

FINAL PROGRESS REPORT

1. TITLE PAGE

Grant Title

Precision Emergency Medicine: Setting a Research Agenda

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2. STRUCTURED ABSTRACT

Purpose: The goal of this study was to establish a 10-year research agenda for precision emergency medicine, defined as the targeted use of big data and technology to deliver acute care effectively to individuals and communities.

Scope: Research is needed to implement precision emergency medicine successfully. To address this gap, the Society for Academic Emergency Medicine sponsored a consensus conference on May 16, 2023. Experts from academia and the technology sector assessed implementation challenges and crafted a patient-centered research agenda.

Methods: Prior to the conference, nine working groups in key areas such as data science and informatics convened over a year to prepare draft research questions. The conference agenda included lectures, panel discussions, and participant-led small group sessions aimed at consensus-building.

Results: A total of 217 people contributed to the planning of the conference, and 115 on-site participants from 53 North American academic institutions attended the meeting. A draft definition of precision emergency medicine was unanimously accepted by the participants. Through iterative discussions, the attendees refined and agreed on the final questions that comprise the research agenda in three rounds of dialogue. This agenda will guide future investigations and inform funding agencies in the field. The educational needs of emergency providers who are expected to incorporate precision emergency medicine were also identified.

Key Words: precision emergency medicine, biomedical ethics, data science, healthcare access, technology, education, informatics, -omics.

3. PURPOSE

Precision emergency medicine is the purposeful use of big data and technology to safely, efficiently, and authentically deliver acute care for individual patients and their communities. Research is needed to optimize the implementation of precision emergency medicine in an efficient and fair manner. The primary objective of this study was to formulate a 10-year research agenda focused on precision emergency medicine.

4. SCOPE

Background / Context: Precision medicine leverages data-driven approaches to tailor healthcare to each patient's unique characteristics, such as their biological profiles, disease manifestations, environment, and socioeconomic status. Adopting precision medicine principles would mark a paradigm shift in emergency medicine towards technologically enhanced, data-driven, higher-quality, and individualized care. However, most emergency providers lack familiarity with these data sources, their interpretation, and how to modify clinical practices accordingly. Emergency medicine has been on the periphery of the precision medicine discourse, lacking a unified definition and a clear research agenda.

To bridge this practice gap, the Society for Academic Emergency Medicine (SAEM) organized a consensus conference on May 16th, 2023, titled "Precision Emergency Medicine: Setting a Research Agenda." The consensus conference, which preceded the larger 2023 SAEM Annual Meeting held in Austin, Texas, aimed to (1) develop a shared understanding of precision emergency medicine, (2) establish a research agenda for precision emergency medicine for the next decade, and (3) identify educational gaps that must be addressed for emergency providers.

5. METHODS

The study used a national consensus conference to derive a prioritized research agenda focused on precision emergency medicine. This event brought together experts from academia and the technology industry to explore the main factors influencing precision emergency medicine, identify implementation challenges, and create a detailed 10-year research plan with a focus on patient-centered outcomes.

A year before the event, the committee formed nine expert working groups in various fields:

- Biomedical Ethics
- -Omics,
- Data Science
- Health Professions Education
- Healthcare Delivery Systems & Access to Care
- Informatics
- Population Health & Social Emergency Medicine
- Sex and Gender
- Technology & Digital Tools.

Experts known for their relevant academic contributions and reputations led each of these groups. The planning committee ensured diversity of the work group team leads and members by including individuals of different genders, races, ethnicities, ages, and geographic locations in these roles. The groups met regularly to develop key research questions that would form the basis of the research agenda. A patient volunteer from the Stanford Patient and Family Advisory Council also joined each group to provide input. The volunteers helped the various teams craft a research agenda informed by the issues that patients face when navigating the healthcare system.

The committee invited prominent figures in the field to speak at the conference and encouraged professionals from the technology sector to participate in the day's activities. The agenda (see below) included a keynote speech, panel debates, interviews, brief presentations, networking opportunities during meals, a technology

exhibit 'gallery walk', and consecutive working group sessions that concluded with a consensus on the research agenda.

