

REVIEW

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Building medical toxicology capacity in Africa: a review and strategic perspective on the need for fellowship training programs

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Abstract

Introduction Toxic exposures and poisoning constitute a substantial but underestimated public health hazard throughout Africa, for which pesticides, drugs, traditional medicine, snake venom, and industrial chemicals are a disproportionate cause of avoidable disease and death.

Methods This narrative review takes into account existing global models of toxicology education while considering African epidemiology and the constraints of its healthcare systems.

Main findings Partly due to this disparity between burden and capacity, medical toxicology is not well established on the continent as a whole, with minimal diagnostic capability, few toxicovigilance programs, and no established fellowship training programs or poison centers. While there are advancements in global models of toxicology education, African researchers should work on a context and locally adapted solution that considers its epidemiology and the constraints of its healthcare system. Fellowship programs supported by governments, academia, and international donors can enhance patient outcomes, strengthen public health surveillance, and support health system resilience.

Conclusion This review highlights the current toxicological landscape in Africa, the capacity gap in clinical and public health, and presents a strategic framework for setting up medical toxicology fellowship programs in response to the African reality.

Keywords Poisoning, Africa, Medical toxicology, Fellowship, Capacity building

Introduction

Exposure to toxins and poisoning is a significant yet under-recognized public health issue worldwide, directly linked to preventable illness and death. Poisoning caused by toxic effects from pesticides, drugs, traditional medicines, envenoming, and industrial chemicals affects

millions of people each year [1]. The World Health Organization (WHO) reported that unintentional poisoning alone is estimated to cause over 100,000 deaths annually, mostly in low- and middle-income countries (LMICs) [2]. Besides fatalities, poisoning also imposes a substantial economic burden on under-resourced health systems within LMICs, as seen in Nigeria, where the typical pediatric poisoning case costs about 168 United States dollars [3].

The African continent carries an undue proportion of this burden. While few epidemiologic data exist because of poor toxicovigilance systems, available study evidence

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suggests a high burden. The WHO estimate 2012 gives figures that show that unintentional poisonings cause an estimated 39,800 deaths and 27.9 million Disability Adjusted Life Years (DALYs) in the African region [4]. Snakebite envenoming, most recently added to the list of WHO's neglected tropical diseases, has effects on millions annually, with the sub-Saharan African region contributing significantly to both global mortality and disability [5]. In addition, urban areas are becoming steadily more frequent in reporting pharmaceutical over-dosage, whereas traditional and herbal medicines contribute to poisoning due to uncontrolled preparation and dosing [6]. Industrialization also introduces occupational exposure risks of heavy metals and chemical toxicity [7].

Despite the negative impact on the health system, poisoning continues to be given low attention across the continent, marked by low reporting rates, a lack of poison information centers, and scattered toxicology monitoring systems [8]. This resulted in policymakers not fully recognizing the problem, less attention, limited access to antidotes, and inadequate prevention efforts [9].

Medical toxicology is a subspecialty field of medicine that focuses on preventing, assessing, diagnosing, and treating exposure to chemicals, drugs, and toxins, offering a key approach to tackling these challenges [10].

In high-income countries (HICs), medical toxicologists play a pivotal role in treating poisoned patients and help shape policies, conduct research, and support regulations through organized training and poison control systems [11, 12]. According to a 2016 review by the African Federation for Emergency Medicine, there has been continued fragmentation, a shortage of skilled workers, and a lack of research in toxicology capabilities. Since there are no formal programs to train medical toxicologists in Africa, poisoning cases are usually handled by doctors without specific toxicology training. While some countries, such as South Africa, Morocco, Egypt, and Senegal, have poison information services, they are often poorly funded and not linked to structured training programs [13].

This gross imbalance between high burdens of poisoning and low levels of formal training is a glaring weakness of African health systems. It can only be closed with regionally specific solutions—namely, the establishment of medical toxicology fellowship training from emergency medicine, internal medicine, or pediatrics practitioners, backed by international collaboration and rooted in local epidemiology [14].

This review aims to address the toxicological milieu in Africa, the clinical and public health capacity gaps, and provide a context-informed mechanism for establishing medical toxicology fellowship programs in the region. Based on international models and regional needs, it

proposes a strategic roadmap towards strengthening toxicology capacity in Africa.

The burden of poisoning in Africa

The patterns and epidemiology of poisoning

Poisoning remains a major contributor to mortality and morbidity throughout Africa, with varied causative agents and populations. The most vulnerable population remains children, with South African hospital surveys reporting frequent admission as a secondary effect of organic solvents, medications, and pesticides, with an associated mortality of approximately 2.1%. The COVID-19 pandemic also altered the epidemiology of child poisonings, emphasizing contextual determinants of exposure risk [15, 16]. In East Africa, especially in Ethiopia, pesticide self-poisoning, using aluminum phosphide, contributes to a high percentage of deaths [17–21]. The primary culprits of accidental poisonings among children are household chemicals and medicines, while intentional ingestions are more common among young adults [15, 17, 18]. Environmental causes, like heavy metal poisoning in Nigeria due to mining and contaminated surroundings, highlight the burden of community-level toxic exposures [22–24].

