“Is There A Doctor On Board?”: Creating a prehospital medical emergency curriculum for medical students

by

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ABSTRACT

Examining the evolving landscape of healthcare systems in the US, coupled with the changing needs of the American public, reveals a critical, growing gap between physician training and societal expectations. When an emergency or public health crisis unfolds in the public eye, physicians are frequently called to respond. Tasks can range from providing care to an acutely ill passenger on a flight, to leading large-scale initiatives such as Overdose Education and Naloxone Distribution programs or Stop the Bleed campaigns in response to emerging threats to public health and safety. In any case, physicians must rely upon proper prehospital emergency training that can empower them to rise to such calls to duty. However, as public expectations rise with regard to physicians' attention to emergencies outside the hospital setting, medical practice and training becomes increasingly tethered to centralized hospital systems. Technological advancements and the increasing sophistication of healthcare operations contribute to the growing disparity between the resource-abundant hospital setting in which physicians and trainees are entrenched, and the prehospital setting that lacks the facilities and services upon which they typically rely. To date, efforts to address this growing gap in medical education remain insufficient.

This project aims to address this critical gap by training preclinical medical students to safely and effectively respond to medical emergencies in the prehospital setting, and by orienting them to the spectrum of prehospital services to improve interprofessional communication and facilitate the development of prehospital solutions to public health problems. The major objectives of this work include: (1) the creation of a new curriculum to translate basic principles of early medical education to the prehospital setting using an interactive, team-based, case-based, flipped classroom model of learning that incorporates medical simulation technology and near-peer education; (2) the completion of a pilot research study to generate longitudinal assessments of

objective knowledge and self-reported confidence to evaluate the effectiveness of the course; and (3) the establishment of this curriculum as an annual offering at Harvard Medical School, as well as the dissemination of preliminary findings from this research study—along with the blueprint for this curriculum—to promote its adoption and continuous improvement at other institutions.

INTRODUCTION

Problem Statement

Examining the evolving landscape of healthcare systems and current trends in medical education reform in the US, coupled with the changing needs of the American public, reveals a critical, growing gap between physician training and societal expectations. Ongoing medical education reform has emphasized changes that include a reduced preclinical phase of medical school, progressively earlier clinical exposure, a transition from lectures and time-based evaluation to team- and problem-based learning with competency assessment, and increased specialization of undergraduate medical education. Of course, much of this reform has been driven by an evolving definition of the role of a medical doctor within the context of sweeping healthcare reform. One of the most prominent components of this reform includes widespread shunting of patient care into the hospital setting, where integration of widely expanded human and technological resources into patient care has drastically redefined the physician role. As a result, responsibility for patient care has become increasingly distributed across a progressively wider range of more specialized individuals, each with a growing reliance upon technology to perform their duties, thereby inevitably decreasing the individual autonomy of all providers in order to strengthen the overall system within a new model of physician-led team-based care. Another major change in healthcare in the US has been marked by the ever-expanding domain of medicalization. In particular, physicians find themselves charged with increasing responsibility to focus on preventive medicine and to address societal issues via public health initiatives that often extend beyond hospital walls. Noteworthy examples include physician leadership in movements focused on the opioid epidemic, mass casualty incidents, and disaster preparedness and response, each largely situated within the prehospital setting. The net result of these ongoing changes reduces to growing societal expectations for physicians to lead prehospital interventions for public health problems at a time

when medical schools progressively minimize the proper training to meet these demands, leaving future physicians without the proclivity to explore such solutions, or leaving them to find ways to fill in these gaps later with minimal orientation.

Summary of Objectives

The proposed project aims to address this critical gap by orienting preclinical medical students to Emergency Medical Services and by training them to safely and effectively respond to medical emergencies in the prehospital setting. The core learning objectives that drive this curriculum include: (1) introduction to Emergency Services in the US, to address the gap between decreased prehospital exposure in medical school and expanding physician involvement in prehospital programs; (2) emphasis on emergency recognition and management, to address the gap created by progressively earlier clinical exposure and a shift in focus away from autonomous bedside care toward critical appraisal of evidence and interprofessional team management; and (3) building upon the previous aim, students will be provided with a practical foundational clinical skillset that will increase their autonomy and confidence while smoothing their early transition to the wards.

The ultimate goals of the project in which this course is embedded include: (1) the creation of a new curriculum to translate basic principles of early medical education to the prehospital setting using an interactive, team-based, case-based, flipped classroom model of learning that incorporates medical simulation technology and near-peer education; (2) the completion of a research study to generate longitudinal assessments of objective knowledge and self-reported confidence to evaluate the effectiveness of the course; and (3) the establishment of this curriculum as an annual offering at Harvard Medical School, as well as the dissemination of preliminary

findings from this research study—along with the blueprint for this curriculum—to promote its adoption and improvement at other institutions.

Background: Characterizing the Problem and Identifying Contributing Factors

Medical Education Reform

The Flexner Report[1], a recommendation for standardized medical education in the US and Canada published in 1910, served as the primary foundation upon which medical school curricula were designed throughout most of the twentieth century.[2–4] However, factors that include radical changes in the overall landscape of American healthcare, accelerating technological innovation with significant implications for information science, and rapid growth in scientific discovery have ushered in a new paradigm in medical education that has been expanding across the US for more than a decade.[5,6] The most prominent features of medical school in this modern era include a transition from traditional lecture-driven didactics to a "flipped classroom" model (i.e., the use of prerequisite learning assignments to prepare students for an interactive exercise designed to encourage students to share, deepen, and apply their knowledge),[5,7–10] an abbreviated preclinical period that allows for expanded elective time,[11] and a shift from time-based requirements to competency-based criteria to measure progress in undergraduate medical training.[6,12,13] Review of the relevant literature shows how each of these changes exerts a direct contribution to the decreasing preparedness of medical students and new graduates to serve as providers and leaders in the prehospital setting.

As of the early 2010s, a trend toward decreasing the preclinical phase of medical school was emerging among top institutions: Duke, University of Pennsylvania, Vanderbilt, Columbia, Baylor, and New York University were among early pioneers.[14–19] The accelerated preclinical

curriculum, which continues to become adopted by more programs each year, poses several major implications for undergraduate medical education, including greater focus on critical thinking than on in-depth content mastery, the shifting of basic science emphasis into premedical studies, and expansion of elective time later in programs. The practice of evidence-based medicine in the 21st century calls for medical schools to adapt to two primary factors: an explosion in the volume of evidence being produced on a daily basis, and a marked acceleration in the rate at which new lessons from the laboratory are translated to the bedside. In specific terms, research suggests that the global body of scientific literature doubles roughly every nine years,[20] and alongside this staggering rate of exponential growth, a compound annual growth rate of roughly 10% for investment in research and development in the pharmaceutical industry[21] serves as a noteworthy indicator of ever-growing investment in medical innovation in the US.

How can US medical schools possibly meet the task of imparting to students the new knowledge that is generated on a daily basis, in addition to teaching them the extensive knowledge base traditionally covered in medical school? This problem has spurred a redefined approach to medical education that focuses less on producing embodied databases of basic science knowledge and medical theory, and more on training lifelong consumers of newly published evidence in real-time at the bedside. For example, research has shown that dynamic point-of-care resources such as UpToDate offers more effective and efficient support to physicians on the wards than does the primary literature,[22] and research demonstrating resultant improvement in patient outcomes when using such resources foreshadows a continued rise in their adoption by providers.[23] These trends support the decision to focus less on content mastery and more on building the skill of critical appraisal of new evidence from myriad sources, and has resulted in greater onus on premedical programs to provide students with a foundation in basic science, evidenced by expanding

prerequisite coursework[24,25] and revisions to the Medical College Admission Test in 2015.[26] This change in philosophy and its associated trends have carried major implications for planning the preclinical phase of medical school, primarily having the effect of liberating schools from covering an extensive body of current facts, and replacing it with the major responsibility of preparing students for a career-long task of locating and assessing the most relevant, up-to-date evidence to support their clinical decision making. The result has been a paradoxical shortening of preclinical studies as previously discussed, and with it, a decrease in basic conceptual scaffolds upon which students can organize their learning during future practice (e.g., decreased knowledge of the physiological substrates of various forms of hemodynamic shock can weaken future learning and interfere with bedside care in the absence of reinforcement and guidance from information technology).

Another consequence of the revamped preclinical curriculum relates to the expanded elective time afforded by its condensation from a strict two-year standard to as little as one year in some cases, such as found at Harvard Medical School.[27] **Figure 1** shows that medical students in the Pathways program at Harvard are afforded nearly two full years of elective time to engineer a unique "pathway" to residency and beyond. Of course, this approach to maximize specialization of medical students before graduation inevitably sacrifices the extent to which medical school can be standardized across individuals, associated with major reduction in the core undergraduate medical curriculum. Not surprisingly, the subject of Emergency Medical Services does not qualify as core material in this increasingly restricted paradigm, and the Curriculum Inventory published by the Association of American Medical Colleges does not even include prehospital care among its more than forty fields of content tracked nationally over time.[28] Perhaps more surprisingly, only roughly half of US medical schools require any duration of time spent in the Emergency

Department in its core curriculum, and most schools that do require it feature expanding core requirements and offer less elective time than the new national average.[29] Therefore, the vast majority of medical students graduate without any exposure to prehospital emergency care, and many leave medical school with little-to-no interaction with their school's Department of Emergency Medicine.

Of course, medical emergency preparedness can be taught in other settings, but the limited literature on the subject indicates that significant gaps exist. A 2011 study of a cohort of 41 US medical students showed that nearly two out of three first- and second-year students failed to request a defibrillator in a standardized simulated cardiac arrest scenario, in addition to finding a compression rate of 58.5 per minute (significantly lower than the recommended 100 per minute), despite the fact that all participants were required to complete basic life support training offered by the American Heart Association.[30] This study shows that junior medical students demonstrate clear gaps in resuscitation preparedness despite required American Heart Association training. One might argue that students can develop these skills on the wards, but further evidence calls this proposition into question; a 2014 study showed that 37% of a group of 152 US medical students reported that they had avoided participating in resuscitation due to lack of confidence in their training.[31] This result not only suggests that students miss out on important training in emergency response as a result of their poor confidence, but also highlights the fact that confidence exerts an important influence upon the training experience students undergo on the wards. After all, given the fact that a 2003 study using the US National Registry of Cardiopulmonary Resuscitation showed that 86% of hospitals included a 24-hour emergency response team (a number which has certainly increased since that time),[32] these events can be not just emotionally challenging for inexperienced students, but also intimidating within the context of a specifically trained team

present at all emergencies. Furthermore, such services simply leave less work available to students, and more importantly, leave students to observe a physician's role during resuscitations that excludes many important steps and procedures that are routinely entrusted to other professionals such as registered nurses and respiratory therapists. Therefore, early interventions to improve confidence and review the entire scope of such protocols might increase engagement and broaden future learning, resulting in accelerated emergency preparedness among trainees. Furthermore, this line of evidence, coupled with the fact that Emergency Medicine is only required at one half of US medical schools,[29] underscores the underrepresentation of Emergency Medicine within undergraduate medical education, which in turn contributes to suboptimal emergency preparedness among medical students.

Emergency Medicine remains a relatively new field in medicine, particularly within medical education. Although the first academic department was founded at the University of Southern California in 1971[33] just a year after the first residency program was launched at the University of Cincinnati,[34] many medical schools did not establish an independent Department of Emergency Medicine until the past decade. For example, Harvard Medical School first established its Department of Emergency Medicine in Fall 2014,[35] just before it launched its Pathways curriculum in 2015 that revolutionized its approach to undergraduate medical education.[27,36] Despite the new presence of an independent Emergency Medicine department on campus, students still expressed concerns about their preparedness to address emergencies, thereby motivating a survey to quantify these concerns. In 2019, a survey sent to first- and second-year medical students at Harvard Medical School showed that 44 of 59 respondents (75%) did not feel comfortable responding to an out-of-hospital emergency, and 57 of 59 (97%) wished to receive more training in how to approach out-of-hospital emergencies. Of note, 31 of the 34 respondents (91%) who

lacked any prior EMS training reported feeling uncomfortable responding to such a scenario. As one student noted, "I have been thinking about this a lot, especially having just traveled on planes during the holiday break. I would love to be able to contribute for medical emergencies on planes, but I am not sure 1) how to respond to the emergencies, and 2) what is legal for us to do as medical students, without full licensure." Quantitative results from this survey are summarized in **Table 1.**

Coupled with evidence from the relevant literature reporting that 83.4% of trainees witness a cardiac arrest during medical school, of which 38.5% occurred in an ambulatory care setting,[31] students often feel underprepared to participate in resuscitations that they are very likely to encounter before graduation, including many in the outpatient setting that can provide critical active experience to students and perhaps even improved care for patients, if properly prepared. Therefore, currently ongoing medical education reform marks an ideal opportunity for Emergency Medicine departments to claim new representation in undergraduate medical education by establishing ownership of the important responsibility to tackle the current educational gap that leaves medical students underprepared to contribute to and learn from medical emergencies. Such a movement can not only expand the role of Emergency Medicine departments within academic medicine, but also increase influence among medical students and further improve recruitment of interested students by increasing exposure to mentors and enhancing confidence in core components of the field. In particular, focused initiatives to instill basics of emergency management in preclinical students can provide a firm foothold for the field to expand its presence in medical schools and further advance the growth of Emergency Medicine as a field, particularly within settings in which academic emergency medicine remains relatively young.

These sweeping reforms across US medical education have been motivated not just by technological development and lessons from education research, but also by radical changes to US

healthcare. Understanding recent trends in healthcare reform provides a critical window into the driving forces behind medical education reform, as well as patterns that indicate future changes.

Healthcare Reform

Studying the effects of healthcare reform on medical training in the 21st century reveals a major redefinition of the role of a typical physician in the US. The classic image of the lone physician making house calls in a business suit carrying a black medical bag that symbolized healthcare a half-century ago has been replaced by massive, futuristic, centralized hubs of patient care, teaching, and research.[37] Specifically, the proportion of physicians employed or affiliated with hospitals (as opposed to self-employed) increased from roughly 24% in 1983 to 42% in 1994,[38] and further rose from roughly 41% in 2000 to 72% in 2010,[39] marking a dramatic threefold increase in just sixteen years. Of course, this massive flux has been largely driven by steep rises in health care costs associated with factors that include the introduction of electronic health records and implementation of government regulations, as well as the extensive administrative demands that they carry.[40] These sources of financial pressure, alongside massive waves of hospital consolidation,[41] have rapidly pulled physicians into healthcare systems that can share increasingly expensive resources as medical innovation—and associated administrative needs—continues to drive these trends forward. In a 2011 New Yorker article, Atul Gawande argues that the only way to consistently deliver high-quality care to patients in this increasingly complex medical landscape is to engineer systems of specialized individuals working within highly organized protocols; in this model, the "cowboy" physicians of the previous generation must give way to modern interdisciplinary "pit crews", such that physicians must transition from solo practitioners to team managers.[42,43] The American Medical Association has officially declared its stance in support of

this model of practice, titled "physician-led team-based care" to describe interprofessional teams with the oversight of one or more physicians.[44–46] These models are attractive to healthcare employers because they can improve labor value by creating care teams that maximize the extent to which providers practice at the top of their licenses, thereby ensuring their continued growth.