PRECISION EMERGENCY MEDICINE: SETTING A RESEARCH AGENDA- CONFERENCE AGENDA

Morning Coffee and Continental Breakfast - 30 minutes - Networking

1. Welcome and Conference Goal

Speaker: Matthew Strehlow, MD, Stanford School of Medicine

The conference chairs will welcome the participants, define precision emergency medicine, review the conference agenda, and clarify the goal of the meeting: *What research questions need to be answered to advance our understanding and implementation of precision emergency medicine?*

2. Keynote: “The Promise and Purpose”

Speaker: Brendan G. Carr, MD MA MS, Icahn School of Medicine at Mount Sinai

Our first keynote speaker will discuss the end goal of a 10-year research agenda for precision emergency medicine, the road we need to travel, risks, rewards, and future casting of the topic. This speaker will have expertise in healthcare access, understand the application of health technology to solve clinical challenges, and an appreciation of precision health. This keynote will educate the conference participants about precision emergency medicine, offer a vision for the future, and inform the consensus building process to come.

- *Objective 1: Describe the intersection of precision health and emergency medicine*
- *Objective 2: Identify current gaps in acute care that can be addressed by current and near-term health technologies*

3. Panel Discussion: “The Data Revolution”

Speakers: Andrew A. Monte, MD, PhD, University of Colorado School of Medicine; Maya Yiadom, MD, MPH, MSCI, Stanford School of Medicine; Richard Andrew Taylor, MD, Yale School of Medicine

The purpose of the first panel discussion is to examine concepts important to big data in emergency medicine, including sourcing, collection, management, and usage. The speakers for this panel will be experts in data science, -omics, and digital technology.

- *Objective 1: Understand how “big data” will alter the practice of emergency medicine*
- *Objective 2: Recognize the critical role for emergency medicine providers as AI and machine learning are increasingly integrated into acute care delivery*

Break - 15 minutes - Networking

4. Working Groups - Session 1: “The Research Incubator”

Conference participants will assemble in one of nine working groups to begin building consensus on a research agenda for precision emergency medicine. Design thinking principles will be used. The goal of this session will be to review and revise key research questions identified by experts in a Delphi process ahead of the meeting. The working groups will include (1) Informatics, (2) - Omics, (3) Data Science, (4) Technology and Digital Tools, (5) Healthcare Delivery Systems and Access to Care, (6) Population Health and Social Emergency Medicine, (7) Biomedical Ethics, (8) Health Professions Education, and (9) Sex and Gender.

- *Objective 1: Describe the current state of the literature and scientific evidence for using “big data” and newer technologies in specific subfields (i.e. workgroups)*
- *Objective 2: Examine the potential research focus areas that can accelerate the ethical, patient-centered incorporation of AI/ML and health technologies in specific subfields (i.e. workgroups)*
- *Objective 3: Formulate a research agenda for precision emergency medicine in specific subfields (i.e. workgroups)*

5. Fireside Chat: “The Adoption Curve”

Speakers: Christopher R. Carpenter, MD, MSc, FACEP, AGSF, Washington University School of Medicine in St. Louis and Christian Rose, MD, Stanford University School of Medicine

This will be an interview-style, two-person discussion between an expert in implementation science and the interviewer, an expert in informatics. The implementation of precision emergency medicine will challenge emergency departments culturally and structurally. The goal of this session is to identify research opportunities in implementation science and precision emergency medicine.

- *Objective 1: Explain the importance of implementation science in advancing emergency medicine and acute care delivery*
- *Objective 2: Identify and appraise the key research opportunities that can accelerate the implementation of precision emergency medicine*

6. Networking Lunch and “The Gallery Walk”

The lunch break will allow time for networking as well as the opportunity to learn more about important topics in precision emergency medicine in a ‘gallery walk’ format. Numerous stations will be arranged in the perimeter of the conference room with different topics and expert facilitators assigned to each station. Participants will be able to walk between stations of interest to have casual conversations with our experts and have their individual questions answered. The potential high-visibility topics for these stations include, ‘-omics,’ ‘artificial intelligence,’ ‘informatics,’ ‘tech,’ ‘big data,’ among others.

7. Keynote: “The Precise Care of Patients”

Speaker: Matthew Strehlow, MD, Stanford School of Medicine

Our second keynote speaker will focus on patient experience. What does precision emergency medicine mean to the individual patient? How is their care improved? What is their lived experience? This speaker will have a background in health technology, specifically wearable and implantable devices.

- *Objective 1: Understand how consumer health technologies and individual data will impact people’s understanding and management of their health*
- *Objective 2: Describe how health technologies and precision health will alter patient engagement and experience with the health system*

8. Panel Discussion: “The Sociobehavioral Phenotype”

Speakers: Kristin Rising, MD, MSHP, Thomas Jefferson University; Margaret E. Samuels-Kalow, MD, MPhil, MSHP, Massachusetts General Hospital; Jody Vogel, MD, MS, MSW, Stanford University School of Medicine.

