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SPECIAL ARTICLE

American College of Medical Toxicology Research Agenda 2024—2030

Neeraj Chhabra[1,2,3] · Alison Meyn[1] · Maryann Mazer-Amirshahi[1,4,5] · Stephanie P. Carreiro[1,6] · Kevin Maskell[1,7] · Marielle Brenner[1,8] · David H. Jang[1,9,10] · Mark B. Mycyk[1,11] · Paul Wax[1]

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Abstract
ACMT recognizes the pivotal role of high-quality research in advancing medical science. As such, the establishment of a formal research agenda for ACMT is a leap forward in communicating the priorities of the College, its members, and the patient populations we serve. This thoughtfully crafted agenda will serve as a strategic compass for ACMT, guiding our pursuit of scientific discovery, fostering innovation, and enhancing outcomes for patients and communities affected by poisonings and exposures.

Keywords ACMT · Research Agenda · MTF · ToxIC · Medical Toxicology

Background

The History of Medical Toxicology as a Specialty

Medical toxicology is the physician practice of evaluation and management of poisoning including drug exposures, chemical exposures, and envenomations. The specialty was first recognized by the American Board of Medical Specialties (ABMS) in 1992 with the first seating for the first ABMS board exam occurring in 1994. Previously, medical toxicologists had been boarded by an independent organization known as the American Board of Medical Toxicologists (ABMT) created by the American Academy of Clinical Toxicology (AACT) in 1974 [1]. In 1999, the Accreditation Council of Graduate Medical Education (ACGME) officially recognized postgraduate education in medical toxicology. As of 2024, there are 30 ACGME recognized physician fellowships in medical toxicology that train physicians with primary medical training in several specialties including emergency medicine, pediatrics, internal medicine, and occupational medicine [2]. According to the American Board of Emergency Medicine (ABEM), there are 563 emergency medicine physicians who hold subspecialty certifications in medical toxicology [3].

Over the past ten years, the specialty has shown increased growth in ACGME recognized medical toxicology

Supervising Editor: Howard Greller, MD

✉ Alison Meyn
info@acmt.net

1 American College of Medical Toxicology (ACMT), 10645 N. Tatum Blvd, Phoenix, AZ, USA

2 Department of Emergency Medicine, University of Illinois Chicago, 808 S Wood, Chicago, IL, USA

3 AI.Health4All Center for Health Equity Using Machine Learning and Artificial Intelligence, Chicago, IL, USA

4 Georgetown University School of Medicine, Washington, DC, USA

5 National Capital Poison Center, Washington, DC, USA

6 University of Massachusetts Chan Medical School, Worcester, MA, USA

7 Rosalind Franklin University Medical School, Chicago, IL, USA

8 University of Iowa Medical Center, Iowa City, IA, USA

9 University of Pennsylvania School of Medicine, Philadelphia, PA, USA

10 The Resuscitation Science Center: Leonard and Madlyn Abramson Pediatric Research Center, Philadelphia, PA, USA

11 Cook County Health, Chicago, IL, USA

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fellowships and the number of fellows who are matched. In 2014, there were 25 available ACGME recognized medical toxicology fellowship programs and 24 fellows that were matched. In 2024, there are now 30 available ACGME recognized medical toxicology fellowships and 50 fellows that matched into the specialty. This is an increase in ACGME medical toxicology fellowships by 20% and an increase in matched fellows by 108% [1, 2].

The practice of medical toxicology has been present in the United States since at least the 1950s, evidenced by the medical direction of US Poison Control Centers. Today, the practice of medical toxicology is diverse. Medical toxicologists practice bedside medicine in hospital settings and provide outpatient management of chronic poisoning and occupational exposures in addition to work through poison centers. As the opioid epidemic continues, many medical toxicologists have also expanded their practices to include addiction medicine.

Aside from direct clinical care, medical toxicologists also provide expertise for other roles within the healthcare system including serving on pharmacy and therapeutics committees and as medication safety officers. Toxicologists are involved in several commercial industries and governmental organizations including the military services and the pharmaceutical, cosmetic, and food industries. Additionally, medical toxicologists are often called upon as expert witnesses for legal cases concerning poisonings.

Looking forward, medical toxicologists are exploring the fields of toxicogenomics, precision medicine, digital therapeutics, and nanotoxicology, all of which are currently in the early stages of understanding.

