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Abstract

Background

Innovation and entrepreneurship are central to healthcare. Physicians are ideally positioned to create sustainable healthcare innovations. However, few medical programs in Canada provide training for students to pursue innovation and entrepreneurship. We created the Entrepreneurship in Healthcare Seminar Series (EHSS), a novel initiative designed to teach medical students about developing innovations and launching entrepreneurial ventures. We evaluated the EHSS based on medical student feedback and suggest future directions.

Methods

EHSS consisted of seven sessions per academic year, each led by a physician-entrepreneur. The session topics outlined a methodological approach to developing a medical start-up, from ideation to implementation, including a formal talk and question/answer period. Quantitative and qualitative evaluations of the program were acquired from anonymized feedback forms with quantitative questions rated on a 5-point Likert scale.

Results

From October 2020 to May 2022, there were a total of 258 unique attendees, of which 199 completed feedback forms (77.1%). 88% of attendees agreed or strongly agreed that the sessions were engaging and well-organized, learning objectives were met, and skills gained will be useful in practical settings. Three key themes arose from attendee open-text responses: importance of aligning personal and professional values with entrepreneurial pursuits, significance of mentorship, and that innovation requires proactive identification of healthcare gaps and creative solutions.

Discussion

Through EHSS, medical students gained a comprehensive overview of medical entrepreneurship and networking opportunities with physician-entrepreneurs. Future work involves expanding the seminar series to include an experiential learning component to apply foundations learnt from the lectures while receiving mentorship.

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INTRODUCTION

The ability to design, develop and implement patient-centered solutions is critical for tackling complex healthcare issues. Design thinking and innovation are necessary for addressing many clinical needs and health systems challenges, such as novel diagnostic and therapeutic technologies [1]. Entrepreneurial frameworks in this context ensure that interventions are feasible and sustainable [2]. The introduction of innovations also requires the development of meaningful relationships across disciplines, thus promoting entrepreneurial spirit fosters collaboration and opportunities to expand the way that medicine is practiced [1,3].

Physicians are ideally positioned to work within interdisciplinary teams and create sustainable healthcare solutions, given their clinical expertise and first-hand experiences with healthcare challenges. Despite this, teaching entrepreneurial skills and concepts in management and healthcare leadership is rarely integrated in the medical education curriculum [1]. Some institutions have introduced MD/MBA and MD/MEng programs to provide interested students with entrepreneurial education and experiences that would otherwise be missed in regular medical education [4,5]. While extracurricular design challenges and incubator initiatives present opportunities for medical students to experiment with design thinking, they do not provide formal teaching on entrepreneurship or management in medicine. Dual degree programs do not meaningfully engage all medical students, nor do they specifically focus on teaching methodologies in medical entrepreneurship [6]. Combined programs are also resource intensive and often require medical students to extend their time in training [7]. Furthermore, lack of coordination across faculties presents difficulties for creating integrated curricula that specifically train physician-entrepreneurs [4,5].

Ideally, entrepreneurial education and leadership skills should be embedded into medical school-wide teaching models, thus providing all students, including those who may not have initial interest in entrepreneurship, with the necessary exposure and skills to innovate and respond to healthcare issues. Through focused and structured experiences, medical students will learn how to recognize gaps in healthcare processes and build novel models with successful outcomes [1]. Acquiring an entrepreneurial skill set early in medical education equips future physicians with robustness in decision-making, collaboration and systems thinking. Expanding traditional medical teaching frameworks to include innovation and entrepreneurship offers students a broader perspective and encourages ways of thinking that will better address unmet clinical needs, improve patient outcomes, and advance our current health systems.

The Entrepreneurship in Healthcare Seminar Series (EHSS) was developed in 2019 to address the lack of formal entrepreneurship education in the current MD program curriculum [8]. The aim of the seminar series is to teach medical students about innovation methodologies and provide a systematic approach to the development of a medical start-up, from ideation to implementation. In this paper, we present an evaluation of the EHSS and implications of this pilot program for the expansion of traditional medical education into the realms of entrepreneurship and innovation.

