning innovation.

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