Given these radical changes in the demands associated with the physician role, medical education has appropriately adapted to prepare students for these new sets of challenges. These reforms are clearly mirrored in the metrics used to evaluate medical students, which have been redesigned to explicitly address new goals for medical training in this new model for practice. Although the notion of competency-based medical education was first introduced in 1978,[47] this paradigm did not take firm hold in US medical schools until the past decade.[13] The Accreditation Council for Graduate Medical Education currently defines six core competencies for medical trainees: (1) patient care, (2) medical knowledge, (3) practice-based learning and improvement, (4) interpersonal and communication skills, (5) professionalism, and (6) systems-based practice.[12] While the first two competencies are solidly traditional, the third addresses a model of lifelong learning necessary to practice evidence-based medicine in the modern era of rapid discovery and innovation, the fourth and fifth focus on proper integration of physicians into human systems that are often large and interdisciplinary, and the sixth directly captures the ability of trainees to embody the modern image of patient care symbolized by Gawande's "pit crews" built around patient care.[12,42] In addition, a movement away from lecture-based curricula that aimed to cover as much medical knowledge material as possible within a designated time period, new models of team-based and problem-based learning within a flipped classroom model shift emphasis away from maximization of content coverage to enable solitary diagnostic reasoning, toward development of a skillset that prepares physicians to critically appraise new information and work

within teams to pool knowledge, delegate tasks, and engage in collaborative reasoning to navigate evidence-based patient care.[5,48]

Examining how medical training has been revolutionized to prepare trainees for a lifetime of critical appraisal of new information and physician-led team-based care reveals a consequent degradation in physician autonomy. As physicians become appropriately more adept at using technology to inform complex diagnostic reasoning and managing teams of individuals as they perform specialized sets of tasks, they become more reliant on these resources and inevitably lose touch with basic skills that have either been replaced by more advanced techniques or delegated to other professionals. Consider peripheral venipuncture as an example. Routine intravenous access tends to be delegated to phlebotomists within the hospital setting, or is often undertaken by nurses in time-sensitive situations, but first-attempt peripheral intravenous access rarely falls to physicians. First, inadequate exposure to such tasks not only precludes physicians from understanding and improving large-scale operations related to it, but can also contribute to misunderstandings between professionals and harm team cohesion. Second, inability to perform these tasks interfere with patient care under limited or constrained resource conditions, such as within the hospital during an emergency (e.g., a mass casualty incident) or outside the hospital (e.g., an inflight emergency). Therefore, although physicians find themselves called to perform tasks such as venipuncture, manual blood pressure measurement, and intravenous medication administration progressively less often, there are clear benefits to exposing trainees to these tasks for the sake of promoting physician autonomy and emergency preparedness. After all, if trainees do not gain exposure during medical school, they will become increasingly less likely to develop these skills as they progress through their training while immersed in hospital systems replete with

abundant human resources and technological support, and as their professional responsibilities grow to distract them from such fundamental tasks.

In sum, routine patient care seems to be benefitting from the incorporation of new technologies and the adoption of team-based care, and medical education has reformed to prepare trainees for associated new sets of challenges. However, the redefinition of the American physician role for the 21st century progressively excludes important attributes that prepare physicians to provide emergency care outside the sophisticated systems upon which they increasingly rely. In other words, while the "cowboy" mentality cited by Gawande has been subjected to appropriate minimization within structured healthcare systems, physicians who find medical emergencies outside these supports can surely benefit from a reserved ability to practice autonomously in the prehospital setting, or even in the event of a disaster that strains hospital resources. In addition, a more well-rounded understanding of the full scope of basic patient care, including the domains that have been delegated to other professionals, can only promote team cohesion and improve physician-led efforts to improve operations. While physician-led teams are trained to respond to emergencies as a cohesive unit within their designated systems, physicians removed from these supportive structures and facilities face sets of challenges that can be hard to find during residency training or medical school, and certainly fall outside the intended domain of physician training. Perhaps societal expectations have accordingly adjusted to these changes? In fact, evidence suggests that a growing trend is moving in the exact opposite direction.

Expansion of Medicalization & The Evolving Medical Doctor Role

Examining the multifaceted trend in the US toward expansion of the physician role beyond the direct episode-based patient-physician relationship underscores the need to address the training

gap that currently neglects practical prehospital care. While routine medical practice and training progressively move to install physicians as leaders within centralized healthcare systems, physicians find themselves increasingly called to address public health matters that lie beyond the scope of these systems. Of course, proper training is required to adequately meet these demands, and examination of trends in medical education and greater healthcare reform reveals unmet training needs that only continue to grow.

Medicalization is defined as "the process by which nonmedical problems become defined and treated as medical problems."[49] In a more general sense, medicalization simply refers to the recruitment of medical professionals and systems to improve a human condition, from childbirth and cosmetic procedures to schizophrenia and addiction. Medicalization has always tended to expand with time, and recent decades have shown a growing trend toward the medicalization of not just individual issues (e.g., death by natural cause), but also societal issues (e.g., mass shootings). These matters span a wide range of responsibilities that include community medicine and global health, emergency medical services, and disaster medicine and emergency preparedness. This diverse set of endeavors is united under the common thread that each of these domains requires physicians to design, practice, impart, and improve a solid practical skillset that can be deployed within prehospital settings by a wide range of professionals—and even laypeople.

In addition to the previously discussed aspects of healthcare reform, a major shift in focus toward public health and preventive medicine has been underway in recent decades.[50–53] This trend is clearly reflected in growing representation in medical school curricula, marked by expanded integration of public health principles into core undergraduate medical training and increased emergence of combined Doctor of Medicine and Master of Public Health programs to prepare trainees for lifelong service of patients at the population-level of analysis.[51,54–56] While focus on

applied epidemiology, social determinants of health, and population-oriented health studies signifies important preparation for public health work even in an abstract sense, a closer look at major applications of this work reveals a less apparent, but equally important need to provide physicians with a portable skillset that can be translated into the prehospital setting in which much of this work must take place.

More than thirty years ago, the World Health Organization set forth a definition for community health that extended the jurisdiction of the medical field, and with it, the professional territory of physicians.[57] This statement related to a worldwide movement toward community-based approaches to preventive medicine, toward enhancement of healthcare access, curtailment of costs, and overall improvement in outcomes.[58–61] Given the recent explosion in popularity surrounding global health and corresponding growth in participation across medical schools,[62] academic investment in community health studies has naturally permeated through domestic healthcare philosophy.[61,63,64] In parallel to its academic influence via global health applications, an even more important driving factor has emerged to establish community health within the US: health economics. In partial response to the previously discussed longstanding shunting of healthcare out of the patient's home, a much newer community-based movement aims to redirect emphasis onto care that prevents hospitalization, largely via lifestyle modification and a more continuous approach to care in the community to prevent and control chronic disease and its acute exacerbations.[65] Telemedicine[66] and community paramedicine[67–69] have emerged as promising new concepts to enact new visions for public health solutions by extending the reach of physicians into the community via the use of telecommunication technology and midlevel practitioners, respectively. These interventions aim not only to improve access and outcomes, but also to cut spending amid growing health economics concerns in the US. For example, Atul Gawande

published an influential New Yorker article in 2011 in which he argued that massive portions of healthcare spending can be attributed to a minority of highly needy patients, and that costs can be reduced without harming quality by focusing resources on the prevention of highly costly medical incidents among the patients most likely to sustain them.[70] These health economics concepts are clearly reflected in—and fueled by—widespread trends toward reimbursement models that abandon fee-for-service in favor of value-based models that reward prevention and penalize overutilization.[71] Of course, these transitions align financial incentives behind these community-based public health movements, further ensuring their growth through the future in the US, while global health efforts continue to spread these practices internationally. In any case, whether undertaken in the heart of the South Bronx or in the farmlands of Nepal, these rapidly developing extensions of healthcare into homes and communities require physician leadership, and in turn, familiarity with prehospital care and basic low-resource medical practices, in order to proactively prepare trainees for the incoming future of medicine.

In addition to the rapid growth observed in the relative infancy of community paramedicine, the broader domain of emergency medical services is expanding as well. For example, New York City's population of 8.4 million people[72,73] generated more than 1.8 million emergency medical calls in 2018,[74] amounting to one 911 call every seventeen seconds citywide. The call volume in New York City has increased by 27% from roughly 1.4 million in 2013[75] to 1.8 million 2018,[74] compared to 0.0001% growth in population from 8,398,739[73,76] to 8,398,748[72,73] over the same timeframe. Therefore, the number of ambulance runs per person-year increased from 0.175 in 2013 to 0.222 in 2018, marking a 27% increase after accounting for negligible population growth. Limited reports on the subject argue not only that these trends have been at work for decades,[77] but also that increasing emergency medical services utilization can be

observed across the US and even worldwide (though improved methods to estimate call volume across multiple systems within the US must be undertaken).[78–81] Using National Hospital Ambulatory Medical Care Survey data, estimates indicate a 16% increase in the rate of ambulance utilization among patients presenting to the Emergency Department nationwide, from 0.061 ambulance runs per person-year in 2005[81] to 0.071 in 2016 (including adjustment for growth in overall Emergency Department volume, given the person-year metric).[82]

The factors that account for this staggering growth lie beyond the scope of this project, but the trend itself highlights the need for physicians to address this massive, rapidly growing source of need for patients within the prehospital setting. In addition, the expanding role of prehospital services in patient care clearly marks an increase in physician interaction with patients transported via ambulance (or perhaps referral of patients to emergency medical transport in the outpatient setting), often including communication with prehospital providers particularly in the Emergency Department. In either case, familiarity with the structure of prehospital services and their personnel and standard operating procedures can facilitate patients' navigation through healthcare system encounters that increasingly include emergency medical services. In addition, educational investment in physicians' understanding of emergency medical services can improve handoffs between prehospital providers and physicians (typically from prehospital providers to physicians, but also in the reverse direction in the event of transfers and outpatient emergencies), which has been established as a critical area of improvement in the field of emergency care.[83–85] Therefore, as the emergency medical services sector of healthcare continues to grow, the need for specialized physicians to lead this industry will increase, and more broadly, nearly all physicians will find themselves interacting with it with increasing frequency over time.

In addition to growing investment in community health and emergency medical services, the recent emergence of numerous physician-led public health initiatives within the domains of emergency preparedness and disaster medicine further indicate the need for physicians to receive training in prehospital care. Importantly, such initiatives have been present for decades. The most famous example might be brief, basic cardiopulmonary resuscitation training offered by the American Heart Association to prepare laypeople in basic management of prehospital cardiac arrest[86] based on the observation 35 years ago that bystander cardiopulmonary resuscitation improved survival.[87] Research has not only shown that bystander cardiopulmonary resuscitation durably improves outcomes,[88] but has also indicated the success of state-mandated programs to train all high schoolers before graduation.[89] Not surprisingly, the number of similar programs that have been modeled after this success story has dramatically increased. Notable examples include Overdose Education and Naloxone Distribution programs, designed by physicians in Massachusetts and adopted across the nation to combat the opioid epidemic,[90,91] and initiatives to address public preparedness for mass casualty incidents such as the Stop the Bleed campaign launched by the White House[92] and the Until Help Arrives campaign created by the Federal Emergency Management Agency.[93] Clearly, as societal concerns regarding a public health threat grow—as in the cases of the opioid epidemic or terrorism and mass shootings in the US—physicians are increasingly called to create, lead, and participate in public health initiatives to address these problems. Therefore, these examples not only illustrate the ever-increasing extension of the physician role into the prehospital domain, but also reflect growing public expectations for physicians to undertake the task of preparing society—from midlevel practitioners and emergency responders to laypeople—for emergencies and leading them through large-scale responses to new crises and disasters as they reveal themselves. This fact serves as a reminder of the reality that

physicians belong to a fundamental tradition of leaving the definition of their role to the public whom they serve.

The Oath of Maimonides, an 800-year-old poem widely embraced by physicians for centuries,[94] opens with the statement "The eternal providence has appointed me to watch over the life and health of Thy creatures."[95] As acknowledged by the Liaison Committee on Medical Education—the accrediting body to medical schools—in Standard 6 of their guidelines, medical schools should outline program objectives that "allow the assessment of medical students' progress in developing the competencies that the profession and the public expect of a physician," thereby underscoring the need of medical education to adapt to public need.[96] While medical schools appropriately strive to prepare students to use public health studies to identify societal problems and design population-oriented solutions,[51,54–56] a number of trends are converging to interfere with physicians' abilities to execute these solutions at the ground-level of the prehospital setting. For example, there is no doubt that proper orientation to prehospital management of cardiac arrest, opioid overdose, and traumatic hemorrhage (e.g., battlefield medicine) drove leading physicians to engineer their respective movements that have each saved lives and brought peace of mind. Therefore, a proper foundation for future learning, which can be imparted to medical students within a brief timeframe, can provide the basis to inform initial planning and facilitate the design of multilevel solutions. Furthermore, as the Society of Academic Emergency Medicine stated in a position paper on this subject over two decades ago, "society has a right to expect that every physician is able to manage acute problems of patients and that a basic knowledge of emergency medical care has to exist."[97] These emergencies occur both at the individual patient level, as in a syncope during a flight, or at the societal level, as in the Boston Marathon bombings in 2013,[98,99] and both require practical preparation to enable physician-led responses to patients' calls for help.

In sum, as the modern physician role increasingly expands to encompass a more public-health-oriented approach to practice in response to academic trends, health economics reform, and evolving public needs, physician training must adapt accordingly. While medical education has made measurable progress in emphasizing population health, social medicine, and epidemiology in core content, attention must also be dedicated to developing a basic introduction to prehospital systems and practical skills that will enable the design of solutions that largely reside outside the healthcare systems in which they tend to train and practice. Whether in the form of growing interest in community health both in the US and abroad, increasing utilization of—and interaction with—emergency medical services, or rising public expectations to meet evolving societal needs, the physicians of tomorrow must anticipate increasing need to become oriented to prehospital care. In turn, medical schools must acknowledge this need and prepare their students to meet associated challenges.

Summary of Contributing Factors

Examining interrelated, ongoing trends in medical education, the current state of healthcare reform, and the ongoing redefinition of the physician role reveals a concerning gap between physician training and public expectations that can only be expected to grow under current conditions. Medical education reform, largely driven by technological development and economic changes that have drastically reshaped the landscape of US healthcare, has motivated a total overhaul of the medical school learning environment (e.g., the transition from lectures to team- and problem-based learning), as well as earlier clinical exposure and widespread expansion of elective time at the expense of core curriculum time. These changes have led to the unintended, yet inevitable consequence of delivering students to the wards with less emergency preparedness and producing greater volume of new residents with little or no exposure to the emergency

medicine, let alone prehospital care. Healthcare reform, most notably marked by massive shunting of patient care out of the home and into healthcare facilities predominated by the physician-led team-based model of care—all of which largely driven by shifting economic factors—has led to further medical education reform to prepare trainees for this new healthcare environment. These changes have appropriately produced new generations of physicians better-suited for a lifelong career of interprofessional team management and critical appraisal of an ever-expanding and constantly updating evidence base at the bedside, but have eroded their ability to practice autonomously outside their increasingly sophisticated high-resource systems. These changes stand in opposition to growing societal demand for expanded medicalization, and in turn increasing extension of physicians into the prehospital sector, in order to develop community health both locally and globally, meet the demands of rapid rises in emergency medical services utilization, and lead public health initiatives to respond to evolving societal concerns regarding threats to public health and safety. These public expectations, which rightly define the physician role, entail a clear and important need for physicians to possess a basic understanding of prehospital care and a practical skillset in low-resource practice, in order to provide care at both the individual and population level, at a time when attention to these capabilities becomes increasingly scarce in medical training. The relationships between these factors, each contributing to a growing training gap in US undergraduate medical education, have been summarized in **Figure 2**.

