International Atomic Energy Agency (IAEA) Background Guide

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International Atomic Energy Agency (IAEA) Background Guide

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Written July 2025

The International Atomic Energy Agency (IAEA), established in 1957, promotes the safe use of nuclear technology, including in healthcare. Nuclear medicine and radiotherapy play a crucial role in diagnosing and treating cancer and other non-communicable diseases; however, access to these technologies remain disproportionate globally. High-income countries often operate hundreds of radiotherapy units, whereas many low- and middle-income countries (LMICs) have few or none.[1] By 2040, it is projected that over 70% of global cancer deaths will occur in LMICs, despite these countries accounting for only about 5% of global cancer care spending.[2] Globally, nearly half of all cancer patients require radiotherapy during their treatment.[3]

To address these disparities, the IAEA launched the *Rays of Hope* initiative in 2022, aimed at strengthening cancer care infrastructure in LMICs through the provision of equipment, workforce training, and technical cooperation. The program initially targeted seven African countries—Benin, Chad, the Democratic Republic of the Congo, Kenya, Malawi, Niger, and Senegal[4]—and has since expanded, with over $70 million mobilized from member states, international donors, and private sector partners.[5] Anchor centres in Algeria, Jordan, Morocco, Pakistan, and Turkey function as regional hubs supporting these efforts.[6]

Despite these advancements, challenges persist in terms of scaling access sustainably, ensuring equipment maintenance, developing qualified personnel, and balancing safety and security concerns with national sovereignty. The strategic allocation of resources between

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[1]IAEA. (2022b, February 1). *Rays of hope*. IAEA. https://www.iaea.org/services/key-programmes/rays-of-hope

[2]IAEA. (2022c, February 4). *IAEA/WHO joint statement on reducing inequity in access to cancer care through rays of hope initiative*. IAEA. https://www.iaea.org/newscenter/statements/iaeawho-joint-statement-on-reducing-inequity-in-access-to-cancer-care-through-rays-of-hope-initiative

[3]*Afomppress*. Asia-Oceania Federation of Organizations for Medical Physics. https://afomp.org/2023/08/31/professional-news-updates-76th-world-health-assembly-iaea-highlights/

[4]Laffan, K., & Agency, I. A. E. (2024, September 20). *Rays of hope: Widening global access to cancer care*. IAEA. https://www.iaea.org/newscenter/news/rays-of-hope-widening-global-access-to-cancer-care

[5]Midgley, E., & Agency, I. A. E. (2024, December 20). *World cancer day 2024 event: Raising rays of hope for cancer care for all*. IAEA. https://www.iaea.org/newscenter/news/world-cancer-day-2024-event-raising-rays-of-hope-for-cancer-care-for-all

[6]Annual report for 2023 | IAEA. (n.d.-b). https://www.iaea.org/publications/reports/annual-report/2023

regional hubs and broader national distribution remains a key consideration in advancing equitable nuclear medicine and radiotherapy services.

I. Expanding access to Nuclear Medicine in Low- and Middle-Income Countries

Statement of the Issue:

The growing global burden of cancer represents not just a health crisis, but a development emergency that is unfolding mostly in LMICs. This widening disparity reflects a structural failure to extend access to essential technologies such as radiotherapy and nuclear medicine, tools which are critical not only for cancer treatments but also for diagnosis, palliative care, and the management of other non-communicable diseases.[7]

IAEA, through its *Rays of Hope* initiative, has taken an increasingly active role in confronting this gap. By providing equipment, training, and institutional support, the IAEA seeks to reduce the inequalities that leave millions without access to timely cancer diagnosis and treatment.[8] However, the pace and scale of progress remain far from adequate. Entire regions in sub-Saharan Africa still operate with fewer than five functioning radiotherapy machines.[9] While high-income countries maintain dense networks of nuclear medicine facilities, many LMICs lack even a single PET scanner or secure isotope supply.[10]

This imbalance is not merely technical, it is political and ethical. Many LMICs continue to face barriers to technology transfer due to export restrictions, regulatory burdens, and geopolitical mistrust surrounding dual-use nuclear technologies.[11] Others express frustration at being excluded from global funding priorities or left behind in innovation pipelines. The IAEA's model, though comprehensive, is constrained by limited voluntary funding, donor fatigue, and

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[7] Hricak H;Abdel-Wahab M;Atun R;Lette MM;Paez D;Brink JA;Donoso-Bach L;Frija G;Hierath M;Holmberg O;Khong PL;Lewis JS;McGinty G;Oyen WJG;Shulman LN;Ward ZJ;Scott AM; (n.d.). *Medical Imaging and Nuclear Medicine: A Lancet Oncology Commission*. The Lancet. Oncology. https://pubmed.ncbi.nlm.nih.gov/33676609/