Clinical outcomes and determinants

The fate of serious poisoning is a product of numerous factors, among them delays in presenting for care, inadequate diagnostic capacity, and the absence of antidotes or critical-care capabilities. Death rates in Ethiopia are still significantly higher than anywhere else in the world, with an advanced poison control infrastructure highlighting the susceptibility of healthcare systems to deal with poisoning emergencies [18, 25, 26]. Rural populations are also placed at greater estimated rates of death as opposed to urban populations, according to research, due to late use of hospitals and application of extremely toxic pesticides [20]. Apart from poisoning hazard, consumption of traditional medicine such as *Hagenia abyssinica* poses another risk [27]. Even if the patients survive, long-term disability, morbidity, and economic losses are frequent, and public health estimates pose the necessity of strengthening the health system as a matter of high priority [28].

The capacity, policy, and research gaps

Africa lags in commensurate infrastructure for toxicology services, even in the face of the clear burden. It has a few poison control centers in most countries, and laboratory and toxicovigilance systems are weak [18, 26]. Through research and capacity-building efforts, including those done by Kenya Medical Research Institute (KEMRI) in Kenya, some progress has been made in toxicology science and drug discovery; However, these are

still isolated efforts [29]. Regional global conferences and sessions, such as the West African Society of Toxicology (WASOT) 2025, have identified closing the science-policy-practice gaps in order to tackle these issues [30]. The WHO regional estimates also indicate a substantially higher mortality due to unintentional poisoning across Africa, which is consistent with the available national data, although recent surveillance is limited [31, 32]. Environmental toxicology issues, including legacy chemicals and new chemical hazards, also add to the need for a multidisciplinary strategy [24, 33].

Policy imperatives should focus on regulating pesticides, improving toxicovigilance, advancing environmental cleanup, and expanding poison control services. Recent evidence from Africa shows that although pesticide misuse and poisoning are widespread, there is very limited data on effective interventions or on which specific chemicals are responsible for the greatest harm, largely because surveillance, training, and regulatory implementation remain weak. There are still research gaps in population-based incidence studies, socioeconomic impacts, and the effectiveness of interventions [17, 18, 26, 34]. All evidence indicates the need to integrate toxicology into broader health system strengthening and public health efforts in Africa.

Developing a medical toxicology fellowship framework in Africa

International experiences

Worldwide, formal education in medical toxicology has existed for decades, especially in the United States, where the Accreditation Council for Graduate Medical Education (ACGME) sets requirements for accredited programs [35]. Most programs follow a two-year fellowship track, typically conducted after residency in Internal Medicine, Pediatrics, or Emergency Medicine [36–40]. These programs at Emory University, Indiana University, University of California, Davis (UC Davis), and the University of Rochester combine poison center-based clinical care with bedside consultation, research training, and public health preparedness [36, 37, 41, 42].

Beyond the United States, fellowships are available in other countries. For example, the Sidra Medicine Fellowship in Qatar [43] in collaboration with the fellowship programs, such as those at Emory and Colorado [42, 44], demonstrate that training opportunities exist outside North America. Professional development programs like those of Fellows of the American College of Medical Toxicology (FACMT) [45] help create global opportunities by providing legitimacy to toxicologists worldwide [46].

These global opportunities share common features—including formal curricula, integrated poison information services, strong research components, and professional

accreditation—yet access to such programs remains limited across the African continent.

Promising African initiatives

Although Africa has not yet established a widely recognized fellowship in medical toxicology, encouraging progress has been made. A notable advancement was the development of a Poison Information Center collaboration model outlined by Marks et al. [13], which highlighted regional cooperation in toxicology services. Additionally, Stellenbosch University launched Africa's first postgraduate diploma in Medical Toxicology [47], a hybrid program designed to provide structured toxicology education.

Additionally, some short courses have been created, such as the Emergency Toxicology and Venomology course offered through Essential Medical Guidance (EMGuidance) Academy [48]. Some centers, like the Forensic Toxicology Unit and the Poison Information Center at the Red Cross Children's Hospital at the University of Cape Town [49, 50], also improve access to poison information, training, and research capabilities. Regional conferences, like the West African Society of Toxicology (WASOT) 2025 meeting, have provided forums for scientific exchange and policy discussions [30].