Given that the medical profession is defined by the population it serves, physician practice and training is appropriately influenced by changes in needs, advancements, concerns, and expectations in greater society, as illustrated in simplified form in **Figure 3**. On one hand, broader social factors such as technological development, resource constraints, political change, or current events reshape the landscape of health economics, driving healthcare reform, and in turn, calling

physicians in practice and training to adapt. For example, societal concern over healthcare spending has motivated political pressure to remodel healthcare reimbursement, which in turn has spurred rising interest in preventive care and community health. On the other, academic medicine adapts within the context of society, leading to direct manipulation of medical training and in turn practice. For example, initial growth in investment in global health surpassed the explicit financial incentives to do so, and this excess interest can be attributed to academic influence driven by social changes within a nation with increasing global connectivity. In other words, healthcare reform is driven by both democratic and technocratic influence, and in this case, medical education experts must recognize that prehospital emergency education must be implemented during medical school in order to address a concerning training gap that has been largely driven by bottom-up sweeping changes throughout the field of medicine. In particular, a massive influx of physicians into hospital employment and outflux of patient care from home has driven radical healthcare and training reform, but a new wave of community health focused on preventive care and a broader definition of the medical profession has emerged in partial response to that movement and will call on physicians to design and implement solutions within the prehospital setting, marked by ever-increasing contrast from high-resource hospital systems. With this in mind, the proposed project aims to provide early training in emergency care to first-year medical students, in addition to orienting them to prehospital services, toward the development of future physicians prepared to render emergency care when called upon and lead response to applicable public health issues as they arise.

Proposed Solution: A Threefold Approach

Given the previously outlined factors contributing to the prehospital emergency training gap in US undergraduate medical training (summarized in **Figure 2**) and its growing significance

and implications, medical educators must work to close this gap in order to prepare physicians for the incoming new wave in medical school (i.e., earlier clinical exposure) and practice (i.e., extension of physicians outside their healthcare systems into the prehospital setting). How can medical schools close this training gap in the context of shrinking core curricula and in the face of important factors that diminish skills that are valuable in the prehospital setting? A threefold approach, packaged within just a 3.5-hour total commitment, can make important progress toward preparing trainees to recognize emergencies; facilitate future development of emergency medical skills; orient students to the growing prehospital sector of healthcare; introduce practical skills to promote autonomy and team cohesion; and improve individual confidence for early, safe, and effective engagement in emergency care. The components that form this proposed solution are summarized in **Figure 4** and conceptually mapped in **Figure 5**.

Introduction to Prehospital Care

The first component that must be included in the proper solution to the prehospital emergency training gap involves orientation to emergency services. The key purposes of emergency services orientation span preparation for three domains of physician duties: (1) proper safety practices and awareness of medicolegal considerations for direct engagement in prehospital patient care, (2) communication skills and familiarity with emergency services to facilitate interaction with prehospital providers and improve care for peri-transport patients, and (3) awareness of the spectrum of prehospital services to enable participation in the development of prehospital solutions to public health concerns and community needs.

The foremost educational objective for prehospital emergency training is scene safety. In stark contrast to the sophisticated, highly controlled facilities teeming with personnel in which

physician training and practice take place, emergencies in the prehospital setting present a host of safety threats to patients, bystanders, and responders. Common dangers associated with patient care in various prehospital settings include infectious disease, traffic, structure or scene instability, fire and hazardous materials, unpredictable bystanders, and the patients themselves, among many others. Why should physicians concern themselves with these threats? Survey data has repeatedly shown that roughly four-in-five physicians are unexpectedly called to provide patient care as an off-duty Good Samaritan in the prehospital setting in which these threats present, most often reporting 3-5 such instances since completing training.[100,101] While physicians might be well-suited to adapt their training in body substance isolation to the prehospital setting, other dangers such as traffic-related threats mark a particularly important topic to cover. Survey data collected from physicians shows that more than one-fifth of physicians' Good Samaritan events occur at road traffic crashes,[100] and research has clearly demonstrated that struck-by crashes present a major threat to first responders at the scene of road traffic incidents.[102] Proper scene size-up[103] and safety practices[104] can be effectively imparted to medical students via very brief training that can protect them when called to respond to emergencies, particularly in the likely event of road traffic crashes.

A brief overview of medicolegal considerations for Good Samaritan care marks another important item to cover in this course that is often raised by participants; students often question how to balance the risks of care under their limited training against the risks of delaying intervention. On this topic, it is most important to emphasize the interstate variation of relevant laws, and more importantly, variation in how those laws can be interpreted and applied, thus creating significant gray areas.[105–107] At minimum, students should be taught about the concepts of consent to treat (including initial self-introduction with level of training) and implied consent,[108,109] and should be made aware of the existence of Good Samaritan laws (which provide

variable protections to responding physicians in all states but are standardized for flights by airlines registered within the US) and Duty to Act laws (which may or may not be in place depending on one's location to compel a physician's response to Good Samaritan incidents under certain conditions).[105–107,110,111] If possible, a brief summary of local legislation on these matters should be introduced. Essentially regardless of regional differences in legislation, students should also be taught that once the decision is made to engage with a patient and establish care, one must attend to the patient until care is properly transferred to another provider, such as a responding paramedic. In addition, proper scope of practice should be discussed according to the specific credentials of the audience within their region. Importantly, evidence suggests that lessons in these medicolegal prehospital topics are not only desired by physicians-in-training, but can also increase their inclination to care for patients in Good Samaritan scenarios.[112]

Orientation to Emergency Medical Services should also prepare future physicians to communicate with first responders and interact with prehospital services. Given that utilization of emergency medical services is steadily increasing as previously discussed (pages 20-21), physicians can expect rising frequency of interaction with prehospital personnel. This includes not only handoffs from the ambulance to the receiving facility during transport to the emergency department or transfer to an inpatient service, but also handoff from the sending facility to prehospital providers during interfacility transfers and outpatient emergencies. Importantly, research has consistently demonstrated that handoffs between physicians and prehospital providers mark a critically important moment in emergency care that can be a common source of suboptimal outcomes.[83–85] Therefore, basic training regarding the nature of various levels of care included in emergency medical services—including the differences in scope of practice between certified first responders versus basic or advanced life support providers, as well as typical mandatory training

among various first responders (e.g., police and firefighters)—can adjust physicians' expectations and facilitate communication both during handoffs and at the time of transfer of care during Good Samaritan events upon arrival of first responders.

Finally, introduction to emergency services, simply by promoting awareness of their structures, capabilities, and limitations, can offer important benefits to physician training in the fields of prehospital care, public health, and emergency medicine. Building upon the previous discussion of growing trends that call physicians to orchestrate prehospital solutions to public health problems (**page 22-23**), tomorrow's physicians will be better able to serve many public health needs if they can rely upon an introductory knowledge of the prehospital systems that can extend their reach into the community. This awareness should include familiarity with major emergency medical services structures (e.g., fire department-based agencies such as the Fire Department of New York,[113] versus municipal third service agencies such as Boston Emergency Medical Services[114] or private agencies such as Fallon Ambulance in Brookline, Massachusetts[115]), the anatomy of a 911 call in the US including public safety answering points and dispatch, and the typical training and equipment associated with common responding units (e.g., basic life support versus advanced life support). Basic introduction to the tools available to physicians, as well as the interface with emergency services that is experienced by patients with increasing frequency,[77–80] can provide an important foundation upon which physicians can build in the future to find new ways to innovate and improve programs in community health and prehospital emergency services to serve the public. In addition to direct benefits to patient care, orientation to Emergency Medical Services can also prove beneficial to the relatively young field of Academic Emergency Medicine. Research has shown that exposure to emergency medical services not only increases confidence among students to promote early engagement in emergency care, but also significantly boosts

interest in pursuing a career in Emergency Medicine among preclinical students.[116] Therefore, such exposure can improve recruitment of talented students to the field, in addition to expanding the presence of Emergency Medicine within early phases of medical school programs. Early exposure is especially important to Emergency Medicine recruitment because research indicates that firsthand experience during a rotation marked the strongest determining factor into students' choice of specialty,[117] and given that only half of schools require an Emergency Medicine rotation,[29] many students must be attracted to elective rotations via early exposures, such as offered by this course.

Practical Clinical Foundation

Second, the proposed solution to the prehospital emergency training gap must include the provision of a practical clinical skillset. The primary goals of this component of the proposed solution include providing a basic framework and skillset for low-resource practice, promoting skills that enable clinical autonomy, and building upon the previous item, encouraging individual confidence among students. As medical training and practice increasingly move under the umbrella of large, complex, high-resource healthcare systems, physicians' preparedness to provide care within low-resource settings consequently deteriorates. The gap between hospital and prehospital care in the US can be understand in two parts: human resources and facilities (e.g., equipment, materials, and technological support). Increased human resources under the physician-led team-based approach to healthcare[44–46] draws practical skills away from the physician role and delegates them to other professionals and staff, and increasing sophistication of hospital resources engenders physician dependence upon such aids and interferes with their ability to practice without them (e.g., establishment of peripheral intravenous access: a skill that is often delegated to other

providers such as phlebotomists or nurses in routine practice, or when performed by a physician often includes use of ultrasound guidance). These changes are almost certainly beneficial to patient care under most circumstances within these systems, but of course are detrimental to care when it must be provided in the absence of these supports. Addressing this training gap entails both basic knowledge and procedural skills that can prove valuable in the prehospital setting but are rarely encountered by physicians and trainees in modern healthcare settings. For example, the old notion that hypotension can be estimated by comparatively assessing carotid, femoral, and radial pulses,[118] though controversial to the extent that it can provide rough quantitative evaluation of systolic blood pressure,[119] can aid patient assessment during emergencies in the absence of a sphygmomanometer and stethoscope, let alone an abundance of staff members equipped with automatic machines as is often available within hospitals. In addition, basic physiologic principles that underlie prehospital care, as featured in emergency medical technician training, can provide junior students with an accessible, useful entry point to understanding more complex concepts later in the course of their studies, as well as a practical scaffold upon which to organize future learning on the wards. For example, by providing students with a basic review of the concept of compensated versus decompensated hemodynamic shock, as taught to prehospital providers,[120] they might be able to use this practical foundation to more easily understand and more effectively retain future lessons about resuscitation with which residents can often struggle under high-stakes scenarios (e.g., understanding how fluid repletion alone can reverse compensated hypovolemic shock, but why vasopressors might be needed to treat the same disorder once decompensated, essentially by artificially extending or restoring the compensated state driven by sympathetic activation).

Providing a basic procedural skillset to complement a framework for low-resource care can not only enable future physicians to provide effective prehospital care, but also boost their autonomy and confidence within routine practice. For example, consider the task of establishing intravenous access during an inflight medical emergency. A survey of 400 physicians indicated that 42% have been called to respond to an in-flight medical emergency, among whom more than 80% reported 1-5 flights per year, demonstrating the fairly high likelihood of physicians to encounter such scenarios even without especially frequent flying.[121] The same study also reported that more than half of physicians surveyed reported "no knowledge" of the medical supplies available on a commercial flight, and when asked to report their understanding of protocols for in-flight medical emergencies, 64% answered "no knowledge" and another 23% reported "a little knowledge" on the subject.[121] Of note, all commercial airliners based in the US must carry intravenous access kits.[111,122] However, even when informed of the availability of the requisite materials, the ability to properly place an intravenous line cannot be assumed. A multisite study of procedural skills among more than two-thousand graduating fourth-year medical students showed that one-third of soon-to-be-residents have started zero or one peripheral intravenous lines, and more than one-third deny the ability to place one without supervisory assistance.[123] Furthermore, research suggests that inadequate procedural training has gotten worse over the past twenty-five years and is on track to continue to worsen under current conditions.[123] This line of research demonstrates a clear training gap that can compromise the ability of physicians to serve the public during prehospital emergencies, and as a result, a proper solution must include dedicated attention to basic knowledge and procedural skills, which are encountered with decreasing frequency during routine physician practice and training but can enable low-resource practice with the power to save lives.

Similar findings regarding other procedures further demonstrate the need for improved procedural training for medical students. One-third of graduating fourth-year medical students from a sample of more than six-hundred denied the ability to suture without supervision, and of greater concern, 39% denied the ability to independently perform cardiopulmonary resuscitation![123] These data underscore the inadequate preparation of medical students to perform routine procedures, despite consistent evidence that procedural skills can be efficiently improved with brief, focused training.[124–126] By introducing these skills to students during preclinical studies, they will become more likely to engage in them later on the wards, and in turn, will emerge from medical school with better preparation to provide and teach prehospital care. Furthermore, such training will produce physicians with a more versatile skillset that can significantly improve hospital care under conditions that strain resources, such as in the event of a disaster or mass casualty incident, during which physicians might be called to practice more autonomously than in the course of routine hospital care.

Early Emergency Preparedness in Medical School: The Case for Medical Simulation

Finally, closing the prehospital emergency training gap will require improved emergency preparedness among medical students in order to promote their engagement in emergency training during medical school, thereby accelerating and deepening their emergency preparedness when practicing independently after graduation. The goal of this area of emphasis is to impart cognitive and practical skills that will better prepare students to: assess patient acuity, adapt their diagnostic reasoning to emergencies, and not only recite but practice the basics of patient stabilization (i.e., ABC: Airway, Breathing, Circulation). Emergency Medicine differs from the traditional approach to patient care taught in medical school in that limited time and information often preclude a provider's ability to collect a full history and exam, process this information into a differential

diagnosis, conduct tests and gather more information, then use the data in aggregate to advance a most-likely diagnosis and formulate a treatment plan accordingly, all in orderly stepwise fashion to minimize errors.[127] Instead, when physicians-in-training encounter their first emergency, they must learn to dispense with this ingrained model and practice a new approach in which life threats are assessed and addressed in order to stabilize the patient for a rapid series of focused diagnostic and therapeutic procedures that often occur in parallel.

For example, consider the case of respiratory arrest secondary to opioid overdose, encountered by a medical student on an outpatient medicine rotation (of note, medical schools currently introduce students to such settings as early as one month into medical school, perhaps before they have even learned how to interpret vital signs[128]). An inexperienced student might freeze upon discovering that the patient is unresponsive and unable to provide a history that can inform her diagnostic reasoning, or perhaps with a bit more training she might confirm presence of a pulse then assess respiratory rate and pupils to support her suspicion of an opioid overdose. However, she might correctly recall that the best treatment (though perhaps not necessarily the best *next step* in treatment) for this condition is naloxone, and delay treatment until she can locate it, assuming she possesses the knowledge to administer it herself. The goal of this proposed training is to no longer ask medical students to learn how to radically reorder their approach to patient care in real time through initial first-hand experiences with emergencies on the wards. Instead, proper approach to such a patient will not only be reviewed using a basic framework effectively taught to prehospital providers with much less medical training (e.g., emergency medical technicians), but also provide them with a safe space in which to practice it. Investing in emergency preparedness among medical students would allow the student in this hypothetical scenario to initiate rescue breathing upon discovering apnea in the presence of a pulse while a staff

member calls for help, rather than abandoning the patient to seek her preceptor only to delay critical intervention and learn through passive observation of the episode.

At a time when the massive domain of medical knowledge and the complexity of patient care continue to grow exponentially,[20,21] medical schools are actually delivering their students to the wards progressively earlier.[11,129] For example, Harvard Medical school dedicates one full day per week to the wards and patient clinics starting just one month into the program![128] As medical schools increasingly adopt models that shorten the preclinical curriculum and hasten integration of clinical exposure into it, medical students across the nation become progressively less prepared to participate in care when first delivered to the bedside.[3,11,129] In this model, early passive (e.g., shadowing) or superfluous (e.g., voluntary patient interviews that do not contribute to care) engagement in patient interaction offer a protracted, more graduated course of clinical exposure than previously featured in the traditional Flexnerian model, which was bisected by an abrupt transition from the classroom onto the wards. However, although students in the new model enter their dedicated clinical clerkships with a greater body of clinical exposure than in the past, those same students first enter the wards with much less preparation, inevitably limiting the educational utility of highly resource-intensive clinical experiences when they occur in the preclinical curriculum. These trends demonstrate a growing need to identify effective ways to accelerate the preparation of medical students for patient care without jeopardizing public health. How can medical educators optimize the benefit of these costly hospital-based, patient-centered components of preclinical curricula?