[8] IAEA. (2022a, February 1). *Rays of hope*. IAEA. https://www.iaea.org/services/key-programmes/rays-of-hope

[9] Maistrenko, O. (n.d.). Division for Human Health: DIRAC (Directory of Radiotherapy Centres). https://dirac.iaea.org/

[10] IAEA. (n.d.). *Reports*. IAEA. https://www.iaea.org/publications/reports

[11] IAEA. (2016, June 8). *Nuclear safety and security*. IAEA. https://www.iaea.org/topics/nuclear-safety-and-security

varying levels of national capacity to absorb advanced technology in many regions.[12] Without bold and coordinated investment by the IAEA, donor governments, private industry, and regional blocs, the ambition of equitable cancer care will remain out of reach.

If current trends persist, the result will not only be preventable deaths, but deepening health inequities and systemic strain on already fragile health systems. The global community cannot afford to treat nuclear medicine access as a secondary issue. Cancer is now a leading cause of death in LMICs, surpassing infectious diseases in many regions.[13]

The question is no longer whether the IAEA should act, but how the international system can scale and sustain its efforts. Without a stronger, long-term commitment from the global health and development community, the world risks reinforcing a two-tiered cancer care system, where the chance to survive depends not on biology, but on geography.[14]

History:

Since its establishment in 1957, the IAEA has supported the peaceful use of nuclear technology across sectors ranging from energy to agriculture to health. Early efforts in nuclear medicine were modest and primarily technical, providing diagnostic equipment, training personnel, and promoting radiation safety. Throughout the 1980s and 1990s, as cancer rates rose globally, the IAEA began integrating radiotherapy and nuclear diagnostics into its Technical Cooperation Programme, with an emphasis on workforce development and basic infrastructure in low-resource settings.

Yet despite decades of assistance, major gaps in cancer care persist. Many low- and middle-income countries (LMICs) still lack functioning radiotherapy machines, trained oncologists, or secure access to medical isotopes. Some countries operate just a single cancer center to serve millions of people; others have none at all. Meanwhile, wealthier states often maintain dense networks of radiotherapy units, advanced nuclear medicine departments, and

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[12] IAEA. (2018, November 30). *Technical cooperation - success stories*. IAEA. https://www.iaea.org/topics/technical-cooperation-success-stories

[13] Stefan, D. C., & Tang, S. (2023, August 15). *Addressing cancer care in low- to middle-income countries: A call for sustainable innovations and impactful research*. BMC cancer. https://pmc.ncbi.nlm.nih.gov/articles/PMC10426184/

[14] Expanding global access to radiotherapy - the lancet oncology. (n.d.-l). https://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(15)00222-3/abstract

domestic supply chains. This stark global imbalance is shaped not only by cost, but by uneven technology transfer, regulatory concerns, and limited investments in local infrastructure.[15]

In 2022, the IAEA launched the *Rays of Hope* initiative in direct response to these disparities.[16] The program marked a shift in approach: rather than supporting countries individually through isolated projects, *Rays of Hope* introduced a coordinated model based on regional anchor centres, multilateral partnerships, and long-term investment in training, safety, and infrastructure.

While the IAEA frames cancer care as a development and equity issue, implementation has raised complex political and ethical questions. Some states are wary of external oversight or the dual-use risk associated with nuclear technologies. Others argue they have been excluded from meaningful access to nuclear medicine due to export restrictions, cost barriers, or lack of technical cooperation.[17] Funding models remain inconsistent: some projects are supported by voluntary contributions, while others depend on external donors or partnerships with private industry. As global health priorities shift, questions continue to surface around sustainability, oversight, and whether the IAEA should focus on expanding services broadly or concentrating resources in high-impact regional hubs.[18]

Analysis:

The global disparity in access to cancer care represents one of the most pressing health inequities of the 21st century. LMICs bear nearly 70% of the global cancer burden, often lacking the technological, financial, and human infrastructure to offer even the most basic diagnostic and therapeutic services.[19] Nuclear medicine is a field for leveraging radioactive isotopes for imaging, diagnosis, and treatment has emerged as a critical tool in the fight against cancer and

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[15] Dos-Santos-Silva, I., Gupta, S., Orem, J., & Shulman, L. N. (2022, April 7). *Global disparities in access to cancer care*. Communications medicine. https://pmc.ncbi.nlm.nih.gov/articles/PMC9053243/

[16] IAEA. (2022a, February 1). *Rays of hope*. IAEA. https://www.iaea.org/services/key-programmes/rays-of-hope

[17] Burge, J., & Agency, I. A. E. (2025, August 13). *Advances in nuclear medicine mean patient protection needs strengthening*. IAEA. https://www.iaea.org/newscenter/news/advances-in-nuclear-medicine-mean-patient-protection-needs-strengthening

[18] Krikorian, L., & Agency, I. A. E. (2024, December 6). *IAEA looks to expand successful Global Nuclear Power Capacity Building Projects*. IAEA. https://www.iaea.org/newscenter/news/iaea-looks-to-expand-successful-global-nuclear-power-capacity-building-projects

[19] World Health Organization. (n.d.-a). *Cancer*. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/cancer

other non-communicable diseases (NCDs). However, its benefits remain largely inaccessible to many LMICs due to high costs and systemic underinvestment. The IAEA, traditionally known for its role in nuclear non-proliferation, has taken on an increasingly vital mandate in addressing this imbalance through programs like *Rays of Hope*.