International organizations are also lending support to local initiatives. The International Health Regulations (IHR) Strengthening Project has enabled “training of trainers” initiatives in Ethiopia [51] and capacity building for poison centers in Africa [52]. These initiatives represent the necessary steps toward establishing a foundation for advanced toxicology training. The potential strategic road-map for establishing a medical toxicology fellowship in Africa is illustrated in Fig. 1.

Proposed model

A sustainable medical toxicology fellowship would fill well-documented gaps in clinical expertise, toxicovigilance, and regulatory capacity across Africa, offering the trained workforce needed to strengthen patient care, surveillance, and evidence-based chemical safety policies [18, 26, 31, 33, 34].

Based on the international experiences and African pilot projects (Table 1), a sustainable fellowship program could be structured around the following pillars:

1. Eligibility

- Physicians who already have trained in Emergency Medicine, Internal Medicine, Pediatrics, or Pharmacology.

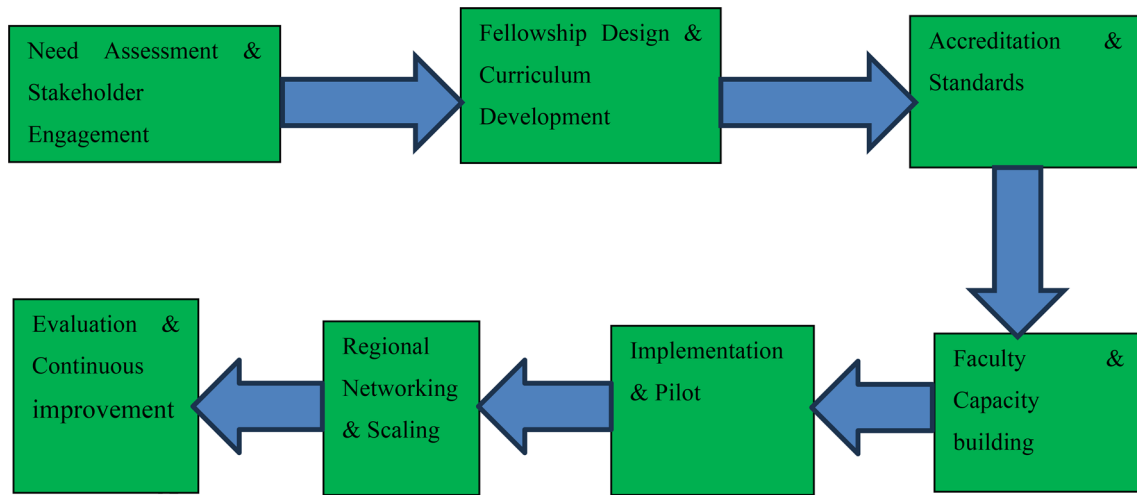


Fig. 1 Schematic diagram for the strategic roadmap for medical toxicology fellowship in Africa

Table 1 Possible pilot sites for Establishing medical toxicology fellowship in Africa [4, 13, 49, 51, 53– 56]

No	Potential pilot site	Region of Africa	Country	Rationale
1	Stellenbosch University/ Tygerberg Hospital	Southern	South Africa	Already has a first postgraduate diploma in medical toxicology in Africa Has poison information center capacity
2	Forensic and Analytical Toxicology Unit/ University of Cape Town	Southern	South Africa	There is Forensic toxicology training, analytical lab infrastructure, and strong toxicology research
3	Collaboration model for the African poison center	Southern	South Africa/ regional	It has proposed a networked poison information center model for Africa It also has a potential framework for fellowship integration
4	University of Nairobi/ Kenyatta National Hospital	Eastern	Kenya	It is a national referral hospital with an Emergency Medicine residency program, with a growth in toxicological research
5	Addis Ababa University/ Tikur Anbessa Specialized Hospital	Eastern	Ethiopia	The largest tertiary hospital with a high burden of poisoning There is also an IHR strengthening project to train the trainers for poisoning management, a program that can potentially collaborate with this University
6	Ain shams University/ poison control center	Northern	Egypt	The busiest poison control center on the continent, which has established training capacity
7	Komfo Anokye Teaching Hospital/ Pediatric Emergency Unit	Western	Ghana	A national referral hospital with a documented pediatric poisoning management unit
8	Mulango National Referral Hospital	Eastern	Uganda	A national referral hospital with a high burden of acute poisoning

- Candidates with prior experience in toxicology, poison centers, or public health emergency response can be considered an asset.
- Applicants from throughout Africa, with provision for regional equity.

2. Curriculum and Duration

- Two-year program, modified from international fellowship standards.
- Core module courses: clinical toxicology, occupational and environmental toxicology, venomology, forensic toxicology, toxicovigilance, public health toxicology, and research methods.
- Scholarly requirement: at least one research or policy output during training.