Medical simulation has been proposed as a safe, effective solution to prepare trainees for their experiences on the wards. Medical simulation enables clinical educators to create a patient care experience on-demand, tailored to the specific lesson plan and students' stage of development,

and allows trainees to practice autonomously at the limits of their ability without risk to patients.[130] Clearly, this combination of advantages renders medical simulation an ideal bridge for students at their earliest stages of training as they grapple with the basics of clinical interviewing, physical examination skills, diagnostic reasoning, clinical maneuvers and procedures, and perhaps most important, teamwork and communication skills.[131] Furthermore, the means by which medical simulation can accomplish these goals, utilizing a highly-interactive exercise under a team- and case-based, flipped-classroom model of education, works in perfect alignment with the new prevailing model of medical education to promote teamwork and foster critical reasoning.[5] In addition, by adding the experiential component that only true, enacted, or simulated patient interaction can offer, students can practice autonomy and learn from firsthand feedback by comparing their predictions to a constantly updating case in real-time, providing a richer and more realistic learning experience than sets of discrete problems more typically used in current classrooms, as supported by state-of-the-art learning theory.[5,130,132–135] Of course, medical emergencies mark an especially important application of this technology. Not only does medical simulation allow educators to expose their students to emergencies on-demand in a controlled and safe fashion,[130] but it also instills confidence in students to appropriately engage in emergency care on the wards to further their learning;[136] importantly, research has demonstrated that insufficient confidence in their training presents a major barrier to students' participation in resuscitations on the wards.[31] This evidence suggests that early deficits in emergency training during medical school can propagate over time and result in poorly prepared, hesitant residents who need to learn emergency care on real human beings for whom they have true responsibility. Therefore, emergency preparedness training marks an important, yet underappreciated aspect of medical education with clear benefits for early exposure, and medical simulation marks a promising

technology that can close this growing gap in preclinical training in a safe way that maps directly onto prevailing learning theory already embraced in medical education.

Plans for Implementation

Relevant Precedents

According to the Association of American Medical Colleges, there are 151 accredited medical schools in the US as of 2019;[137] the Zucker School of Medicine at Hofstra/Northwell[138] and the School of Medicine Greenville at University of South Carolina[139] are the only two that require students to complete emergency medical technician certification during preclinical training. Research suggests that these emergency medical technician training and practice programs, built into undergraduate medical education programs, offer many important benefits including self-reported growth in a comprehensive list of patient care skills (e.g., obtaining a medical history, conducting a physical exam, building rapport with patients, responding to a patient's medical and psychosocial issues), professionalism, confidence, awareness of systems-based practice, and communication and interpersonal skills that promote teamwork.[140,141] Although the idea to require emergency medical technician training for medical students was first trialed nearly fifty years ago,[142] these two pioneering medical schools are among the newest in the country (established in 2008[143] and 2012[144], respectively), which might suggest the start of a new trend toward early integration of prehospital training among new schools. However, the fairly large time commitment of roughly 1.5-2 months[145,146] associated with these programs might cause medical schools to hesitate before implementing them within existing curricula. Perhaps an accelerated course, designed to focus on content from such programs that is currently missing from medical schools based on comparative analysis of standard outlines of the two curricula, might offer an ideal solution for facilitated integration into current programs.

Given the clear promises of a program for early prehospital emergency training for medical students, coupled with the time commitment and extensive overlap associated with full emergency medical technician certification, a new hybrid program can offer a solution that strives to maximally deliver the benefits of prehospital training while minimizing disruption—or repetition—of current medical school curricula. Rather than using a two-month emergency medical technician curriculum to first introduce students to basic medicine and patient care upon arrival on campus, schools can install a brief, focused program midway through the preclinical curriculum that aims to translate basic lessons from their early education to the prehospital setting. By using medical simulation technology in a flipped classroom model, this program would fit seamlessly into the prevailing model of modern preclinical medical education, founded upon lessons from education research and established tenets of learning theory. [130,132–135] Such a solution would not only provide students with an orientation to emergency services and prehospital care that would be unique at most medical schools, but also promote emergency preparedness, development of practical skills, and improved teamwork in ways that will accelerate students' growth and better prepare them for future practice in the modern landscape of US healthcare.

Course Design

The three-phase design of this curriculum is summarized in **Table 2**. The timeline of plans to implement this project is illustrated in **Figure 6**. Both of these figures are quoted from the grant application submitted by Gregory Peters, Alexander Ordoobadi, and Kirstin Woody Scott, MPhil, PhD, under the mentorship of Charles Pozner, MD, for the Be The Change Grant Award opportunity offered by the Emergency Medicine Residents' Association.[147] Notice of Award was provided in March 2019.

Project Aims

The following project aims are quoted from the grant application submitted by Gregory Peters, Alexander Ordoobadi, and Kirstin Woody Scott, MPhil, PhD, under the mentorship of Charles Pozner, MD, for the Be The Change Grant Award opportunity announced by the Emergency Medicine Residents' Association.[147] Notice of Award was provided in March 2019.

Aim 1: To equip medical students with a basic understanding of the skills that may be needed to respond to an emergency in the prehospital care setting.

This project aims to meet a currently unmet need to teach basic skills of prehospital care to medical students, thereby bolstering both their preparedness and confidence. This project is designed to complement an existing 2-hour Basic Life Support training session that students complete twice during medical school, with greater emphasis placed on translating skills learned elsewhere to the prehospital setting.

Aim 2: To provide undifferentiated medical students with early exposure to Emergency Medicine.

Primarily geared toward first-year students, the Prehospital Emergency Bootcamp may be a student's first exposure to the field of Emergency Medicine and associated faculty. Students will also be exposed to subspecialties of the field, including but not limited to medical education, Emergency Medical Services, and disaster medicine, as well as opportunities to network with a variety of Emergency Medicine faculty involved in this project. The third phase of this program also offers a structured mechanism through which medical students can explore options for further exposure to Emergency Medical Services.

Aim 3: To promote improved interprofessional interaction between future physicians and prehospital providers and orient students to the concept of incident command systems.

This course will introduce students to common models of emergency medical services and 911 systems and the roles and scope of practice of prehospital providers. Improving interprofessional knowledge among future physicians can foster an improved understanding of the scope of care that can be provided to patients outside of centralized healthcare settings and translate to improved interactions with other providers throughout their careers. In addition, this orientation to prehospital services can provide a foundational knowledge base upon which future physicians can apply prehospital solutions to public health problems they might encounter in their careers.

Aim 4: To integrate the course into the core curriculum at Harvard Medical School and distribute the course to other Emergency Medicine Interest Groups within the Emergency Medicine Residents' Association network.

Recently, Harvard Medical School underwent a major overhaul of its undergraduate medical education curriculum. As the institution has been committed to continuous quality improvement and broadening opportunities for students to engage with desired programs, we will work with Harvard Medical School leadership and leading Emergency Medicine faculty regarding how to best integrate this Bootcamp into future iterations of the curriculum. Our team is well positioned to have these discussions as some of us have served as Education Representatives or in other student leadership positions at the institution. We will capture data on initial iterations of this Bootcamp for use in discussions regarding the optimal way to institutionalize and further develop this program. The program is designed using the "flipped classroom" methodology—combining preparatory learning with a highly interactive in-class model—that has been embraced at Harvard

Medical School in its new curriculum, lending itself for natural integration. Given that similar medical education reforms are currently underway at medical schools throughout the country, we anticipate that findings from this pilot initiative will be beneficial to other institutions that wish to introduce this training for their students.

Aim 5: To develop a quality improvement mechanism and conduct scholarly work to study the utility of this program for dissemination of findings across the Emergency Medicine Residents' Association network and beyond.

This project includes a research component. We plan to capture pre- and post- intervention data that will allow us to effectively evaluate the utility of the Prehospital Emergency Bootcamp for participants. This will involve a mix of both quantitative and qualitative survey data as well as focus groups with participants. We intend to share these data not only with Harvard Medical School leadership in the effort to promote greater integration of this content into the broader curriculum (as noted in Aim 4 above) but also through the Emergency Medicine Residents' Association network. If appropriate, we will summarize our findings and lessons learned for a peer-reviewed journal or other scholarly endeavors. Further, we intend to embrace a continuous quality improvement mindset and adapt the pilot Bootcamp in response to participant feedback and aim to have it more effectively meet evolving needs and optimize educational methodologies.

Aim 6: To promote leadership in medical simulation education across training generations—from students to residents and attending physicians—within Emergency Medicine.

This project provides senior medical students with an opportunity to work directly with Emergency Medicine residents and faculty on a unique medical education opportunity that involves simulation

experience. Under the mentorship of faculty and residents involved with the project, senior medical students will help to generate the content proposed for preparatory work for their first-year peers and gain valuable experience in creating learning objectives and short concept videos to introduce content that will later be revisited in the interactive dynamic component of the Prehospital Emergency Bootcamp. Further, these medical students along with residents and faculty will co-create the simulation-based exercises, thereby promoting integration and continued knowledge transfer between medical students, Emergency Medicine residents, and faculty. Finally, this work intends to expand the representation of Emergency Medicine within the core curriculum at Harvard Medical School, toward the promotion of its newly independent academic department within the institution.

DESCRIPTION OF SCHOLARLY PRODUCT

Key Personnel

- Gregory Peters is the student principal investigator of this project, responsible for assembling the project team, co-writing the curriculum, administering the course, preparing and administering the research study, and teaching the course. He is a fourth-year medical student and co-president of the Emergency Medicine Interest Group applying into Emergency Medicine with more than a decade of employment and volunteer service at multiple Emergency Medical Services agencies in New York City, including a leadership role in medical training and curriculum development at the Edgewater Park Volunteer Fire Department in Bronx, NY.
- Alexander Ordoobadi is a student co-investigator of this project, responsible for co-writing the curriculum development, administering the research study, and teaching the course. He is a fourth-year medical student and co-president of the Emergency Medicine Interest Group applying into General Surgery with a background as a former paramedic with Bethesda-Chevy Chase Rescue Squad in Montgomery County, MD.
- Kirstin Woody Scott, MPhil, PhD is a student co-investigator of this project, responsible for contributing to curriculum development and administering the course. She is a fifth-year medical student and co-president of the Emergency Medicine Interest Group applying into Emergency Medicine with extensive medical education experience including service as a Medical Education Representative and co-chair of the Liaison Committee on Medical Education Student Leadership Team at Harvard Medical School, and Legislative Coordinator of the Emergency Medicine Residents' Association Medical Student Council.

- Charles Pozner, MD, is the faculty mentor for this project and the principal investigator of the associated research study, responsible for mentoring the student leaders working on this project, coordinating support from additional faculty experts and staff at the STRATUS Center for Medical Simulation at Brigham and Women's Hospital, and overseeing design and execution of the project. He is not only an Associate Professor of Emergency Medicine at Harvard Medical School and the Executive Director of the STRATUS Center for Medical Simulation, but also served as former medical director of the Metropolitan Boston Emergency Medical Services Council.

Curriculum

Context & Key Learning Objectives

The Pathways curriculum at Harvard Medical School currently starts with a 13-month preclinical curriculum, which includes one day per week dedicated to a graduated clinical skills curriculum mainly focused on clinical interviewing and physical examination, directly preceding the yearlong principal clinical experience on the wards as captured in **Figure 1**. The proposed course of prehospital training is designed for installation roughly midway through the preclinical year, in order to translate early lessons from the classroom and the wards to the prehospital setting and provide a focused set of practical skills to prepare students for the principal clinical experience in year two, provide a unique introduction to emergency medical services, and orient them to emergency care at an early stage in training. After completing this course, each participant should be able to complete each of the following key learning objectives, quoted from the preparatory work provided in **Appendix 1**. This preparatory work document was written by Gregory Peters with contribution from Alexander Ordoobadi and Kirstin Woody Scott, MPhil, PhD, and underwent final review and revision by Charles Pozner, MD.

- Describe the means by which responders can keep themselves, patients, bystanders, and each other safe at the scene of an emergency.
- Communicate effectively with the emergency response system and appropriately integrate oneself into teams with other responders.
- Describe the general process by which a 911 call results in the response of emergency services, and describe the relative roles and medical training of key first responders.
- Assess the clinical stability of patients based on information available in the prehospital setting.
- Explain a basic approach to stabilizing patients using the ABC paradigm.
- Demonstrate recognition and appropriate initial care of life-threatening conditions commonly encountered in the prehospital setting.

Preparatory Materials

Mandatory preparatory work, consistent with the flipped classroom model of medical education, must be completed before participants present for the in-person workshop. The preparatory work for this course is provided in **Appendix 1**. This preparatory work document was written by Gregory Peters with contribution from Alexander Ordoobadi and Kirstin Woody Scott, MPhil, PhD, and underwent final review and revision by Charles Pozner, MD.

Course Agenda

The agenda for this course, organized using a template prepared by Charles Pozner, MD at the STRATUS Center for Medical Simulation, is provided in **Appendix 2**. This course agenda was

written by Gregory Peters, revised by Alexander Ordoobadi and Kirstin Woody Scott, MPhil, PhD, and underwent final review and revision by Charles Pozner, MD.

Structured Debriefing

Research has clearly demonstrated the importance of debriefing as a critical component of medical simulation exercises.[148–152] In order to maximize the consistent effectiveness of debriefing sessions and the overall course, a set of key learning objectives has been defined for each of the three emergency scenarios that constitute the interactive workshop. Debrief sessions are included immediately after each of the three exercises to ensure the provision of specific feedback and the completion of the learning objectives for each topic. All resident facilitators (volunteers from the Harvard Affiliated Emergency Medicine Residency program, recruited by Gregory Peters) who teach the course are provided with these objectives and given brief instruction in proper debriefing practices based on the relevant literature (as well as instruction from medical simulation experts at the STRATUS Center for Medical Simulation) before leading their sessions. Key learning objectives for each scenario are included within the course agenda, shown in **Appendix 2**.

Research Study

The research study included in this project to study the effectiveness of the proposed curriculum is described in the manuscript included in **Appendix 3** (first draft prepared by Gregory Peters with the expectation of future contributions from additional co-authors). After increasing the sample size by holding an additional session during Winter 2020, this draft will be updated, revised, and potentially submitted to The Emergency Medicine Journal as a short report (this manuscript is formatted in accordance with the applicable submission guidelines).[153]

DISCUSSION

Promises of Proposed Solution

The potential beneficial implications of this program can be divided into the domains of medical education, public service, and academic emergency medicine. Medical students who participate in this program will receive a set of foundational medical knowledge and practical skills that will enhance their preparation for the clinical year of medical school. The simulated medical emergency exercises in this course aim to improve students' ability to participate in emergency care on the wards,[154] which can in turn optimize their learning experience related to emergency care before graduation. After all, research has shown that more than one-third of graduating fourth-year medical students deny the ability to perform cardiopulmonary resuscitation independently,[123] despite a report that 83.4% of students witness a cardiac arrest during medical school,[31] likely at least partially due to the finding that more than one-third of graduating students reported a history of avoiding participation in resuscitations due to lack of confidence in their training.[31] Therefore, by improving confidence early in medical school as suggested by the preliminary data generated by this project, students might engage with future emergencies in the course of their training and practice in ways that will produce residents with greater emergency preparedness as a result of this brief early intervention.