The History of the American College of Medical Toxicology

The American College of Medical Toxicology (ACMT) was developed in 1993 after the American Board of Medical Toxicology (ABMT) was disbanded following the official recognition of medical toxicology as a specialty by the American Board of Medical Specialties (ABMS). ACMT was founded to provide a physician-led organization for Medical Toxicologists. Since that time, the College has continued to expand and currently represents the vast majority of physicians who are Board Certified in medical toxicology, as well as non-physician affiliate members [1].

The College provides many services to medical toxicologists, other physicians, and the general public. ACMT provides position statements and guidelines for medical practice, provides a board review course for medical toxicologists, produces educational webinars, organizes an Annual Scientific Meeting for medical toxicology research, and manages the Journal of Medical Toxicology, among many other endeavors. The College supports research efforts by connecting medical toxicologists to research mentors and helping medical toxicologists find appropriate grants for research funding [1].

In 2010, the Toxicology Investigators Consortium (ToxIC) was developed and serves as the research arm of the College. ToxIC is a multicenter network for toxicology surveillance and research in medical toxicology at ACMT. This network was developed to empower medical toxicologists across the US and abroad to conduct surveillance and research that is both impactful and rigorous. The ToxIC program has numerous projects within its' umbrella that are funded by federal agencies and industry. These projects range from drug safety, drugs of abuse, novel therapeutics, harm reduction, and global health [4].

Executive Summary

Need for a Research Agenda

ACMT recognizes the pivotal role of high-quality research in advancing medical science. As such, the establishment of a formal research agenda for ACMT is a leap forward in communicating the priorities of the College, its members, and the patient populations we serve. This thoughtfully crafted agenda will serve as a strategic compass for ACMT, guiding our pursuit of scientific discovery, fostering innovation, and enhancing outcomes for patients and communities affected by poisonings and exposures.

This research agenda is designed to identify and prioritize critical domains where scientific investigation is poised to yield significant breakthroughs in the realm of medical toxicology. It mirrors ACMT's unwavering commitment to maintaining a vanguard position in medical science and effectively translating research findings into tangible, real-world solutions. It can serve as a

valuable tool for informing decisions regarding resource allocation, member educational endeavors, and the strategic planning for scientific conferences. Furthermore, this agenda stands as a testament to the College's dedication to cultivating a culture of perpetual learning and professional growth among our members, underpinning an environment rich in scientific inquiry.

Beyond a blueprint, this research agenda embodies our pledge to harness the power of scientific exploration in achieving the mission of ACMT: advancing the toxicologic care of patients and populations and advocating for the specialty of medical toxicology [5]. We envision this document as a dynamic, evolving tool, subject to periodic refinement in response to shifting priorities and emerging evidence. It is intentionally neither exhaustive nor static. We anticipate that this research agenda will be an invaluable resource for the principal stakeholders in medical toxicology research, including clinicians, scientists, funding bodies, and the patient populations we are privileged to serve. Our collective efforts and collaboration are paramount in advancing the field and achieving our shared goals.

Research Prioritization Task Force Goal

The research agenda task force was convened to identify and prioritize areas of research critical to advancing the practice of medical toxicology in both the short and long term over the next six years. Our intent is to aid medical toxicologists in keeping up with the modernization of medicine and in reaching all populations in need of care.

In fulfilling this mission, our goals and primary emphasis are progressing the specialty by filling gaps in the available literature, raising awareness of medical toxicology as a specialty, and educating future researchers on the resources available to support them in their efforts.

Research Priorities

Overview

ACMT's research task force has identified eight priority areas for the 2024–2030 Research Agenda. These topics have been found to be integral to the specialty of medical toxicology and the public the specialty supports.

Research Priorities by Short-Term and Long-Term Objectives [6]