METHODS

Program Design

EHSS was designed as an extracurricular program to introduce medical students to the fundamental principles of entrepreneurship in healthcare. The program committee developed the initiative between

May 2019 and September 2019, and EHSS was first launched in the 2019-2020 academic year. In this paper, we focus on the 2020-2021 and 2021-2022 academic years of EHSS, when the program was more refined and delivered virtually due to social distancing restrictions of the COVID-19 pandemic. The seminar series consisted of seven sessions, each approximately two hours in duration, delivered from October to May per academic year. Each session was designed and taught by a physician-entrepreneur, and six out of seven speakers were also founders and chief executive officers (CEOs) of their respective entrepreneurial ventures.

Each speaker created their lecture based on the session learning objectives (**Table 1**) and included anecdotes from their personal entrepreneurial journeys. The learning objectives for each session were informed by the Entrepreneurship 101 Framework, a validated approach for teaching entrepreneurial concepts that was developed by MaRS, North America's largest urban innovation hub [8,9]. This framework consists of five modules that teach learners how to define their startup idea, develop their value proposition, understand their target audience, carry out financial planning, and navigate business structures and regulations [9]. The MaRS Entrepreneurship 101 course developers granted our team written permission to refine their framework for medical students and inform the development of our learning objectives [9].

The format of each session began with a brief introduction of the EHSS program and statement of the specific learning objectives. This was followed by an introduction of the speaker, their didactic lecture for the first hour, and a facilitated question-and-answer period for the remaining time. Students who attended four out of the seven sessions were awarded a certificate of completion granted by the program committee. A certificate was offered to increase student interest in the initiative and encourage longitudinal participation in the program, allowing us to obtain constructive feedback and comprehensive program evaluations. The series was advertised to all medical students (years 1 to 4) at our institution, which includes approximately 200-250 students per year.

Program Evaluation

Medical student attendees were asked to complete anonymized feedback forms at the end of each session. The anonymized post-session feedback surveys were completed using Google Forms. The link to the Google Form for each session was shared with attendees via the Zoom chat and posted on a shared screen using a QR code for ease of access at the end of each session. The post-session survey consisted of demographic information (year of medicine, campus), six to eight questions graded on a 5-point Likert scale (four of these questions were identical across all post-session surveys and the remaining were specific to the learning objectives of the session), two questions regarding the pace and duration of the sessions, and three open-ended questions (**Supplement 1**). Responses to the open-ended questions were coded by two researchers (AM, HM) and consensus was reached by adopting Braun and Clark's six-phase approach to generate, modify, and define themes within the written feedback [10].

We determined that our study was exempt from review by our Institutional Review Board, given that students voluntarily completed anonymous Google feedback forms at the end of each session which did not require students to login to their Google accounts nor provide any identifying information. Furthermore, completion of feedback forms did not affect participation of students in the seminar series, as completion was completely voluntary.

RESULTS

Participant and Session Demographics

There was a total of 199 feedback forms completed by EHSS student attendees between 2020 and 2022, representing a 77% response rate (**Table 2**). From October 2020 to May 2021, there were a total of 172 unique attendees, of which 147 completed feedback forms (85.5%). From October 2021 to May 2022, there were a total of 86 unique attendees, with 52 feedback forms completed (60.5%). Approximately 74% (147/199) of all feedback forms completed were from the 2020-2021 iteration of the series. Of the attendees who completed feedback forms from 2020-2022, approximately 66% were 1st-year medical students (n=131), 25% were 2nd-year medical students

(n=50), and 9% were 3rd/4th-year medical student clerks (n=18) (Table 2).

The EHSS session with the highest total number of unique attendees was Session 2: "Introduction to Healthcare Entrepreneurship and its Role in the COVID-19 Response" (N=54), whereas Session 3: "How to be Entrepreneurial about a Skillset" recorded the highest number and proportion of feedback forms completed post-session (N=40, 87.0%).

Learning Objectives: Average Learning Objective Score

Across all years, the majority of students (>88%) agreed or strongly agreed (>4.0 average score) that the sessions were engaging and well-organized, that learning objectives were met, and that the knowledge and skills they gained will be useful in practical settings (**Table 3**). The overall average learning objective score was 4.55. Students responded most positively to facilitators sharing their personal experiences to enhance student learning (score = 4.61), as well as the general structure of the sessions (score = 4.58). The lowest average score was observed for the real-world applicability of the knowledge and skills gained in the session (average score = 4.47) (Table 3). All sessions of the EHSS received positive responses from attendees, with average learning objective scores ranging from 4.48-4.67.