This program is expected to promote not only student development, but also public service. Given preliminary data to suggest significantly improved knowledge in prehospital care, students are expected to emerge with better preparedness to respond to public emergencies as Good Samaritans (such as in the in-flight medical emergency scenario), in addition to emergencies that occur in the outpatient setting and require greater physician autonomy than in inpatient settings (such as in the simulated scenario of respiratory arrest in an outpatient clinic). Research suggests

that physicians are likely to encounter such scenarios,[31,100,101] and as high-resource hospitals proceed to resemble such settings progressively less with time, medical schools should consider investing in brief, focused training to adapt students' medical training to the prehospital setting. Physicians have a moral duty to respond to patients' calls for help when emergencies unfold not only on an individual basis, but also at the population level. As the prehospital sector of healthcare expands across its spectrum—from emergency medical services and community paramedicine to prehospital public health initiatives such as layperson cardiopulmonary resuscitation training and Opioid Overdose Education & Naloxone Distribution programs—physicians can expect the frequency of their interactions with these services to only increase. Programs such as these offer a solution to medical schools as they aim to prepare their students for a new wave in healthcare that extends physicians' care beyond the walls of hospitals and clinics into the community.

Finally, this program promises important benefits for the field of Academic Emergency Medicine. Emergency Medicine remains in its relatively infancy as an independent academic department in many US institutions (for example, Harvard did not establish Emergency Medicine as its own department until late 2014),[35] and this program marks an important opportunity for the field to increase its representation within core preclinical curricula and expand its presence within schools. This program ensures early exposure to Emergency Medicine concepts, skills, careers, and faculty, which can in turn inspire students to pursue electives within the field and ultimately enhance student recruitment for residency. This potential benefit is especially important because only half of schools require an Emergency Medicine rotation,[29] and data suggests that experience during clinical rotations mark the most important factor in their choice of specialty.[117] Furthermore, by focusing on basic yet important skills and content that can often be overlooked on the wards, this program creates excellent opportunities for near-peer education by emergency

medicine residents and senior students with a prehospital background, which further enriches the educational value of this program by promoting a valuable skillset for a future career in academic emergency medicine.[155,156] Finally, programs such as these, led by Emergency Medicine faculty with expertise in fields that include medical education, medical simulation, emergency medical services, and disaster medicine, can inspire interest in Emergency Medicine subspecialties and increase their influence at academic institutions, further empowering the field.

Limitations & Future Work

The use of medical simulation in this course marks a pedagogical strength of the program, but also its foremost logistical weakness. The two parallel medical simulation scenarios that mark the centerpiece of this course are associated with costly initial investments and low student-to-facilitator ratios. For example, a medical school with 2 simulators would need to run 10 sessions for 15 students each in order to serve a class of 150; this would require a minimum commitment of 30 hours from three educators plus one technician. Medical schools might hesitate to commit such extensive resources to such a program. However, by limiting the scope of this course to Basic Life Support for junior medical students, senior medical students with prehospital backgrounds and emergency medicine residents were able to engage in voluntary near-peer education, which not only significantly reduced the costs of the course, but also enriched its training benefits for future careers in academic emergency medicine. Of course, this decision comes at the cost of important Advanced Life Support skills—best taught by those with more advanced training—that would increase the benefit to participants, but this cost-benefit analysis will differ at each site of implementation. Similarly, the extent of student benefit from participating in this course depend upon the current state of their training, including the amount of resources available at clinical sites (e.g., greater overlap would be observed in many low-resource county hospital settings) and the

existence of other programs to teach similar content and skills (e.g., the benefits of this course would be very limited at the two medical schools that currently require full Emergency Medical Technician certification upon arrival on campus). Therefore, the limitations of this course would vary at other institutions, and in turn, implementation at other sites should entail work adjustments specifically tailored to the context in question.

Future efforts must be undertaken to increase participation and spread the program to additional sites, in order to generate more data on the benefits and potential areas of improvement for this course. In addition, more work must be invested into developing the comparative analysis between medical school and prehospital provider training, especially given the heterogeneity between schools and regions, in order to maximize gains while minimizing overlap. In addition, this program will benefit from new ideas to focus the curriculum and improve overall value, perhaps by finding new ways to reduce the need for costly equipment and extensive time commitment from highly trained individuals without significant reduction in quality. Finally, improved metrics to assess the effectiveness of this program must be developed in order to evaluate a wider variety of benefits from participation, in addition to measuring the durability of these benefits and the extent to which they translate into appreciable changes in real-world practice. For example, such advancements might reveal the need for refresher courses over time, or indicate the need to redesign content for improved retention.

Concluding Remarks

Examining the quickly evolving landscapes of US healthcare and medical education, in addition to emerging trends within prehospital care, reveals a growing need for medical schools to address an important training gap related to physicians' preparedness to provide patient care and

promote population health in the community. This work proposes a novel 3.5-hour prehospital emergency curriculum—designed using a comparative analysis of the two curricula and modeled after the prevailing tenets of modern medical education theory—for facilitated integration into medical school programs to close this training gap. Preliminary data from a pilot study of the effectiveness of this course suggest that it can boost participants' confidence and knowledge related to prehospital systems, skills, and concepts. Important potential benefits include students with improved emergency preparedness, physicians with greater ability to respond to public emergencies and apply prehospital solutions to public health problems, and promotion of the still-growing field of Academic Emergency Medicine. Future work is needed to increase the evidence base evaluating this course, develop improved metrics to assess its efficacy, and promote its implementation at additional medical schools nationwide.

TABLES AND FIGURES

Note: Tables and figures cited within the appendices of this report are featured within the text of those appendices and are not included here.

Tables

Table 1: Results from a survey sent to 330 first- and second-year medical students at Harvard Medical School in January 2019. Fifty-nine students responded (17.9%), including 39 first- and 20 second-year students.

Survey Item	Yes: n (%)	No: n (%)
I feel comfortable responding to a medical emergency as a first responder outside the hospital setting.	15 (25%)	44 (75%)
I would like to receive more training in responding to medical emergencies outside the hospital setting before earning my MD.	57 (97%)	2 (3%)
Have you received first responder training prior to or outside of medical school?	25 (42%)	34 (58%)

Table 2: Overview of curriculum design in three phases.

Phase One: Preparatory Work	A consolidated set of preparatory materials will be distributed to participants for completion before each workshop. This 30-minute module will consist of a list of learning objectives, excerpts from selected readings, a concept video to present the key framework for course content (which will be curated and created by the senior medical students under the mentorship of course faculty), and a pre-test that will consist of both knowledge and confidence assessments related to the learning objectives on prehospital care. We will post course materials via a secure private platform and make it available to students upon enrolling. Content will mirror themes covered in the interactive workshop in service of the outlined educational objectives.
Phase Two: Interactive Workshop	The three-hour interactive workshop session marks the core of the Prehospital Emergency Bootcamp, which includes a didactic session and three rotations that combine a prehospital emergency scenario with a debrief. STRATUS Center staff will be heavily involved in optimizing resource management and ensuring feasibility when developing this phase. In brief, this workshop includes: A. An interactive didactic session designed to reinforce lessons covered in the preparatory work in service of the educational objectives. B. Three simultaneous rotations designed to cover content and teach practical skills useful in the prehospital setting, each with its own debrief session: 1. Simulation: Opioid overdose in an ambulatory clinic. 2. Simulation: Anaphylaxis on an airplane. 3. Tabletop exercise: Motor vehicle crash with hemorrhage. The details of each component of the interactive workshop are included in the attached program agenda. To conclude each workshop, a post-test will be administered for comparison to pre-course measurements, along with a quality improvement instrument.
Phase Three: EMS Experience (optional)	Upon enrolling in the Prehospital Emergency Bootcamp, students will be invited to opt into scheduling a ride-along experience with a local EMS agency following completion of the first two phases, in order deepen their orientation to emergency medical services.

Figures

Figure 1: Pathways Curriculum at Harvard Medical School, established in 2015.[27]

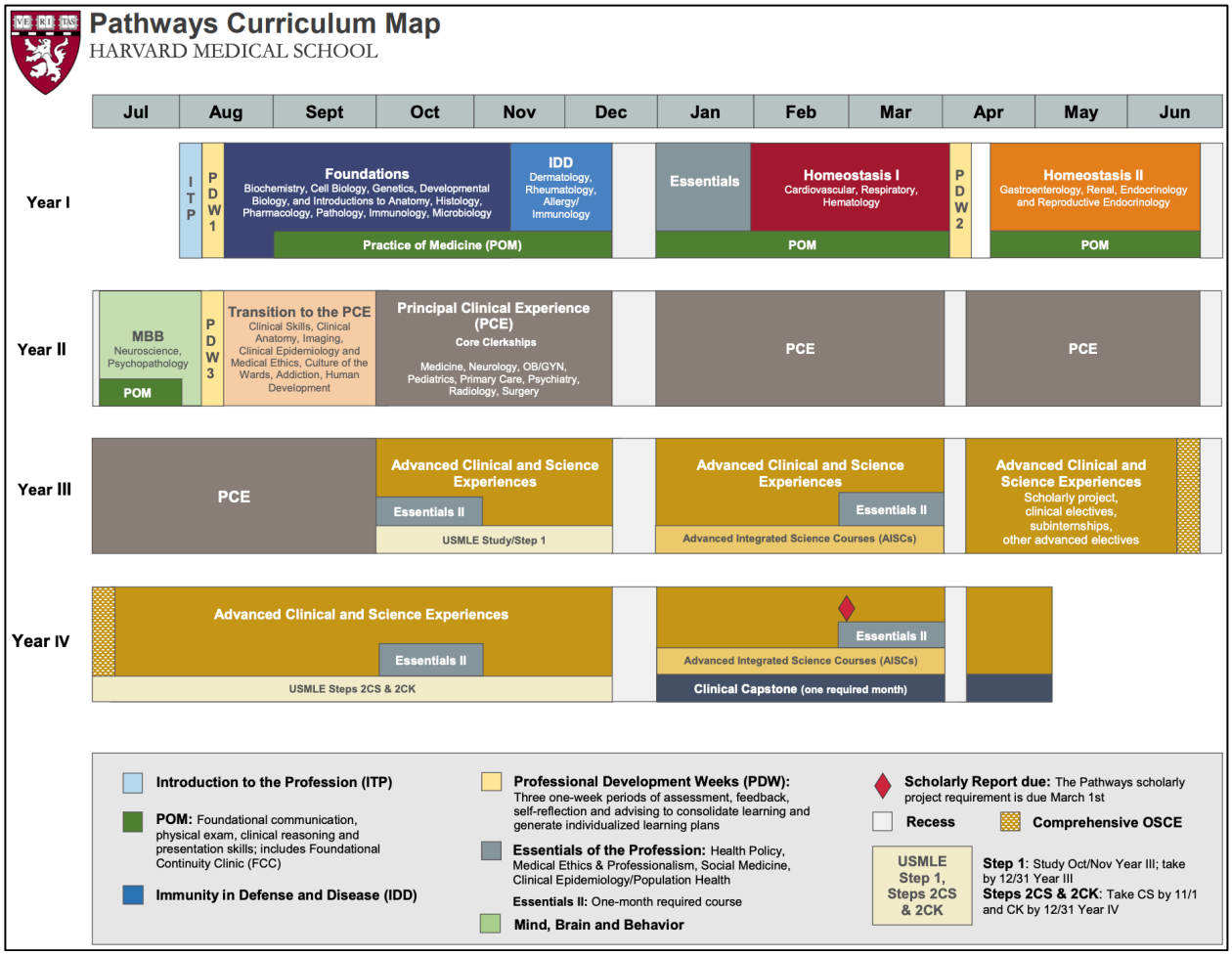

Figure 2: Factors contributing to the proposed training gap in US medical schools.

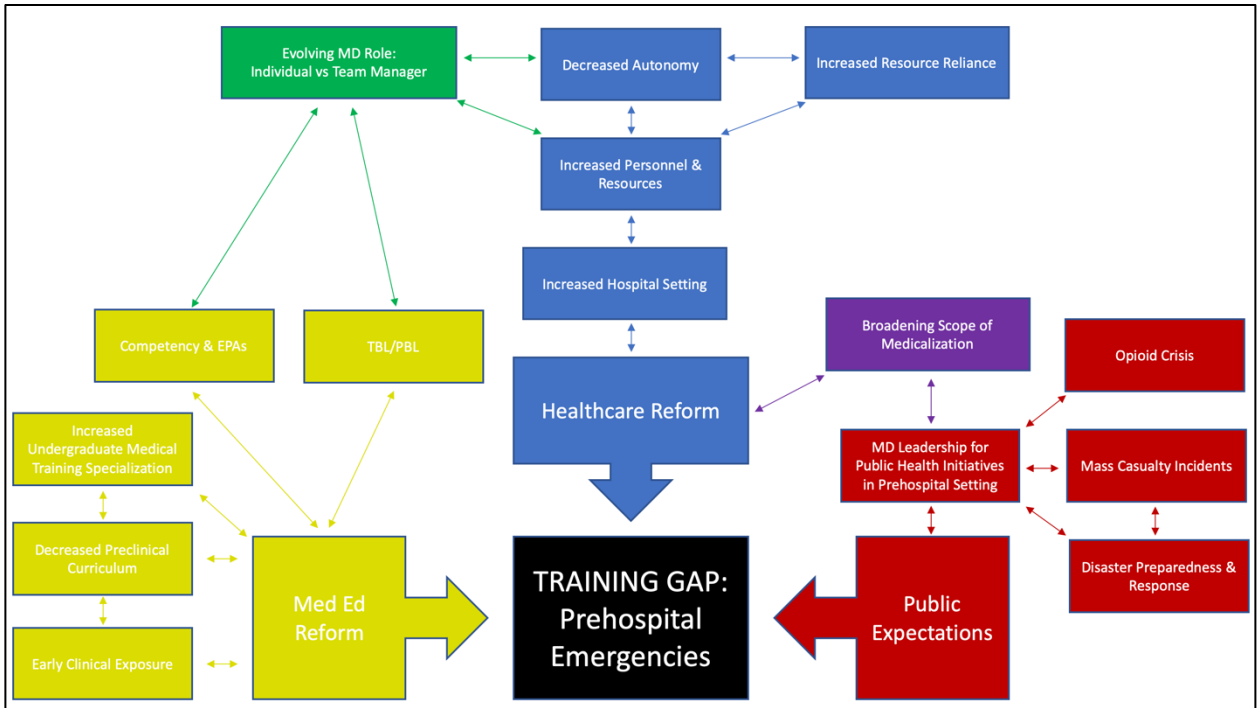

Figure 3: Concept map of societal changes exerting influence upon physician training and practice. Democratic factors are represented in blue, and technocratic factors in red.