Topic	Short-term Objectives	Long-term Objectives
1. Drugs of Abuse	1.A.-Identify ways to expand the care of patients with substance misuse and substance use disorders in varied practice settings and further solidify the interaction and overlap between medical toxicology and addiction medicine	1.A.-Implement system-level and patient-level approaches to facilitate the initiation and maintenance of therapy of medications for substance use disorders
	1.B.-Characterize medical outcomes of patients with substance use disorders cared for by medical toxicologists	1.B.-Develop large-scale toxico-surveillance programs to monitor the non-medical drug supply for novel opioids and psychoactive substances
	1.C.-Identify barriers to the implementation of evidence-based substance-related harm reduction and treatment practices	1.C.-Partner with local and federal agencies including the National Institute on Drug Abuse (NIDA) and the US Drug Enforcement Administration (DEA) to decrease the number of people dying from the drug overdose epidemic
2. Drug Discovery & Novel Therapeutics	2.A.-Identify candidate therapeutics including novel agents, antivenoms, and already available pharmaceutical agents with potential for drug repurposing as focused poisoning therapies	2.A.-Determine the efficacy of novel and repurposed pharmaceuticals in the treatment of poisoning-related illness
	2.B.-Evaluate the safety of novel treatment agents in medical care	2.B.-Build infrastructure and key partnerships to identify safety concerns in post-market surveillance
	2.C.-Identify and evaluate the effectiveness of medical devices used in the treatment of poisoned patients including extracorporeal elimination methods to support native organ function	2.C.-Increase medical toxicologist involvement in statistical modeling research, animal model research, and clinical trials for novel therapeutics as part of the Food and Drug Administration (FDA) pharmaceutical evaluation and approval process

Topic	Short-term Objectives	Long-term Objectives
3. Drug Safety & Pharmacovigilance	3.A.-Identify genomic markers and special populations at risk for individual drug adverse events	3.A.-Build infrastructure and data system(s) to systematically track pharmaceutical adverse events
	3.B.-Discover clinically relevant safety events related to novel and repurposed pharmaceutical agents	3.B-Determine feasibility and effectiveness for the implementation of pharmaceutical genomic testing across diverse practice locations and populations
	3.C.-Identify emerging issues of non-medical pharmaceutical use including inappropriate use and diversion	3.C.-Foster sustainable partnerships with federal organizations to share data and expertise from specialists in medical toxicology
4. Global Health/ Environmental Health	4.A.-Describe local adverse effects related to poor air quality, water quality, radiation, environmental exposures or events, and occupational exposures	4.A.-Evaluate the effectiveness of mitigation and treatment interventions for the toxicologic consequences of occupational exposures and environmental disasters
	4.B.-Describe toxicologic exposures and variations in treatments around the globe; and identify areas that would benefit from medical toxicology expertise	4.B.-Develop programs to ensure high-quality medical toxicology care in all global environments consistent with local values regardless of resources
	4.C.-Identify ways in which climate change is changing the epidemiology of toxicologic exposures	4.C.-Develop evidence-based recommendations to address toxicologic concerns related to climate change
5. Harm Reduction & Injury Prevention	5.A.-Describe the extent of inadvertent exposures to potentially harmful pharmaceuticals among diverse populations and evaluate their impact on public health	5.A.-Identify effective interventions to prevent harm from inadvertent exposure to pharmaceutical agents
	5.B.-Foster collaborative partnerships with public health entities, prehospital providers, and law enforcement for the expansion of harm reduction efforts	5.B.-Evaluate and advise local and national policies aimed towards harm reduction from toxicologic exposures
	5.C.-Evaluate surveillance and public outreach efforts for potentially dangerous emerging trends including those via social media	5.C.-Develop automated methods of toxicosurveillance using multiple data sources including electronic health records, prehospital data, social media, and internet sources
6. Medical Toxicology Sustainability	6.A.-Describe practice pathways for medical toxicologists including outpatient practice, hospital-based practice, industry, academics, government agencies, and poison center integration; and characterize the value and diversity in medical toxicology models of care	6.A.-Improve the feasibility of independent toxicology practice outside of the continued practice in parent medical fields
	6.B.-Identify barriers to sustainable toxicology practice through economic evaluations which consider reimbursement, case referral challenges, and marketability	6.B.-Sustain and grow the specialty of medical toxicology through educational programs, research training, and focused outreach
	6.C.-Identify opportunities to enhance diversity and inclusion of the workforce within the field of medical toxicology	6.C.-Increase the number and diversity of practicing board-certified medical toxicologists to match that of the patient populations we serve
7. Special Populations & Health Equity	7.A.-Identify ways in which social determinants of health influence harmful exposures and the treatment of diverse populations cared for by medical toxicologists	7.A.-Mitigate disparities in the treatment of patients with toxicologic exposures
	7.B.-Improve the study of exposures and treatment for populations historically underrepresented in research including pediatric patients, neonates, older adult patients, pregnant patients, lactating patients, incarcerated patients, transgender patients, and obese or overweight patients	7.B.-Create pathways and encourage best practices for the ethical inclusion of historically underrepresented groups in medical toxicology research
	7.C.-Identify issues of bias and equity in the treatment of patients with toxicologic exposures	7.C.-Evaluate and refine existing clinical decision support tools to attenuate bias and promote equity