Thematic Analysis of Open-Text Responses

Three key themes arose from a qualitative thematic analysis of attendee's open text responses; the importance of aligning personal and professional values with entrepreneurial pursuits, the impact of mentorship on developing an entrepreneurial skillset with the confidence to pursue ideas, and that innovation requires proactive identification of healthcare gaps and creative solutions (**Supplement 2**). Students consistently stated they gained insight into the significance of finding synergy between personal values and entrepreneurial ventures, suggesting that this theme was recurrent throughout multiple sessions (**Supplement 2**). Mentorship was also consistently reported to be a significant take-away for students, including identification of unique paths to entrepreneurship, how to apply diverse skillsets in entrepreneurship, and finding inspiration from the experiences and anecdotes of session facilitators. Finally, skills related to identifying healthcare problems, problem mapping, and how to develop creative solutions were cited by students as fundamental tools for medical entrepreneurship gained from the series (**Supplement 2**).

DISCUSSION

Our medical system is continuously seeking to enhance patient safety and quality of care, while balancing the need for increased efficiency and cost-effectiveness. Therefore, equipping physicians-in-training with the skills necessary to innovate and lead systems-level interventions within the healthcare industry is essential. Few studies have assessed the implementation and outcomes of informal entrepreneurship programs in medical school. Thus, we sought to elucidate the efficacy of such a program and inform promising next steps for the iterative improvement of similar entrepreneurship-related programs in medical curricula.

In the present study, medical students attended seven physician-entrepreneur-led seminars tailored to provide the basic tools to design, develop, and implement an entrepreneurial venture. Of participating student attendees, over 88% agreed or strongly agreed that the sessions were engaging and well-organized, that learning objectives were met, and that the knowledge and skills they gained in the program will be useful in practical settings. This lends preliminary evidence for the ability of a seminar-based program to sufficiently meet the MaRS masterclass "Entrepreneurship 101" learning objectives [9]. Students responded most positively to facilitators sharing their personal experiences in entrepreneurship. This finding aligns with research showing that lecturers who provide personal anecdotes of their own entrepreneurial experiences, offer professional advice, and tailor their content to the interests of their students, greatly enhance the quality of entrepreneurial courses [11]. Thus, encouraging speakers to reflect on their personal entrepreneurial journey, within session themes, should be a priority when developing and implementing entrepreneurial programming.

Students reported that they felt more encouraged to pursue personal passions and entrepreneurial ventures based on the personal stories and

mentorship offered by session leads. This theme aligns with a growing body of research that identifies the value of mentorship in entrepreneurship, specifically amongst novice entrepreneurs. Studies show that mentorship provides mentees with enhanced management skills, improved personal vision for their business venture, and a greater sense of self-efficacy [12-14]. Thus, providing supplementary opportunities for more tailored mentorship by speakers may assist students with developing confidence in their entrepreneurial goals. Students also highlighted the importance of aligning personal passion with entrepreneurial ventures as a key teaching from the series. These findings offer strong support for the introspection that entrepreneurship training equips students with. The understanding that personal and professional passions can complement one another is an indispensable concept that students may carry with them throughout their training. Through entrepreneurship education, medical trainees are encouraged to identify issues and topics that they are passionate about, thus inspiring them to pursue paths of interest that are personally meaningful, which may help to protect against burnout and enhance the quality of patient care [15].

The lowest learning objective scores were reported for the real-world applicability of the knowledge and skills gained in sessions. Although the average score remained >4 on a 5-point Likert scale, we recognize the importance of providing relevant and practical tools for students to apply in real-world settings. As such, several solutions may be explored to better meet this learning objective, including one-on-one mentorship opportunities with speakers and facilitated workshops after lectures to practice entrepreneurial skills, such as delivering an effective pitch or conducting market research. Ensuring a repertoire of speakers who can share their unique expertise in medical entrepreneurship may also greatly benefit students. Students enrolled in MD/MBA programs in the US identified acquisition of a broad range of skills as a key benefit of their combined program [16]. Topics relating to medical technology development, quality improvement, health information technology, and hospital management were particularly highlighted as useful [16]. Evidently, diversifying speaker expertise and expanding entrepreneurial-related topics may lend itself to providing more practical and applicable knowledge and skills for attendees.