The purpose of this panel discussion is to define the sociobehavioral phenotype and examine its implications for precision emergency medicine. This session will explore the importance of contextualizing health data to the realities of the local community, as well as the use of data science to build the social phenotype. The speakers for this panel will be experts in population health, social determinants of health, and data science.

- *Objective 1: Define the sociobehavioral phenotype*
- *Objective 2: Examine the importance of contextualizing health data to the local community*
- *Objective 3: Critique the use of “big data” to build sociobehavioral phenotypes*

9. Working Groups - Session 2: “The Cross Pollination of Ideas”

Conference participants will return to their working groups, which will pair up to form four large groups. The goal of this session will be to bring together two working groups to tackle specific topics from distinct perspectives, as these 3 collaborations will be necessary for the successful implementation of precision emergency medicine. The discussion topics and working group pairings will include the following Topic - Working Group Pairings: “Patient Privacy” - (1) Informatics and (7) Biomedical Ethics “Implementation” - (5) Healthcare System Delivery and (4) Digital Tools “Social Phenotypes” - (6) Population Health and (3) Data Science “Physician Retraining” - (2) -Omics and (8) Health Professions

- *Objective 1: Understand the areas of overlap across subfields (i.e. workgroups) in researching precision emergency medicine*
- *Objective 2: Examine the potential for integration across research focus areas that can accelerate the ethical, patient-centered incorporation precision emergency medicine in the different subfields (i.e. workgroups)*
- *Objective 3: Formulate joint research questions and draft research agendas for precision emergency medicine across subfields (i.e. workgroups)*

Education Break - 15 minutes - Networking

10. Lightning Lecture: “The Democratization of Precision Emergency Medicine”

Speaker: Ava Pierce, MD, UT Southwestern Medical Center

In this mini keynote, an expert in the field of biomedical ethics will explore health disparities that may result from poor implementation of precision emergency medicine. The working groups will be urged to consider this topic and other cautions as they develop their respective contributions to the research agenda.

- *Objective 1: Identify the risks of implementing precision emergency medicine*
- *Objective 2: Appraise key opportunities to strengthen the ethical and equitable implementation of precision emergency medicine*

11. “The Regroup”

Speaker: Holly Caretta-Weyer, MD, MHPE, Stanford University School of Medicine

The conference chairs will provide directions for the final consensus building session that follows and clarify the expected deliverables of the working groups. This brief regroup session is to ensure that each working group summarizes their efforts efficiently and effectively.

- *Objective 1: Describe the consensus building process for setting a research agenda*

12. Working Groups - Session 3: “The Consensus”

Conference participants will return to their original working groups from the morning to finalize their research imperatives. The goal of this session will be to summarize their efforts, come to consensus, and plan to report their findings to the larger audience.

- *Objective 1: Consolidate the research opportunities within precision emergency medicine*
- *Objective 2: Design a draft research agenda for precision emergency medicine within the specific subfield(i.e. workgroup)*

13. Working Group Report Outs: “The Research Agenda”

Speaker: Michael Gisondi, MD, Stanford University School of Medicine

This final large group session will allow time for each working group to report the findings of their work. These reports will reflect the research questions that must be answered in the coming decade and serve as the key deliverables of the consensus conference. An audience participation app such as Poll Everywhere will be used to upvote/downvote items in a final consensus building activity.

- *Objective 1: Describe the research opportunities in emergency medicine that will drive the integration of data science and new technologies into practice*
- *Objective 2: Recognize areas for integration across different subdomains of emergency medicine*
- *Objective 3: Organize an approach to research into precision emergency medicine*

14. Closing: “The Lessons Learned and Next Steps”

Speakers: Holly Caretta-Weyer, Michael Gisondi, Matthew Strehlow, Jody Vogel

The conference chairs will acknowledge the work accomplished before and during the consensus conference, thank the participants, review the key findings of the meeting, identify knowledge generated, and clarify next steps such as writing white papers, finding grants, seeking industry partners, etc.

- *Objective 1: Summarize key research opportunities in precision emergency medicine identified during the conference*

6. RESULTS

In total, 217 individuals played a role in the design, planning, or implementation of the consensus conference, including workgroup members, an advisory board, patient volunteers, participants from the technology sector, conference attendees, and administrative staff. The conference attendees were made up of 115 on-site participants representing 53 academic institutions from the United States and Canada.