3. Delivery Modalities

Hybrid format

- In-person attachments or rotations at regional hubs (e.g., South Africa, Kenya, Nigeria, Ethiopia).
- Online didactics through the African Federation for Emergency Medicine (AFEM) supported networks.
- Clinical rotations in Emergency Medicine, Intensive Care Unit, Pediatrics, Poison Centers, and Forensic Toxicology labs.
- Regional rotations or exchanges to expose fellows to varied toxicological contexts.
- Faculty drawn from African institutions, supported by visiting international experts.

4. Accreditation and recognition

Table 2 Implementation challenges and possible solutions for Establishing medical toxicology fellowship in Africa [13, 45, 52, 53, 59, 60]

	Key challenges	Potential Solutions
1	Lack of trained faculty	<ul style="list-style-type: none"> Establishing collaboration programs with established fellowships in the US, UK, the Middle East, and India Hybrid online mentorship
2	Infrastructure & diagnostic gaps	<ul style="list-style-type: none"> Prioritize pilot sites with the existing capacity Integrating tele-toxicology networks to support resource-limited centers
3	Policy & accreditation barriers	<ul style="list-style-type: none"> Engaging the African Federation for Emergency Medicine Engaging national health ministries national professional medical boards, councils, and associations
4	Sustainability & funding	<ul style="list-style-type: none"> Incorporating toxicology training into post-graduate programs such as Emergency Medicine, Internal Medicine, etc. Advocacy for national budget allocation Support from WHO, CDC, IHR, etc.
5	Retention of trained subspecialists	<ul style="list-style-type: none"> Developing clear career pathways Research opportunities Competitive salary packages with additional incentives

- Joint accreditation through the African Federation for Emergency Medicine (AFEM) by engaging national professional medical boards, councils, and associations.
- Alignment with ACGME program requirements [30, 35] to ensure global comparability.
- Recognition pathways to international professional societies (e.g., FACMT) [45].

5. Sustainability and capacity building

- Graduates as trainers of trainers, scaling expertise regionally.
- Integration with national poison control systems, Africa CDC initiatives, and WHO recommendations.
- Establish ongoing partnerships with WASOT, AFEM, and international universities for technical support and research collaboration.

The initial phase of the proposed fellowship program is planned for locations with existing capacity to ensure high-quality pilots. While these sites may not fully align with the geographic distribution of toxicological incidents across Africa, piloting in existing centers allows for feasibility and program evaluations. A subsequent phase is envisioned to expand training opportunities to regions with limited capacity to address unmet needs and strengthen toxicology services continent-wide.

Implementation challenges and possible solutions for establishing medical toxicology fellowships in Africa

Conducting medical toxicology fellowship training programs in Africa comes with its own set of challenges, from the availability of faculty to infrastructure. Establishing such programs can bring essential clinical, regulatory, and toxicovigilance capacity in Africa; however, their long-term impact depends on sustained funding, political support, and integration into health systems. For example, the Work and Health in Southern Africa (WAHSA) “Action on Pesticides” program achieved early successes with multi-level interventions. However, it ultimately failed due to funding cuts, highlighting the critical importance of sustainability for capacity-building initiatives [57, 58]. These are, however, manageable. Table 2 synthesizes the implementation challenges and provides strategic, context-based solutions to inform policy-makers, institutions, and global stakeholders on how to implement toxicology training on the continent.

Conclusion

In Africa, poisoning remains a serious yet underestimated public health issue, exacerbated by a lack of specialized training programs, weak surveillance systems, and limited diagnostic capabilities. Although international medical toxicology training models offer useful frameworks, Africa needs a tailored approach that considers its specific epidemiological, infrastructure, and regulatory challenges. By improving clinical management, strengthening toxicovigilance systems, guiding policy, and encouraging research, medical toxicologists play a crucial role in reducing the poisoning burden. Developing medical toxicology fellowship programs that collaborate with regional and global partners, are supported by poison information centers, and are integrated into Emergency Medicine and Internal Medicine Departments provides a strategy to enhance patient outcomes and public health readiness. To elevate toxicology from a neglected field to a key component of Africa’s healthcare resilience, governments, academic institutions, and international partners should coordinate their financial efforts. Ultimately, this is because investment in medical toxicologists transforms into investment in Africa’s health security.

Abbreviations

ACGME	Accreditation Council for Graduate Medical Education
AFEM	African Federation for Emergency Medicine
CDC	Centers for Disease Control and Prevention
FACMT	Fellows of the American College of Medical Toxicology
HICs	High income countries
IHR	International Health Regulations
KEMRI	Kenya Medical Research Institute
LMICs	Low and middle-income countries
UC Davis	University of California, Davis
UK	United Kingdom

US United States
WASOT West African Society of Toxicology
WHO World Health Organization

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Competing interests

The authors declare no competing interests.

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