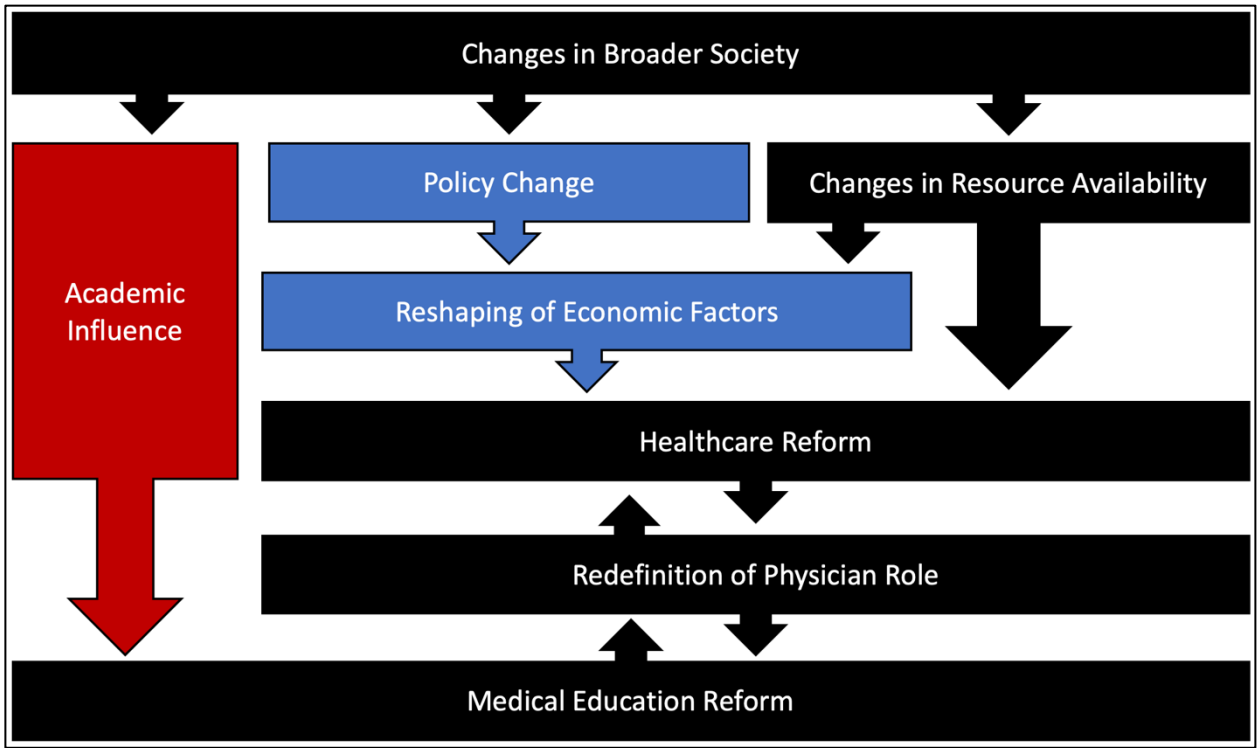

Figure 4: Components of the proposed solution.

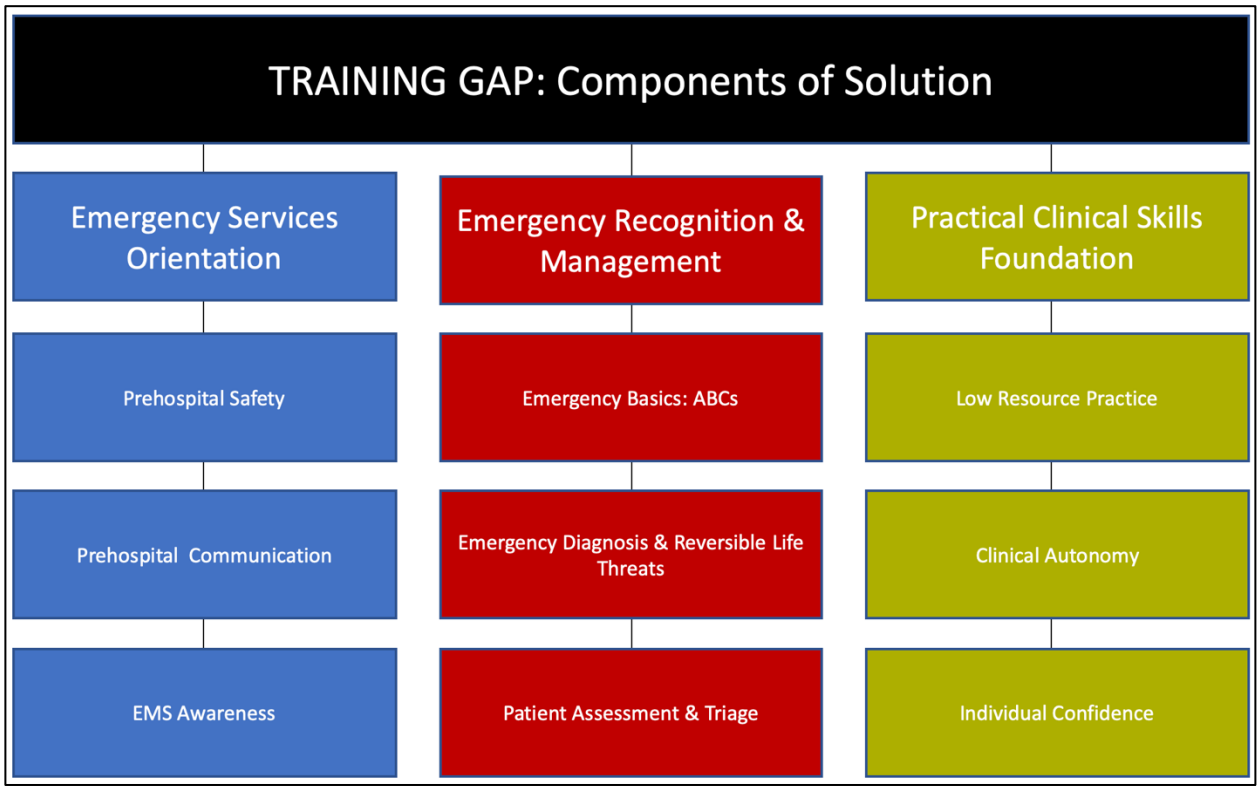

Figure 5: Course educational objectives mapped onto contributing factors to the training gaps they address (blue), as well as the key components of the proposed solution (red).

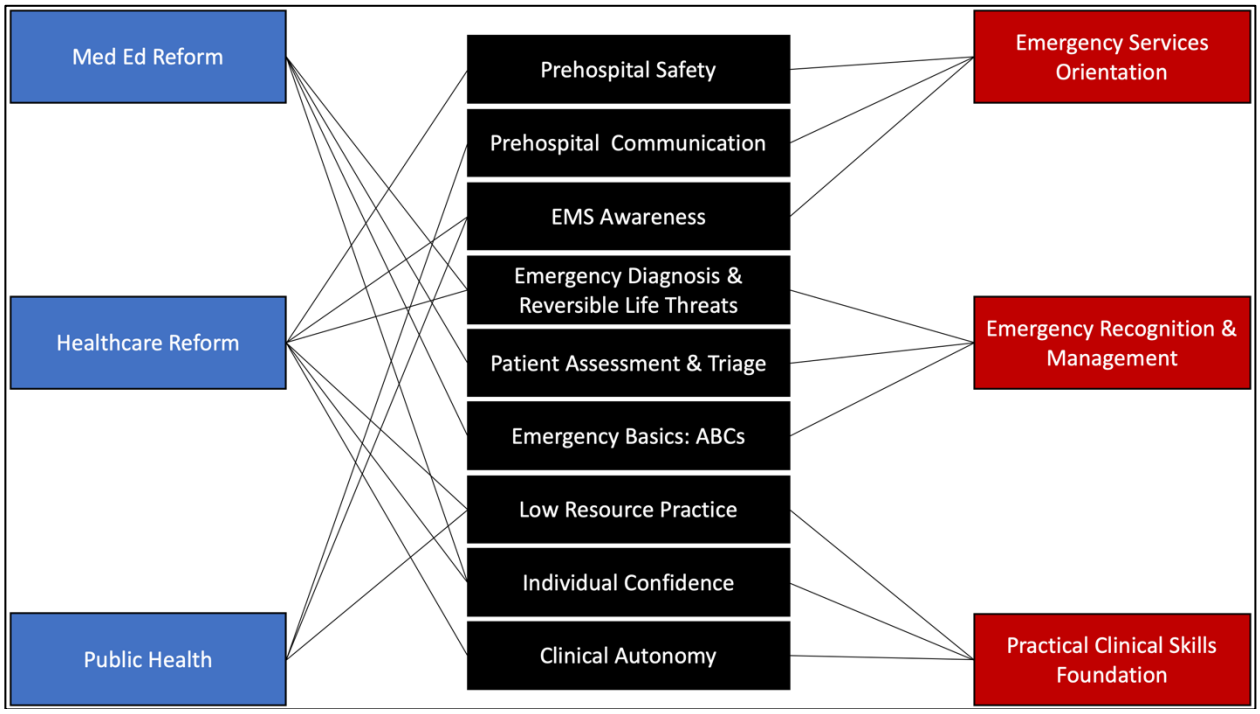

Figure 6: Gantt chart depicting the proposed timeline to complete this project, from February 2019 through April 2020. X denotes a workshop or quality improvement (QI) meeting, respectively.

	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2019	Jan 2020	Feb 2020	Mar 2020	Apr 2020
Curriculum Development	■	■	■	■											
Simulation Design		■	■	■											
Procurement			■	■											
Workshop Sessions (Pilot Session)					(X)		X		X		X		X		
Continuous QI					X	X		X		X		X	■		
Report Preparation													■	■	■
Dissemination															■

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APPENDICES

Appendix 1: Preparatory work required before the in-person workshop, consistent with the flipped-classroom model of medical education.

HMS EMIG Prehospital Emergency Response Training Workshop

Thank you for your interest in this new program! In 2019, the HMS Emergency Medicine Interest Group (EMIG) is launching an optional training workshop designed to prepare students with a framework for responding to medical emergencies in the prehospital setting safely and effectively. We hope that you enjoy it and emerge with increased competence and confidence to provide care to patients anywhere they might present to you as a future physician.

After completing this short training, you should be able to:

- Describe the means by which responders can keep themselves, patients, bystanders, and each other safe at the scene of an emergency.
- Communicate effectively with the emergency response system and appropriately integrate oneself into teams with other responders.
- Describe the general process by which a 911 call results in the response of emergency services, and describe the relative roles and medical training of key first responders.
- Assess the clinical stability of patients based on information available in the prehospital setting.
- Explain a basic approach to stabilizing patients using the ABC paradigm.
- Demonstrate recognition and appropriate initial care of life-threatening conditions commonly encountered in the prehospital setting.

IMPORTANT: Before reading further, you should have already completed the pre-course survey that was shared with you when you via email. If you have not yet completed this survey, please stop and take the survey now.

If you have any questions, concerns, or suggestions regarding these preparatory materials, please feel free to contact the course developers at hmsemig@gmail.com.

General Approach to Scene and Patient Assessment

Please watch this 7-minute concept video, which provides a framework for responding to a prehospital emergency. https://www.youtube.com/watch?v=PMF1mo_GGt0

To summarize, here is a general framework that can be used if you find yourself responding to someone in need of help:

1. Establish—and maintain—scene safety
2. Assess responsiveness (AVPU: Alert, Verbal, Painful, Unresponsive)
3. Airway
4. Breathing
5. Circulation
6. Call for help

Please consider this framework as you read the following 3 examples that highlight a few types of emergencies that healthcare professionals are likely to encounter outside of the hospital setting.

SCOPE OF PRACTICE LIMITATIONS: These training materials make references to the administration of drugs (e.g., epinephrine, glucagon) and procedures (e.g., IV access) that are restricted to licensed healthcare providers. This workshop does NOT certify you to perform these skills independently. You should not administer drugs or perform advanced procedures without appropriate supervision from a physician until you have graduated from medical school and possess a medical license. Medications that should not be administered by medical students without appropriate supervision are highlighted in red. However, you may perform basic life support skills like CPR, AED, and bleeding control maneuvers while still a medical student. In addition, you may administer naloxone in the state of Massachusetts to an individual appearing to experience an opioid-related overdose without possessing a medical license (M.G.L. c. 94C, § 19B(g)).

Pre-Hospital Emergency Examples

Example 1. Opioid Overdose

Opioid overdose has received significant nationwide attention in recent years due to a recent increase in mortality. Efforts to improve emergency medical intervention by first responders and as well as the public have helped to address this concerning trend, though much more work remains to be done. Given that physicians are called to help lead these efforts, it is important for medical students to know how to recognize and treat opioid overdose.

Pathophysiology Highlights

Opioids suppress the action of respiratory centers in the brainstem, resulting in hypoventilation or even respiratory arrest. Without prompt treatment, permanent brain damage or death can result.

Presentation

- On scene clues to potential opioid overdose include the presence of drug paraphernalia (needles, pill bottles) or information from bystanders.
- Physical exam could demonstrate decreased respiratory rate (<10 breaths per minute), pinpoint pupils, decreased level of consciousness, and track marks from IV drug injection.

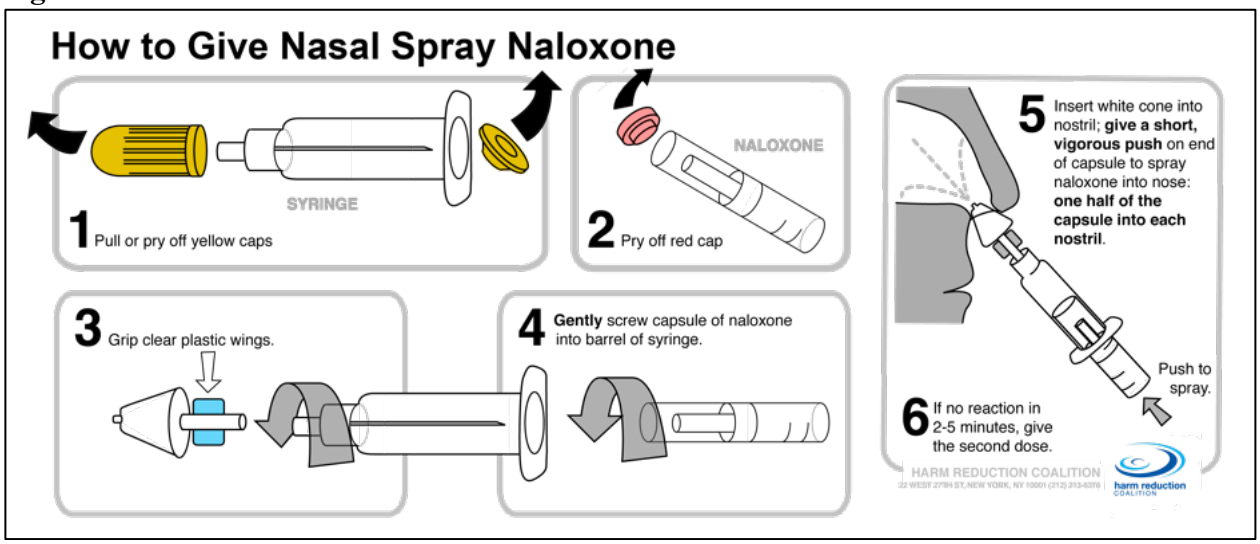
Treatment

Managing the ABCs is the key treatment for opioid overdose and can keep a patient alive even if naloxone is not available.

- Airway: Open the airway with either the head-tilt, chin-lift or jaw thrust maneuvers. If available, consider placing an airway adjunct like a nasopharyngeal airway (NPA) or oropharyngeal airway (OPA).
- Breathing: Perform rescue breathing if the patient's respirations are inadequate (e.g., less than 8 breaths per minute) or absent. If available, respiratory support can be provided with supplemental oxygen or a bag-valve mask (BVM). **Performing rescue breathing is the key treatment for opioid overdose.**
- Circulation: Monitor pulse. Prolonged apnea can lead to cardiac arrest. If no pulse, start CPR.

Naloxone is an opioid antagonist that can reverse the effects of opioid overdose and restore proper respiratory drive. Naloxone can be administered intranasally (IN), typically at a starting dose of 2-4 mg (see **Figure 1**). Continue to monitor and manage ABCs until first responders arrive. Importantly, the half-life of naloxone is shorter than the half-life of many narcotics and thus additional doses may be required. Patients who receive naloxone should therefore be transported to an emergency department for monitoring. Note that naloxone administration can precipitate acute opioid withdrawal and can therefore lead to agitation.