Topic	Short-term Objectives	Long-term Objectives
8. Technological Advancements	8.A.-Use technological advancements in data science and medical informatics, including machine learning, computer vision, and artificial intelligence to develop algorithms and applications to improve the care of patients by medical toxicologists	8.A.-Determine the utility and clinical impact of artificial intelligence and related tools on the care of poisoned patients
	8.B.-Evaluate the utility of wearable, other non-invasive sensor technologies, and ingestible devices as digital diagnostics/therapeutics for toxicologic disease	8.B.-Support infrastructure to develop programs and partnerships to bring effective technological advances in medical toxicology to the care of all poisoned patients regardless of location
	8.C.-Educate medical toxicologists on emerging technologies with potential to improve the care provided to poisoned patients	8.C.-Evaluate the implementation of technological advancements into clinical practice to enhance the care provided by medical toxicologists

Discussion

The Importance of Funding

Securing research funding is increasingly critical to the process of conducting practice-changing scientific research. Although many small scale (but impactful) studies can be conducted without funding, execution of prospective, large scale and/or multi-site research requires more resources. ACMT recognizes the important role of extramural funding for the advancement of our research agenda.

ACMT and its partner organization, the Medical Toxicology Foundation (MTF), actively support junior investigators through a variety of funding opportunities. The goals of these seed grants are not only to advance the science of medical toxicology, but also to advance the careers of emerging investigators. ACMT/MTF sponsored projects provide preliminary data to support larger grant applications (e.g. applications for federal funding) and opportunities to present research at ACMT's Annual Scientific Meeting (ASM). The College has also partnered with other organizations such as National Institute on Drug Abuse (NIDA) to provide mentor facilitated awards, as well as the Society for Academic Emergency Medicine Foundation (SAEMF) to provide collaborative awards[7].

Other organizations that have historically funded toxicology research include those focused on emergency medicine (SAEMF, ACEP). While there is no federal agency dedicated to medical toxicology, investigators in our specialty have historically received funding from agencies focused on substance use disorders (NIDA, SAMHSA), public health (CDC), and drug safety/regulation (FDA) among others.

Representative Funding Sources	
Government	Private Organizations
Centers for Disease Control and Prevention (CDC)	American Academy of Clinical Toxicology (AACT)
Department of Health and Human Services (DHHS)	American College of Emergency Physicians (ACEP)
Federal Drug Administration (FDA)	Emergency Medicine Foundation (EMF)
National Institutes of Health (NIH) / National Institute on Drug Abuse (NIDA)	Medical Toxicology Foundation (MTF)
Substance Abuse and Mental Health Services Administration (SAMHSA)	Society for Academic Emergency Medicine (SAEM)
Veterans' Health Administration (VA)	

Training and Education's Role in the Future of Medical Toxicology Research

Education and training for the next generation of clinician-scientists in the specialty of medical toxicology is a critical step in advancing the care of poisoned patients. This includes but is not limited to the development of skills and knowledge related to research conduct, scientific writing, funding acquisition, and medical ethics. Additionally, professional networking to identify mentors and collaborators is critical to the growth and sustainability of a research career. Creating a pipeline of highly skilled investigators in the specialty of medical toxicology has been deemed a high priority by the College. Accordingly, key initiatives have been undertaken to support these efforts [8]. These include:

The **ANTIDOTE** (**A**dvancing **N**ew **T**oxicology **I**nvestigators in **D**rug abuse and **O**riginal **T**ranslational research **E**fforts) **Institute** is a NIDA/NIH funded research program (Grant No. 1R25DA058490) that provides an opportunity for fellows and junior faculty to develop their own area of investigation, network with peers and experienced investigators in the field, and gather practical knowledge on topics core to developing a successful research program. The two-year curriculum combines in person retreats at ASM, bi-monthly team meetings, and monthly mentorship meetings along with seed funding to longitudinally support emerging investigators.

The "**Confronting the Overdose Epidemic by Engaging Patients to Improve Medical Toxicology Research**" program, funded by PCORI, aims to develop a connection between patients and medical toxicology researchers to advance patient-centered outcomes research on intentional overdoses. The program offers a series of virtual activities that bring together patients who have personally experienced intentional overdoses with toxicology researchers, to facilitate collaboration and highlight the value of people with lived experiences as research team members.