The IAEA's support in cancer care transcends mere advocacy. Through technical cooperation, the Agency provides radiotherapy machines, cyclotrons (a device that allows scientists to study the structure of matter), and nuclear imaging technologies to under-resourced health systems. It also funds training programs for oncologists, radiopharmacists, and medical physicists while assisting in national cancer control planning. Unlike many development actors, the IAEA combines infrastructure development with capacity-building in a way that prioritizes sustainable technological integration over temporary relief.[20] Crucially, it promotes Southern cooperation and technology transfer, empowering countries to develop local manufacturing capacity and reduce long-term dependency on foreign donors.

Despite these efforts, access to nuclear medicine remains starkly uneven. In Africa, over 20 countries do not have a single radiotherapy machine, and more than 50% lack nuclear medicine departments.[21] While high-income countries have on average 10-15 linear accelerators per million people, many LMICs must manage with one or two machines serving entire nations. The resulting treatment delays, diagnostic errors, and limited care options expose millions to unnecessary suffering and premature death.

The *Rays of Hope* initiative, launched by the IAEA in 2022, aims to redress these disparities by scaling nuclear medicine access through strategic investment in infrastructure, training, and regulatory readiness.[22] However, the scope and sustainability of this initiative depend heavily on funding. While the IAEA's traditional donors, including the U.S., EU, and Japan, continue to provide voluntary contributions, long-term financing must also involve multilateral development banks, regional blocs, and private sector partners. The African Union (AU), Association of Southeast Asian Nations (ASEAN), and World Health Organization (WHO) are well-positioned to play a coordinating role in aligning cancer control goals with

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[20] IAEA. (2022a, February 1). *Rays of hope*. IAEA. https://www.iaea.org/services/key-programmes/rays-of-hope

[21] IAEA. (n.d.-a). *Reports*. IAEA. https://www.iaea.org/publications/reports

[22] Maistrenko, O. (n.d.-a). *What is directory of Radiotherapy Centres (dirac)?*. Division for Human Health: DIRAC (Directory of Radiotherapy Centres). https://dirac.iaea.org/

broader health and development strategies. Private technology firms, meanwhile, have a commercial incentive to support market entry in emerging economies and could offer subsidized equipment or public-private partnership models for radiotherapy deployment.

However, this expansion effort is not without its geopolitical and ethical tradeoffs. Some governments remain wary of international oversight of nuclear technologies, fearing that medical cooperation may evolve into strategic dependency or infringe on national sovereignty. These political concerns must be addressed through transparent partnerships and equitable licensing agreements, or risk undermining trust in IAEA-led initiatives.

A central policy dilemma lies in balancing resource allocation. Should health ministries in MICs prioritize radiotherapy (an expensive, specialized treatment) over more widely needed services like primary care, vaccination, or disease control? These are not merely logistical questions but ethical ones, forcing policymakers to weigh long-term gains against immediate needs.

Moreover, nuclear technology's utility extends beyond cancer. It is increasingly vital for diagnosing cardiovascular and endocrine diseases, sterilizing medical equipment,and supporting broader public health efforts.[23] For example, the IAEA uses isotope hydrology to help countries manage their water resources by determining the quality, age, and origin of water supplies, which are critical for sustainable development and climate resilience.[24] In the area of food security, nuclear techniques such as food irradiation, exposes food to ionizing radiation and is used to eliminate harmful microorganisms and insects, improving food safety and shelf life.[25] Therefore, expanding nuclear health infrastructure could yield cross-cutting development dividends, reinforcing health system resilience more broadly.

Ultimately, the success of global nuclear medicine expansion hinges on coherent multilateral coordination, transparent governance, and realistic expectations. The IAEA has made substantial progress, but without deeper integration into regional development agendas, and without addressing disparities in technology access and geopolitical trust, initiatives like *Rays of Hope* risk falling short of their transformative potential. In an era marked by rising non-

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[23] IAEA. (2016b, June 8). *Sustainable development goals (sdgs)*. IAEA. https://www.iaea.org/about/overview/sustainable-development-goals

[24] IAEA. (2016a, April 13). *Water Resource Management*. IAEA. https://www.iaea.org/topics/water-resource-management

[25] IAEA. (2016a, April 13). *Food irradiation*. IAEA. https://www.iaea.org/topics/food-irradiation

communicable diseases (NCDs), investing in equitable access to nuclear medicine is not just a technical necessity, it is a moral imperative.