Figure 1. Administration of intranasal naloxone



If you are curious to learn more, please watch this <3min video on how naloxone is administered through some of the existing delivery mechanisms available to the public and/or healthcare professionals: https://www.ama-assn.org/delivering-care/opioids/how-administer-naloxone

Note: *There are ongoing efforts at HMS to improve curriculum exposure to substance use disorder treatment and management that includes naloxone administration training. Please contact us at hmsemig@gmail.com if you are interested in learning more!*

Example 2. Hypoglycemia

Hypoglycemia most commonly occurs in insulin-dependent diabetics who inadvertently take too much insulin. It can also occur in patients without a history of diabetes due to rare neuroendocrine tumors (*you will learn more about this in Homeostasis II*). While patients with diabetes are usually able to detect symptoms of hypoglycemia and consume carbohydrates to restore their glucose levels, in severe cases, patients can develop altered mental status, unresponsiveness, and/or seizure. Because hypoglycemia can be easily treated, it is important to consider it on the differential when you encounter someone with altered mental status, seizures, or unresponsiveness.

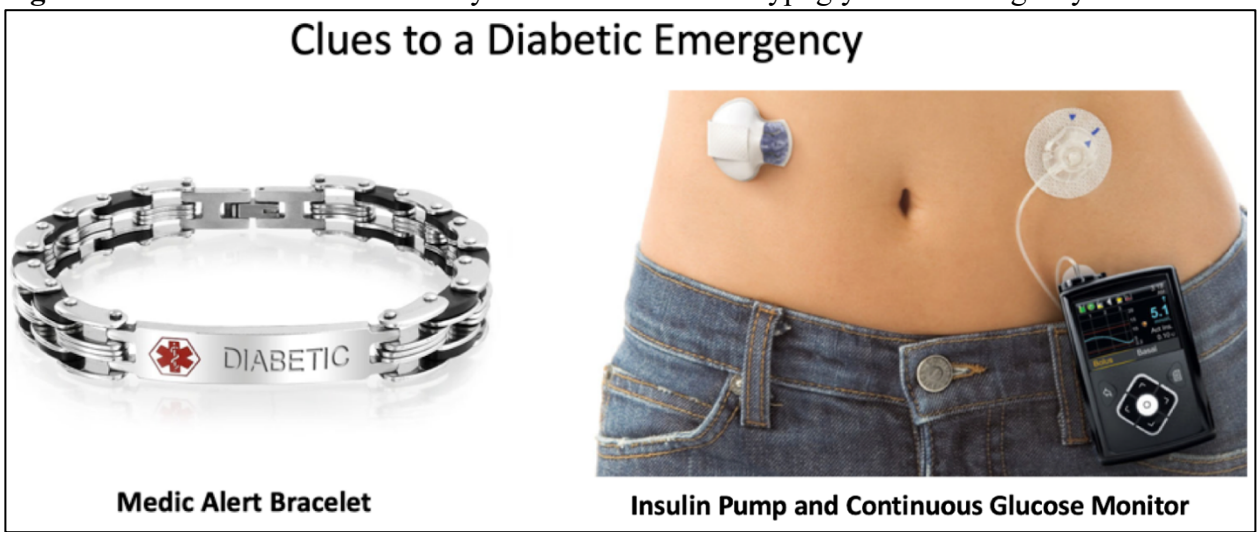
Pathophysiology Highlights

Insulin causes a wide range of effects throughout the body, including action at the cellular level to increase uptake of glucose from the blood. The body possesses reliable mechanisms that protect against excess endogenous insulin release in the fasting state, as well as mechanisms that compensate for decreased glucose intake, rendering naturally-occurring dangerous hypoglycemia very rare in normal settings. However, mismatch between exogenous insulin and glucose intake can cause severe hypoglycemia that can lead to altered mental status, coma, or death.

Presentation

- The following are some "on scene clues" that hypoglycemia is a cause of altered mental status: presence of a medic alert bracelet/necklace, presence of an insulin pump or continuous glucose monitor, and information from bystanders/family (see Figure 2).
- Initial symptoms of hypoglycemia can include confusion, anxiety, diaphoresis, irritability, pallor, headache, vision changes, and palpitations. As the hypoglycemia becomes more severe, patients can develop altered mental status leading to unresponsiveness. Some patients with severe hypoglycemia have seizure activity.
- If available, blood glucose should be measured using a point-of-care glucometer. **Hypoglycemia is defined as a blood sugar less than 70 mg/dL**, although patients who are unresponsive from hypoglycemia usually have much lower blood sugar, often less than 50 mg/dL.

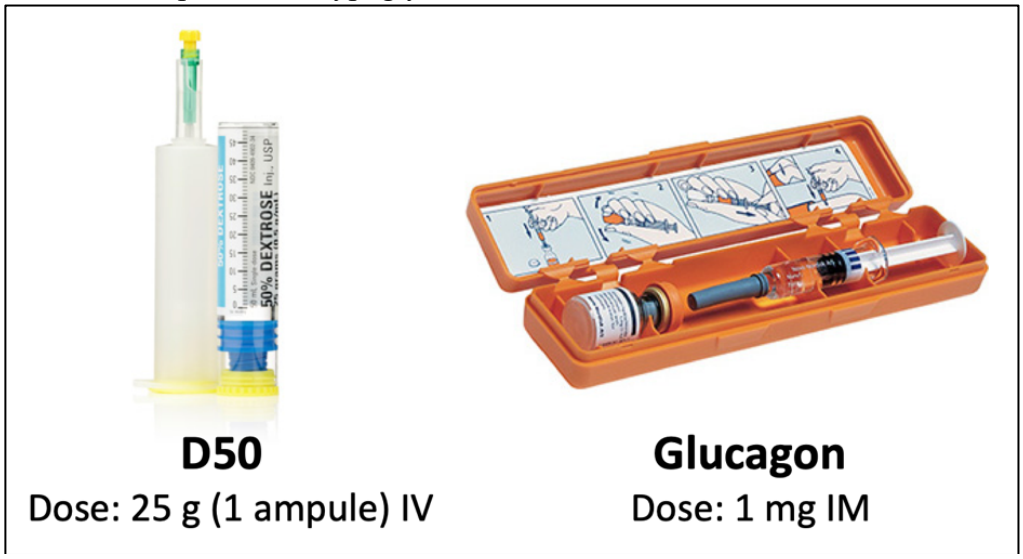
Figure 2. On Scene Clues to Identify Patients At Risk of Hypoglycemic Emergency



Treatment

If the patient has sufficient mental status to swallow and protect the airway, oral glucose can be provided in the form of food, beverages, or **glucose paste/gel**. If the patient lacks sufficient mental status, oral glucose is unsafe due to the risk of aspiration. In clinical settings where IV access can be obtained, administration of a 50% dextrose solution (**D50**) should be provided, typically at a starting dose of 25g for adults with additional doses pending further assessment (see Figure 3). Alternatively, **glucagon**, a hormone that triggers glucose release, can be administered intramuscularly (IM), avoiding the need for IV access. Many patients with type I diabetes own a glucagon rescue kit. If glucagon is available, administer 1 mg intramuscularly (IM). If you are curious about how to use a glucagon rescue kit, watch this video: https://www.youtube.com/watch?v=cHuyxbYG26g. Following administration of either D50 or glucagon, continue to monitor ABCs until EMS arrives or the patient regains consciousness. Always reassess the patient after administering any intervention.

Figure 3. Treatment Options for Hypoglycemia



Example 3. Anaphylaxis
Anaphylaxis is a potentially life-threatening allergic reaction. Patients may not be aware of their allergy or that they were exposed to the causal allergen. The presentation can vary but often includes hives, wheezing, airway swelling, gastrointestinal (GI) upset, and potentially circulatory collapse. Rapid diagnosis and immediate treatment with epinephrine is lifesaving.

Pathophysiology Highlights
Exposure to the causative allergen triggers the systemic release of a variety of cytokines, including histamine, from mast cells and basophils. These chemical mediators affect multiple organ systems:

- Circulatory system: vasodilation and increased vascular permeability leading to distributive shock.
- Respiratory system: bronchoconstriction and airway edema leading to respiratory distress.
- Gastrointestinal system: gut edema and smooth muscle spasms, leading to vomiting and abdominal pain.
- Skin: increased vascular permeability leads to fluid accumulation in the dermis, resulting in the classic hives rash. Histamine triggers the sensation of itchiness.

Presentation
The classic presentation of anaphylaxis is the acute onset of respiratory distress and hives after exposure to an allergen. However, anaphylaxis can also present with cardiovascular and/or GI involvement. A comprehensive list of presenting signs/symptoms by organ system includes:

- Skin and mucosa: Hives, itching, and swollen lips/tongue/oropharynx. Hives or other skin manifestations are present in 90% of cases.
- Respiratory: sensation of throat closing, stridor and/or wheezing, shortness of breath, wheezing, cough. difficulty swallowing.
- Circulatory system: hypotension and tachycardia.
- Gastrointestinal system: nausea, vomiting, crampy abdominal pain.

Treatment
Immediate administration of **epinephrine** is the key treatment for anaphylaxis. Epinephrine for anaphylaxis is usually administered through an EpiPen. **Adult EpiPens** are used for adults and children weighing more than 25 kg and contain 0.3 mg of epinephrine. **Pediatric EpiPens** are used for children weighing less than 25 kg and contain 0.15 mg of epinephrine. EpiPens should be administered to the lateral thigh and can be administered through clothing. Anaphylaxis can persist or rebound after EpiPen administration, so emergency transport to a hospital is always indicated. Please watch this brief video on how to use an EpiPen: https://www.youtube.com/watch?v=UugQ5wU6f2A.

Note on Epinephrine
In many clinical settings, epinephrine is available in a vial rather than in an EpiPen. Epinephrine comes in two concentrations. The 1 mg/1 mL (1:1,000) concentration is what is used in the EpiPen and is only for intramuscular (IM) injection in patients with anaphylaxis. The 1 mg/10 mL

(1:10,000) concentration is administered IV and can be used to treat patients with severe hypotension from anaphylaxis. This concentration is also used in cardiac arrest. For a patient in anaphylaxis, the dosing of epinephrine is 0.01 mg per kg of body weight, with a maximum dose of 0.5 mg. In anaphylaxis, the 1 mg/1 mL (1:1,000) concentration should be used and administered intramuscularly (IM). **Note that the 1 mg/1 mL (1:1,000) concentration should NEVER be administered IV**. The dosing and concentration of epinephrine is confusing and is a frequent source of medication errors, so it is important to learn about the forms and dosing of epinephrine early in medical school (Figure 4).

Figure 4. Forms of Epinephrine and Dosing*

The Many Varieties of Epinephrine

	Adult EpiPen	"Code" Epinephrine	Epinephrine Vial
Concentration	1 mg in 1 mL (1:1,000)	1 mg in 10 mL (1:10,000)	1 mg in 1 mL (1:1,000)
Use	Anaphylaxis	• Cardiac Arrest • Anaphylaxis with severe hypotension	Anaphylaxis
Dose/Route	0.3 mg IM (anaphylaxis)	1 mg IV (cardiac arrest, severe anaphylaxis)	0.01 mg/kg max 0.5 mg (anaphylaxis)

*Do not administer epinephrine without appropriate supervision.

Appendix 2: Course agenda, organized using a template prepared by Charles Pozner, MD at the STRATUS Center for Medical Simulation.

Program Agenda:

Date	Time	Program Length
Multiple	Multiple	3:00

Duration	Module Title / Format	Content Description	Concurrent?	Number of Learners	Leaders	Room requirements
0:15	**Welcome & Orientation**	Introduce safe learning environment, introduce sim, provide tour of sim room/manikin	No	18	2-3: GP, AO, DN, SS	PowerPoint display with audio; one sim room for tour
0:25	**Introduction (Didactic)**	Scene safety, basics of 911 and EMS, legal considerations, general approach to prehospital patient	No	18	2: GP, AO	PowerPoint display with audio
0:05	**Transition**					
0:35	**Scenario 1**	Opioid overdose simulation	Yes	6	1+1: SS, JC; GP	HPS Room
0:05	**Transition**					
0:35	**Scenario 2**	Anaphylaxis simulation	Yes	6	1+1: SS, JS; GP	HPS Room
0:05	**Transition**					
0:35	**Skills Session 1**	MVA tabletop exercise	Yes	6	2: AO; GP	Conference Room with slide capability and white board
0:05	**Transition**					
0:15	**Wrap up / Evaluations**	Complete QI instruments	No	18	2: GP, AO	Conference Room

Program / Session Title:	**Opening Didactic**				
Lead Faculty/ Course Director:	Name: Charles Pozner, MD Title/position: Executive Director				
Additional Faculty: (Please include names where available)	Number: 2-3 Discipline: EM Level of training: MS3-4				
Goal of the session:					
Educational Objectives:	Following this session, the participants should be able to: Assess and maximize scene safety. Explain how 911 activates EMS and basics of incident command and triage. Demonstrate initial assessment and treatment in prehospital setting. Communicate effectively when interacting with prehospital providers.				
Participants:	Number: 18 Discipline: Medical Students Level of training: MS1				
Content Description	Through an interactive discussion there will be an introduction to the concepts of scene safety in the prehospital setting, the 911/EMS communications system, the basic principles of the initial care of the ill and injured in the prehospital setting, and effective communication when reporting emergency and transferring care to EMS.				
Rooms required: (General description of ideal spaces. STRATUS will assign suitable rooms.)	Conference room with audio/video display.				
Simulation Specialists:	None				
Will there be Industry involvement?	No				
Specific equipment required:	Station	Equipment	Quantity	STRATUS to provide	Faculty to provide
	Didactic	Audio/Video Display	1	X	
		White Board	1	X	

Case Title:	**Ambulatory Clinic Respiratory Failure**		
Lead Faculty/ Course Director:	Name: Charles Pozner, MD Title/position: Executive Director		
Case Summary	34M presents at clinic for follow-up of recent mitral valve replacement. He is somnolent with decreased respiratory rate in the setting of opioid overdose.		
Clinical Diagnosis	Opioid overdose.		
Educational Objectives of this case:	Following this session, the participants should be able to: 1. List the common clinical features of opioid overdose. 2. Demonstrate maintenance of airway using head-tilt-chin-lift and jaw-thrust maneuvers, use of oropharyngeal and nasopharyngeal airways, and application of supplemental oxygen and BVM. 3. Demonstrate the appropriate administration of intranasal naloxone.		
Venue	Ambulatory clinic		
Total Time	40 mins: Case= 10 min. + Debriefing= 30 min		
Number/role of Participants:	Patient: Manikin	Learners: 6 medical students	Confederate: none
Patient Information	Name: John Doe	DOB: 1/1/1985 Age: 34	
	Weight: 70kg	Gender: Male	
Patient History	PMH: infective endocarditis, IV drug use PSxH: mitral valve replacement (POD 7) Meds: Lovenox Allergies: NKDA Family History: unknown		

<u>Case 'Narrative' 'Flow':</u>

Prior to start	Reason for visit: Patient is ay clinic for follow-up visit following MVR for infective endocarditis 6 days ago. Patient somnolent in waiting room, responds to painful stimuli only.		
	Trigger:	**Vitals / Status:**	**Learner actions/ Comments:**
Start scenario (Phase 1)	Two students enter, patient responds only to loud verbal stimulation and falls back to sleep, provides few-word answers with slurred speech	HR: 90 BP: 130/80 RR: 8	Establish scene safety, call for local help and 911, position patient and establish airway, administer oxygen via NRM, assess vitals
Phase 2	Patient now rousable to noxious stimulation only	HR: 110 BP 130/80 RR: 5	Switch to BMV with supplemental O2, request and administer intranasal naloxone