The **NIDA Mentor Facilitated Training Program is** a partnership between NIDA and ACMT that aims to support the development of junior investigators interested in becoming experienced researchers in the field of substance use disorders (SUD). The goals of the program are: 1) to promote the dissemination of SUD research findings, thereby improving knowledge and ultimately the utilization of evidence-based SUD treatment among health care providers, 2) and to facilitate the professional growth and development of future clinician leaders in SUD management.

The **ToxIC Fellow in Training Program (ToxIC FIT)** that aims to introduce fellows to the process of large multicenter research and surveillance, enhance their career in medical toxicology research through mentorship, provide opportunities for networking, and provide education in scientific publications through co-authorship.

The **Journal of Medical Toxicology (JMT) Research Concepts Section** was launched in 2010 to allow medical toxicology investigators a platform to rapidly advance and disseminate research. The section aims to provide a forum for rapid publication to support funding applications by obtaining high-level reviews from funded researchers. To date, the section has published multiple manuscripts serving as foundational publications for successful grant applications from medical toxicologists [9].

In addition to current efforts, ACMT has identified several areas of potential growth for future opportunities. The most commonly cited barrier to a career in research is research methodology education and obtaining mentorship. ACMT has worked diligently to minimize these barriers with the current programs offered but continues to look for partnerships to further expand programs offered to junior researchers. Additional opportunities which the College will explore in the future will include training in the form of methodology courses (virtual/in person or "boot camp" style), or more broadly offered opportunities (e.g. grand rounds or journal clubs focused on research methodology).

Ethical Considerations and Unique Challenges to Medical Toxicologists

Those performing research in the field of medical toxicology encounter some unique challenges and ethical considerations. While randomized, controlled clinical trials are considered the gold standard in the medical literature, ethical considerations make it difficult to enroll poisoned patients. As such, the specialty of medical toxicology has relied heavily on case reports, case series, and large databases, such as the National Poison Data System (NPDS) in the pursuit of research. While of great value, each of these approaches has its own limitations [10].

It is possible however, to perform more robust research involving poisoned patients. Such patients may present intoxicated or be in extremis or may be suicidal or in police custody. Many unintentionally poisoned patients are children. Obtaining informed consent in these vulnerable populations is possible, but the process is complex. In situations where alterations in mental status or critical illness renders the patient unable to consent, randomized clinical trials are still possible. The Exception From Informed Consent (EFIC) requirements for emergency research allow for a waiver of informed consent in very specific situations where the time-sensitive and life-threatening nature of the presentation would make obtaining informed consent impractical. Patients with an acute life-threatening overdose would be included in this definition. Because informed consent is waived, EFIC studies have more rigorous requirements and oversite than traditional IRB approved studies, which do make EFIC studies more costly and time-consuming [11]. Another alternative is to obtain delayed informed consent when the patient is no longer intoxicated and is clinically stable. Both of these approaches have been successfully used in medical toxicology [12].

Another challenge encountered in medical toxicology research is when there are multiple substances involved, thus making it difficult to study the effects of an individual agent. While initially complex, this scenario provides an opportunity for detailed exploration into the interactions among these substances. Despite potential delays in obtaining laboratory confirmation, researchers are spurred to develop precise methodologies and foster interdisciplinary cooperation. Furthermore, examining the effects of long-term, low-level exposures, despite testing limitations and potential confounders, highlights the necessity for targeted investigative approaches.

Despite these challenges, research in medical toxicology has steadily advanced over time, with noticeable improvements in research quality. Moving forward, our efforts should be focused on equipping toxicology researchers with the necessary training and support to overcome these challenges. By doing so, we not only enhance the quality of our research but also demonstrate our unwavering commitment to upholding patient safety and welfare.

Conclusion

The establishment of this formal research agenda by the American College of Medical Toxicology (ACMT) aligns with the organization's mission to advance the toxicological care of patients and populations while advocating for the specialty of medical toxicology. This agenda, though not exhaustive, serves as a strategic guide for scientific discovery and innovation for the College, reflecting our vision of ensuring that every patient and population benefits from the expertise of medical toxicologists. The ongoing evolution of this agenda underscores ACMT's commitment to remaining at the forefront of medical toxicology, driving advancements in patient care, and innovation for the specialty.

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Declarations

Conflicts of Interest None.

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