A recent literature review in the New England Journal of Medicine emphasized that entrepreneurial skills are a vital competency for all physicians, given that patient care is shifting towards more team-based delivery models [17]. Specifically, soft skills of communication, leadership, and teamwork are enriched through entrepreneurship teaching and practice [16,18]. Seminars focused on building these competencies, including leadership skills, time management, communication, problem-solving, creativity, critical thinking, and adaptability, may provide students with more relevant competencies which they can apply to not only entrepreneurial settings, but also in clinical environments with patients and interdisciplinary teams.

We also recognize that the online delivery of entrepreneurial seminars likely contributes to discord between learning entrepreneurial concepts and applying such knowledge. Higgens et al. emphasizes that entrepreneurship requires experiential learning and hands-on experience to fully refine one's innovative competencies [19]. In our current program, students are not required to design or complete an entrepreneurial-related activity. Accordingly, providing students with the opportunity to pursue an entrepreneurial project or "field-experience" may be an important means to enhance the applicability of knowledge and skills taught in the program. One concern that arises is the potential for students to feel overwhelmed with taking on an additional project. To mitigate this, options such as participating in entrepreneurial games, field trips to healthcare companies, prototyping sessions, venture design competitions, or computer simulations may also be promising first steps [20-22].

We encourage the integration of entrepreneurship education into undergraduate medical curriculum, especially during pre-clerkship years. Similar to the importance of clinical experience in pre-clerkship for improving medical knowledge and guiding career decision-making, exposure to entrepreneurship in the early years of medical school allows for proactive career exploration [23]. Acquiring an entrepreneurial

skill set early in medical education also equips students with skills to better address unmet clinical needs and improve our current health systems. These are key competencies that are important to seed at the beginning of medical school, allowing students to develop, practice and integrate them over time. We recognize that response rates to the post-session feedback form decreased from 85.5% in 2020-2021 to 60.5% in 2021-2022, and total number of attendees decreased from 86 in 2020-2021 to 45 in 2021-2022. We attribute this to two possible explanations: (1) the series speakers and topics remained the same from years 2020-2021 to 2021-2022 thus students who had attended in the previous year may not attend again; and (2) given that these sessions remained virtual due to COVID-19 restrictions, fatigue and burnout associated with attending online extracurricular sessions may have discouraged students from attending and engaging with the post-session feedback forms over time. Similarly, the fewer number of attendees in the later sessions of the series may be explained by fatigue associated with virtual sessions in the context of the pandemic.

While all EHSS sessions received positive responses, we found that the sessions themed around "Developing your idea" and "Introduction to Healthcare Entrepreneurship and its Role in the COVID-19 Response" were particularly perceived as practically useful in real-world settings. Regardless of one's interest in pursuing the physician-entrepreneur pathway, cultivating innovative consciousness and entrepreneurial spirit will be useful for all medical students who will practice in settings that are constantly evolving as new clinical needs and gaps emerge [24]. From EHSS, medical students gained a comprehensive overview of medical entrepreneurship and opportunities to network with experts in the field. Our future work involves expanding the seminar series to include an experiential learning component. Through practice, students can become more familiar with entrepreneurial scenarios and gain exposure to responding to opportunities and challenges as they present themselves in real-world settings.

CONCLUSION

The Entrepreneurship in Healthcare Seminar Series (EHSS) was designed to raise awareness of healthcare entrepreneurship among early-stage medical learners. The series was well-received, as it exposed medical students to unique pathways to entrepreneurship and allowed them to develop skills related to identifying healthcare problems, problem mapping, and ideating innovations. The series provides a model for other Canadian medical schools to introduce entrepreneurship into their formal curricula and create new opportunities for students to explore this interesting and important field.

LESSONS FOR PRACTICE

- Entrepreneurship education in medical school provides opportunities for developing skills related to identifying gaps in healthcare and ideating innovative solutions.
- Mentorship in entrepreneurship provides medical students with enhanced management skills, improved personal vision for their ventures, and greater confidence.
- Exposure to entrepreneurship in early medical education allows for proactive career exploration and development of skills to better address unmet clinical needs.

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Table 1. EHSS syllabus outlining session topics, learning objectives and speakers.