Phase 3	EMS arrives, patient is agitated	Responsive HR: 110 BP: 130/80 RR: 20	Relay pertinent information to EMS, transfer care
Scenario End	**Care is transferred to EMS**		
Desired Learner actions	Assess and manage scene Position patient/jaw thrust Report emergency effectively Deliver oxygen Use of BMV Administer intranasal naloxone		
Cues for patient and /or confederates	Participants should respond to condition of patient. They should work collectively to assess and manage patient		

Setup required	**Equipment (examples):**	**Quantity**	**STRATUS to provide**	**Faculty to provide**
	Mannequin 3G	1	X	
	O2 source	1	X	
	Intranasal naloxone training kit	1	X	
	BP cuff	1	X	
	Stethoscope	1	X	
	NRM	1	X	
	BVM	1	X	
	Nasal cannula	1	X	

Case Title:	**Inflight Anaphylaxis**		
Lead Faculty/ Course Director:	Name: Charles Pozner, MD Title/position: Executive Director		
Case Summary	19F on airplane with h/o DM and peanut allergy presenting with emesis, urticaria, and respiratory distress with stridor following a midflight meal containing peanut oil.		
Clinical Diagnosis	Anaphylaxis.		
Educational Objectives of this case:	Following this session, the participants should be able to: List the typical clinical features of anaphylaxis. Take vital signs and place the patient on oxygen. Prepare and administer the intramuscular dose of epinephrine via EpiPen. Explain the medical resources available on commercial flights.		
Venue	Commercial aircraft cabin		
Total Time	40 mins: Case= 10 min. + Debriefing= 30 min		
Number/role of Participants:	Patient: manikin	Learners: 6 medical students	Confederate: flight attendant
Patient Information	Name: Jane Doe	Age: 19	
	Weight: 50kg	Gender: female	
Patient History	PMH: DM PSxH: cesarean section 1 year ago Insulin, (Doesn't carry EpiPen) Allergies: peanuts, penicillin Family History: mother with epilepsy		

<u>Case 'Narrative' 'Flow':</u>			
Prior to start	Medical assistance summoned overhead. Passenger is in marked respiratory distress on arrival. There are urticaria on face and arms. Patient is alone.		
	Trigger:	**Vitals / Status:**	**Learner actions/ Comments:**
Start scenario (Phase 1)	Students enter, flight attendant (FA) states patient complained of trouble breathing. The patient vomited and feels her throat is closing. FA provides medical kit. Patient has not carried EpiPen in years.	Anxious. HR: 122 BP: 100/70 RR: >24 (with stridor)	Assess scene safety, Obtains history and VS Administer supplemental oxygen Looks through medical kit supplied by FA.
Phase 2	Patient becomes somnolent and respirations are more tachypneic and shallow with less audible stridor.	Anxious. HR: 134 BP: 70/40 RR: >24	Ask FA for EpiPen (not carried by commercial aviation) Assist ventilations Consider emergency diversion

Phase 3	Fellow passenger offers EpiPen. FA states that pilot has reached their medical command.	Anxious. HR: 134 BP: 70/40 RR: >24	Reads label, administers IM epi via EpiPen in R Thigh.
Phase 4	Patient less somnolent, no stridor, voices improvement.	Reports improvement HR: 100 BP: 120/70 RR: 18	Communicates effectively with medical command. Plan is to continue diversion given inability to predict clinical course.
Scenario End	**Pt comfortable without respiratory distress.**		
Desired Learner actions	Recognize anaphylaxis Manage medical resources available on plane Administer IM epinephrine via EpiPen Effective plan and communication with medical command		
Cues for patient and /or confederates	FA provides cues regarding patient's appearance (anxiety, flushing). Patient answers questions about history, symptoms. FA offers medical direction call if students struggle/request diversion.		

Setup required	**Equipment (examples):**	**Quantity**	**STRATUS to provide**	**Faculty to provide**
	SimMan 3G	1	X	
	O2 Tank	1	X	
	Inflight medical kit (detailed in budget)	1		X
	EpiPen Trainer	1	X	

Program / Session Title:	**Motor Vehicle Collision (MVC) Tabletop Exercise**				
Lead Faculty/ Course Director:	Name: Charles Pozner, MD Title/position: Executive Director				
Additional Faculty: (Please include names where available)	Number: 2 Discipline: EM Level of training: PGY1-4				
Goal of the session:	Introduce the principles of scene and patient management at an out-of-hospital emergency.				
Educational Objectives:	Following this session, the participants should be able to: Demonstrate the assessment and steps to maximize scene safety at an MVC. List the initial strategies for the management of exsanguinating hemorrhage, basic emergency airway management, and protection of cervical spine. Demonstrate effective communications with EMS.				
Participants:	Number: 6 Discipline: Level of training: MS1				
Content Description	Using a tabletop exercise, the instructor will interactively present an MVC scenario, discuss scene safety (including special considerations for traffic), navigating the MVC scene, basic triage, initial stabilization, and effective communication with EMS.				
Rooms required: (General description of ideal spaces. STRATUS will assign suitable rooms.)	Conference room				
Simulation Specialists:	None				
Will there be Industry involvement?	No				
Specific equipment required:	Station	Equipment	Quantity	STRATUS to provide	Faculty to provide
	MVC Tabletop	White Board	1	X	
		Video Display	1	X	
		BMV	1	X	
		Airway Trainer	1	X	
		Tourniquet	1	X	
		Extremity for tourniquet	1	X	

Appendix 3: Copy of manuscript or publication, if not already submitted previously in the Statement of Intent.

Creating a Prehospital Medical Emergency Curriculum for Medical Students: A Pilot Study

[authors to be determined]

Author Affiliations: [to be determined]

Corresponding Author: [to be determined]

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Key Messages

What is already known on this subject: New programs for Emergency Medical Technician training and practice during the preclinical phase of medical school show promising benefits for medical student development at a time when physicians are increasingly called to interact with the prehospital sector of healthcare to advance preventive medicine, address public health problems, and communicate with emergency medical services. However, these time-consuming programs can be difficult to integrate into already-established preclinical curricula, particularly as they tend to shorten in duration.

What this study adds: This study proposes a novel 3.5-hour flipped-classroom curriculum using medical simulation that aims to introduce high-yield concepts and skills from prehospital care to first-year medical students, and reports preliminary data to support its success in improving knowledge and increasing confidence.

Abstract

Background: New programs for Emergency Medical Technician certification during the preclinical phase of medical school show promising benefits for medical student development at a time when the prehospital sector of healthcare—including the spectrum from emergency medical services to community health and disaster medicine programs—continues to grow. This work aims to propose and study the effectiveness of a novel 3.5-hour prehospital emergency curriculum that can be easily integrated into medical school.

Methods: Junior medical students were invited to participate in the proposed class, which was designed using a comparative analysis of Emergency Medical Technician training and medical school to identify high-yield gaps for medical students, and modeled after the prevailing tenets of

modern medical education theory. Students completed study instruments both before starting and after completing the course, which included a confidence survey (15 items rated on a 5-point Likert scale) and a knowledge assessment (26 multiple choice items related to course content) to enable longitudinal comparison via paired-samples t-tests.

Results: Seventeen junior medical students participated in this pilot study: 14 first-year and 3 second-year students. Self-reported confidence scores significantly increased from a mean of 2.28 (sd=0.77) to 3.93 (sd=0.56) out of 5 (p=1.8e-7). Objective knowledge scores significantly increased from a mean of 15.4 (sd=2.94) to 20.2 (sd=2.02) out of 26 (p=1.0e-7).

Conclusion: Preliminary findings suggest this novel course, which can be readily implemented within existing medical school programs, can improve knowledge and increase confidence among student participants.

Introduction

Examining the evolving landscape of healthcare systems and medical education in the US, coupled with the changing needs of the American public, reveals a critical, growing gap between physician training and societal expectations. Over the past half-century, advancement in medical science and technology—along with changing economic forces—have shunted patient care from the community into high-resource, increasingly consolidated healthcare settings.[39] Medical education has reformed accordingly over the past decade, including widespread curriculum overhauls to prepare students for a lifetime of critical appraisal of new evidence and interprofessional teamwork within a new model of physician-led team-based care,[5] as reflected in updated national standards for medical student assessment.[13]

These changes in training and practice produce physicians that are better-suited to provide care within highly organized healthcare systems, but create a training gap marked by diminished ability to provide care in the absence of the supports upon which they increasingly rely. For example, more than one-third of graduating fourth-year medical students deny the ability to perform cardiopulmonary resuscitation independently,[123] despite a report that 83.4% of students witness a cardiac arrest during medical school,[31] likely at least partially due to the widespread implementation of dedicated response teams in training settings.[32]

The requirement of Emergency Medical Technician certification during preclinical studies, as has been recently adopted by two new medical schools, shows promising benefits for students related to this concerning gap in practical, low-resource training.[140,141] However, their length and considerable overlap with medical school content interfere with their implementation in existing curricula. This study proposes a novel 3.5-hour prehospital emergency curriculum—designed using a comparative analysis of the two curricula and modeled after the prevailing tenets of modern medical education theory—for facilitated integration into medical school programs to close this important training gap.

Methods

First- and second-year medical students were invited to voluntarily participate in a new 3.5-hour prehospital emergency class. Participant recruitment occurred at Harvard Medical School during the 2019-2020 academic year, in accordance with Institutional Review Board approval from Partners Human Research (#2019P001524) and a Reliance Agreement with Harvard Medical School (#2428). Student volunteers were sent a pre-course instrument that included a 5-point Likert scale survey of self-reported confidence related to 15 tasks associated with the course's learning objectives, as well as a multiple-choice test including 26 items to assess knowledge of

relevant content. Sample items are included in **Figure 1**. Upon completing this instrument, access to mandatory preparatory work (estimated 30 minutes) was provided along with an invitation to participate in an in-person workshop at the STRATUS Center for Medical Simulation at Brigham and Women's Hospital. This 3-hour session started with a brief interactive didactic session to build upon the preparatory work, followed by three parallel rotations: medical simulation exercises on opioid overdose in an outpatient clinic and on anaphylaxis on an airplane, and a tabletop exercise on hemorrhagic shock at a motor vehicle collision. Finally, participants completed the same research instrument after the course (plus a brief survey of demographic data) to enable longitudinal assessment of confidence and knowledge using paired-samples t-tests. This project was supported by a grant from the Emergency Medicine Residents' Association.

Preliminary Results

Seventeen medical students participated in this pilot study: 14 first-year and 3 second-year students. The average age of participants was 23.0 years (sd=1.70), including 11 males and 6 females. Two participants reported prior emergency responder experience beyond the certified first responder level (one Emergency Medical Technician-Basic and one military medic), in addition to mandated cardiopulmonary resuscitation training upon entering medical school. None of the second-year medical students had more than one month of experience on the wards. These demographic data are summarized in **Table 1**. Self-reported confidence scores significantly increased from a mean of 2.28 (sd=0.77) to 3.93 (sd=0.56) out of 5: $t(16)=8.73$, $p=1.8e-7$. Objective knowledge scores significantly increased from a mean of 15.4 (sd=2.94) to 20.2 (sd=2.02) out of 26: $t(16)=9.10$, $p=1.0e-7$. Further detailed results are included in **Table 2**.

Discussion

These preliminary results support the hypothesis that this novel prehospital emergency curriculum can boost students' confidence and knowledge related to awareness of the organization, capabilities, and limitations of emergency services, as well as ability to independently provide prehospital care. These findings bear obvious implications for students' ability to respond to Good Samaritan events in the future. Importantly, survey data has repeatedly shown that roughly four-in-five physicians report having responded to prehospital medical emergencies as a Good Samaritan, most often reporting 3-5 such instances since completing training, therefore demonstrating the likelihood of encountering such scenarios.[100,101]

The benefits of this training extend far beyond prehospital episodes of emergency patient care. This program offers the potential to improve students' autonomy on the wards and accelerate their clinical training, in addition to providing an introduction to prehospital care to enable informed participation in future development of prehospital solutions to public health problems (major precedents include layperson cardiopulmonary resuscitation training, community paramedicine to advance preventive care, telemedicine, Stop the Bleed, and Opioid Overdose Education & Naloxone Distribution programs). Furthermore, this program promotes representation of Emergency Medicine in preclinical curricula and creates opportunities for near-peer education by senior medical students and residents to further their preparation for careers in academic emergency medicine.

This work has important limitations. The design of this course, including medical simulation, marks a pedagogical strength of the program but a significant logistical weakness. Low ratios of students to facilitators and costly simulation equipment limit the volume of students that can be taught per time. For example, with two simulators available, ten sessions for 15 students each would require 30 hours of time for at least four facilitators to serve a class of 150 students.

Further work is already underway to increase the sample size of this study and add to the evidence to support the beneficial effects of this program. Furthermore, future efforts to implement this program at other sites, further focus the curriculum, and optimize value of resource-intensive aspects of the course will serve to increase its likelihood of adoption at other schools.

Tables & Figures

Figure 1: Sample items from the research instruments used in this course. A: sample item from confidence survey. B: sample item from knowledge assessment (correct answer: 0.3 mg).

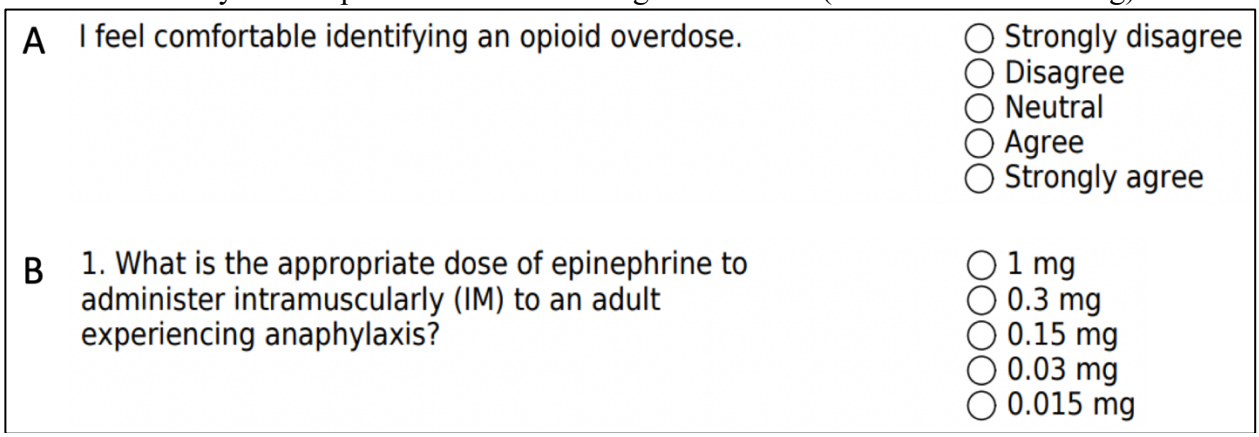

Table 1: Participant demographics. All participants are either first- or second-year medical students. Prior training refers to any training prior to starting medical school greater than certified first responder training. SD: standard deviation.

Age: mean (SD)	23.0 (1.70)
Sex: number of females (percent)	6 (35.3%)
School status: number of first-year students (%)	14 (82.4%)
Prior training: number with prior training (%)	2 (11.8%)
Total participants	17

Table 2: Changes in confidence and knowledge scores in pre- versus post-course measures. SD: standard deviation. CI: confidence interval.

Assessment	**Pre-Test: Mean (SD)**	**Post-Test: Mean (SD)**	**Score Difference: Mean (CI)**	**P-value**
Confidence	2.28 (0.77)	3.93 (0.56)	1.65 (1.25 – 2.05)	1.8e-7
Knowledge	15.4 (2.94)	20.2 (2.02)	4.82 (3.70–5.95)	1.0e-7

References

Please see main references section of this report, included in pages 59-70.