The principal goal of this consensus conference was to develop a detailed agenda of research questions and educational gaps that must be addressed to facilitate widespread implementation of precision emergency medicine. To achieve this goal, we focused on three specific aims:

Aim 1: Develop a shared mental model of precision emergency medicine. At the beginning of the meeting, we introduced a working definition of precision emergency medicine. The definition received unanimous acceptance from the attendees, indicating a common understanding of the concept. It states: "Precision emergency medicine is the purposeful use of big data and technology to deliver acute care safely, efficiently, and authentically to individual patients and their communities." This definition creates a shared mental model of precision emergency medicine for researchers, providers, and other stakeholders in the field.

Aim 2: Establish a research agenda for precision emergency medicine for the next decade. The consensus-building process involved three rounds of discussion and review by the working group members and conference participants. This process refined and prioritized a set of research questions that comprise the 10-year research agenda. This research agenda aims to inform funding agencies and guide researchers in tackling the most significant challenges to effectively implementing precision emergency medicine. The research questions and corresponding work group domains are below in Table 1. Three key themes were evident from discussions during consensus-building activities: the critical role of data, the interconnected nature of research questions across different domains, and the potential benefits and challenges posed by advances in health technology and data science/artificial intelligence.

Aim 3: Identify educational gaps that must be addressed for emergency providers. Finally, the Health Professions Education working group specifically examined the educational needs of emergency providers expected to incorporate precision emergency medicine in their clinical practices, with recommendations for resident trainees and board-certified physicians.

Table 1: Research Agenda for Precision Emergency Medicine

Workgroup Domain	Research Questions
Biomedical Ethics	<ol style="list-style-type: none"> 1. How should precision medicine be used to maximize patient benefit and continue medical progress without overburdening clinicians or putting institutional needs first? 2. How can data be used to provide the greatest societal benefit while allowing individuals to retain ongoing control of selected private information? 3. How do we minimize or prevent subsequent harm resulting from algorithms influenced by implicit bias and structural disparities for marginalized groups (homeless, drug addiction, people with mental illness, geographic, financial, technology access, other identities, clinician acceptance in certain areas or specialties)?

Workgroup Domain	Research Questions
Data Science	<ol style="list-style-type: none"> 1. What precision EM care delivery problems are best addressed with machine learning and data sciences techniques? What needs to be considered to translate these solutions to bedside? 2. How can we reduce barriers to privacy and legal restrictions that make the initiation of single institution, and particularly multi-centered research, difficult? How can we use medical education and governance to work through these restrictions and build both clinician and patient trust? What processes are needed both in EM and in health systems to have successful implementation and maintenance? 3. What is limiting our ability to validate and generalize findings and methodologies to advance data sciences for precision EM care? How can we evolve best practice for data quality: Data standardization? Managing missing data? Monitoring practice and data shift?
Healthcare Delivery and Access to Care	<ol style="list-style-type: none"> 1. How should EDs and health systems integrate into the communities they serve (e.g., use of health information exchanges [HIEs]) and use prediction tools to better deliver care and optimize care transitions across care delivery spaces? <ol style="list-style-type: none"> 1. What are best practices for identifying and engaging stakeholders and conducting research on and implementation of personalized medicine within emergency care delivery systems? 2. How do we integrate other clinicians and use bidirectional data transfer to optimize this system (e.g., prehospital providers, primary care offices, rehab facilities, etc.)? 3. What measures can be used to evaluate equity in the implementation of precision medicine within systems of emergency care?
Health Professions Education	<ol style="list-style-type: none"> 1. What is the future role of humans in medicine, and what skills do those clinicians need when using AI algorithms? What technologies will they need to practice precision emergency medicine? How do we teach trainees to act, reason, or think in the <i>absence</i> of precision medicine tools? 2. How do we incorporate the patient voice in clinician training in precision medicine? For example, which skills and clinician role (understander, explainer, collaborator, advocate, skeptic) will patients deem most important for learners to master? 3. What techniques are best for teaching interdisciplinary leadership skills, or so-called 'fusion skills,'²⁹ in undergraduate and graduate medical education settings to best prepare our trainees for the future AI workplace? Is there a developmental framework for trainees at different levels of medical and computer training? How will they find and convey information, and how will those skills enhance decision science? Which role will clinicians assume in their adoption of precision medicine: trainers, explainers, or sustainers?
Informatics	<ol style="list-style-type: none"> 1. What informatics systems can we employ to overcome the barriers of fragmented systems and improve acute unscheduled care? 2. How can we optimize information delivery and clinical summarization to improve safety and reduce cognitive overload for patients and clinicians? 3. How do we build collaborative data, information, and knowledge ecosystems to support dynamic, scalable solutions for emergency care?