Session Number	EHSS Session	Learning Objectives
1	Healthcare Entrepreneurship – The Basics, and Industry Case Study	● Recognize multiple different forms of physician entrepreneurship in healthcare and beyond ● Understand examples of ways entrepreneurship can be incorporated into a medical career ● Become familiar with the overall structure of the biotechnology and pharmaceutical industries ● Recognize ways that physicians can become involved in the biotechnology and pharmaceutical industries
2	Introduction to Healthcare Entrepreneurship and its Role in the COVID-19 Response	● Recognize the role of entrepreneurship in healthcare ● Identify different forms of entrepreneurship in healthcare (i.e. scalable startup, owning a small business, intrapreneurship) ● Understand how healthcare entrepreneurship has played a part in the response to COVID-19
3	How to be Entrepreneurial about a Skillset	● Recognize their current skill set and how it may be applied to entrepreneurial ventures ● Identify ways in which non-traditional skills can be useful for healthcare entrepreneurship
4	Developing your Idea	● Understand the importance of customer interviews to 1) explore the problem that users want to solve; 2) obtain feedback regarding the proposed solution ● Determine the value proposition of the product/service and articulate it in a value proposition statement ● Design and test their minimum viable product (MVP) with customers and iteratively improve it

5	Thinking about your Customer	● Develop the customer persona for a product/service ● Perform the basics of market research (market size, market segmentation, target market) ● Design a business model canvas for a new product/service
6	Healthcare Entrepreneurship, Entrepreneurial Traits, Building your Team	● Identify ways in which healthcare entrepreneurship is different from entrepreneurship in other fields ● Recognize the attributes and personal qualities of a successful entrepreneur ● Outline strategies for assembling an effective team ● Recognize common pitfalls when building a team
7	Funding your Startup	● Explain the different healthcare funding models in Canada ● Identify key financial metrics: users, revenue, acquisition cost, business model ● Determine how to obtain buy-in from investors (strategies for articulating the company mission, information to provide, etc.)

Table 2. Demographic Data of Attendees Participating in the Entrepreneurship in Healthcare Seminar Series (EHSS) from 2020-2021.

Year of EHSS	**Number of Participants**		**Medical School Year**		
	Total Attendees	**Total Feedback Forms**	**1st year**	**2nd year**	**3/4 year**
2021-22	86	52 (60.5%)	45	5	2
2020-21	172	147 (85.5%)	86	45	16
2020-22	258	199 (77.1%)	131	50	18
EHSS session					
1: Healthcare Entrepreneurship – The Basics, and Industry Case Study	46	39 (84.8%)	27	6	6
2: Introduction to Healthcare Entrepreneurship and its Role in the COVID-19 Response	54	35 (64.8%)	23	8	4
3: How to be Entrepreneurial about a Skillset	46	40 (87.0%)	28	11	1
4: Developing your Idea	34	26 (76.5%)	16	8	2
5: Thinking about your Customer	27	22 (81.5%)	15	5	2
6: Healthcare Entrepreneurship, Entrepreneurial Traits, Building your Team	27	23 (85.2%)	9	11	3
7: Funding your Startup	24	14 (58.3%)	13	1	0

Table 3. Summary of Score Averages of Post-Session Surveys of the Entrepreneurship in Healthcare Seminar Series (EHSS) on a 5-Point Likert Scale (1-5), from 2020-2022, based on Session Theme.

Learning Objectives	**EHSS Session***							**Average Score**
	1	2	3	4	5	6	7	
The knowledge and skills I gained from this session will be useful in a practical, real-life setting	4.38	4.49	4.50	4.58	4.50	4.39	4.43	**4.47**
I felt engaged throughout the session	4.38	4.60	4.35	4.62	4.59	4.22	4.64	**4.49**
My learning was enhanced by the knowledge and experiences shared by the facilitator	4.67	4.67	4.43	4.77	4.59	4.48	4.64	**4.61**
I found the set-up of the session to be well-organized	4.49	4.77	4.50	4.69	4.73	4.39	4.50	**4.58**
Average Score	**4.48**	**4.63**	**4.45**	**4.67**	**4.60**	**4.37**	**4.55**	

**EHSS Session*

1: Healthcare Entrepreneurship – The Basics, and Industry Case Study

2: Introduction to Healthcare Entrepreneurship and its Role in the COVID-19 Response

3: How to be Entrepreneurial about a Skillset

4: Developing your Idea

5: Thinking about your Customer

6: Healthcare Entrepreneurship, Entrepreneurial Traits,

Building your Team

7: Funding your Startup