Workgroup Domain	Research Questions
Omics	<ol style="list-style-type: none"> 1. How can we best translate the findings of -omics research to the bedside to improve emergency medical care? 2. How can we construct the needed network/platform for emergency departments conducting multi-center -omics research? 3. How do we grow and develop the EM -omics research and implementation workforce?
Population Health and Social EM	<ol style="list-style-type: none"> 1. What are the best practices for precision social EM to ensure accountability and equity and prevent stigmatization, discrimination, and criminalization? 2. What are meaningful outcomes for precision social EM from the perspective of patients, the health system, and communities? 3. How do we leverage precision medicine to most effectively develop interventions to improve individual and population health?
Sex and Gender	<ol style="list-style-type: none"> 1. How can we translate relevant scientific research regarding sex and gender-specific care from other fields into EM in a timely manner? 2. How do changing sex hormone profiles (endogenous and exogenous) affect the presentation, diagnosis, treatment, and prognosis for emergency department patients across the lifespan? 3. How do patient and clinician gender identity (or other attributes) affect clinical decision making and implementation in EM?
Technology and Digital Tools	<ol style="list-style-type: none"> 1. Through the lens of precision EM, what are the greatest unmet needs that technologies and digital tools can enable EM to more quickly diagnose patients and identify the best therapeutic and disposition pathways? 2. How do we increase academic EM leading emerging technology research in collaboration with current and emergent technology companies focused on improving precision EM care? How do we create an innovations network that leverages institutional experience and economies of scale to allow academic clinicians and technology companies low barriers to collaborate on focus areas, study, and scale new technologies and tools? 3. How can we achieve consensus on a national framework for evaluating, adopting, and implementing precision EM tools and technologies, and what is the threshold of evidence needed to validate the usefulness of new technologies for their target populations?

Conclusion. In summary, the 2023 SAEM Consensus Conference on precision emergency medicine culminated in a 10-year research agenda designed to promote the adoption of this innovative practice paradigm through extensive stakeholder engagement. Precision emergency medicine seeks to enhance the treatment of acutely ill and injured patients by incorporating new technologies and alternative care delivery models, building upon the core competencies of emergency physicians. The future sees emergency physicians adeptly using artificial intelligence to tailor diagnostics, treatments, and care plans to individual patient needs. Nevertheless, without solid implementation strategies based on evidence, the potential of precision emergency medicine may be compromised by the inappropriate use of technologies, bias, errors, and inequity. The field of emergency medicine must proactively participate in the precision medicine movement to manage the upcoming changes in practice effectively and redefine acute care within the specialty. We are confident that our consensus-driven research agenda will prioritize the health and safety of both our patients and clinicians as these shifts in paradigms occur.

7. LIST OF PUBLICATIONS AND PRODUCTS

The study investigators and the Society for Academic Emergency Medicine will be disseminating the conference findings over the next few years through several planned manuscripts (see two that have been accepted for publication below). Several of the conference working groups have white papers in preparation for publication.

Chan T, Thoma B, Finnell J, Farell SE, Gordon BD, Pusic M, Cabrera D, Gisondi MA, Caretta-Weyer H, Stave CD, Ankel F. Precision Medicine within Health Professions Education: Defining a Research Agenda for Emergency Medicine using a Foresight and Strategy Technique (FaST) Review. *AEM Education and Training*. Accepted 2/11/24. *In press*.

Strehlow M, Alvarez A, Blomkalns A, Caretta-Weyer H, Gharahbaghian L, Imler D, Ayesha Khan A, Lee M, Lobo V, Newberry JA, Ribeira R, Syer S, Shen SH, Gisondi MA. Precision Emergency Medicine. *Academic Emergency Medicine*. Accepted May 2024, in press.

Strehlow M, Gisondi MA (co-first author), Caretta-Weyer H, Ankle F, et al. 2023 SAEM Consensus Conference on Precision Emergency Medicine: Development of a policy relevant, patient-centered research agenda. *Academic Emergency Medicine*. Accepted 4/11/24. *In press*.