Conclusion:

The IAEA's evolving role in global cancer care (represented by initiatives like *Rays of Hope*) demonstrates the Agency's growing commitment to addressing one of the most urgent health inequities of our time. By facilitating access to nuclear medicine and radiotherapy in LMICs through equipment provision, workforce training, and regional coordination, the IAEA has laid the groundwork for more equitable care.[26] Yet substantial challenges remain. Disparities in technology access, limited funding predictability, and geopolitical tensions over nuclear oversight continue to undermine long-term progress.[27]

The tension between ambition and capacity is at the heart of the IAEA's global health mandate. What is clear, however, is that global health equity cannot be achieved without investment in advanced technologies, including those that carry political and technical complexity. Nuclear medicine is not a luxury, in many contexts, it is a life-saving necessity.[28] As cancer rates continue to rise across LMICs, the international community must match the IAEA's technical expertise with sustained financial and political commitment.[29] Without that alignment, even the most promising initiatives risk falling short of their transformative potential.

Questions to consider:

1. How can international cooperation go beyond donations to help LMICs build lasting nuclear medicine programs?
2. How can the global community address trust issues and power imbalances to ensure more equitable access to nuclear technology for medical use?
3. How can we make sure that help given to LMICs lasts long-term?

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[26] IAEA. (2022a, February 1). *Rays of hope*. IAEA. https://www.iaea.org/services/key-programmes/rays-of-hope
[27] Lemoine, M., et al. (2021). *Access to Cancer Care in Low-Income Countries: Challenges and Strategic Responses*. *The Lancet Oncology*, 22(5), 605–617.
[28] IAEA. (n.d.-a). *Reports*. IAEA. https://www.iaea.org/publications/reports
[29] IAEA. (2016a, June 8). *Nuclear safety and security*. IAEA. https://www.iaea.org/topics/nuclear-safety-and-security

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Afomppress. Asia-Oceania Federation of Organizations for Medical Physics. https://afomp.org/2023/08/31/professional-news-updates-76th-world-health-assembly-iaea-highlights/

Laffan, K., & Agency, I. A. E. (2024, September 20). *Rays of hope: Widening global access to cancer care*. IAEA. https://www.iaea.org/newscenter/news/rays-of-hope-widening-global-access-to-cancer-care

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Hricak H;Abdel-Wahab M;Atun R;Lette MM;Paez D;Brink JA;Donoso-Bach L;Frija G;Hierath M;Holmberg O;Khong PL;Lewis JS;McGinty G;Oyen WJG;Shulman LN;Ward ZJ;Scott AM; (n.d.). *Medical Imaging and Nuclear Medicine: A Lancet Oncology Commission*. The Lancet. Oncology. https://pubmed.ncbi.nlm.nih.gov/33676609/

IAEA. (2022a, February 1). *Rays of hope*. IAEA. https://www.iaea.org/services/key-programmes/rays-of-hope

Maistrenko, O. (n.d.). Division for Human Health: DIRAC (Directory of Radiotherapy Centres). https://dirac.iaea.org/

IAEA. (n.d.). *Reports*. IAEA. https://www.iaea.org/publications/reports

IAEA. (2016, June 8). *Nuclear safety and security*. IAEA. https://www.iaea.org/topics/nuclear-safety-and-security

IAEA. (2018, November 30). *Technical cooperation - success stories*. IAEA. https://www.iaea.org/topics/technical-cooperation-success-stories

Stefan, D. C., & Tang, S. (2023, August 15). *Addressing cancer care in low- to middle-income countries: A call for sustainable innovations and impactful research*. BMC cancer. https://pmc.ncbi.nlm.nih.gov/articles/PMC10426184/

Expanding global access to radiotherapy - the lancet oncology. (n.d.-l). https://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(15)00222-3/abstract

Dos-Santos-Silva, I., Gupta, S., Orem, J., & Shulman, L. N. (2022, April 7). *Global disparities in access to cancer care*. Communications medicine. https://pmc.ncbi.nlm.nih.gov/articles/PMC9053243/

Burge, J., & Agency, I. A. E. (2025, August 13). *Advances in nuclear medicine mean patient protection needs strengthening*. IAEA. https://www.iaea.org/newscenter/news/advances-in-nuclear-medicine-mean-patient-protection-needs-strengthening

Krikorian, L., & Agency, I. A. E. (2024, December 6). *IAEA looks to expand successful Global Nuclear Power Capacity Building Projects*. IAEA. https://www.iaea.org/newscenter/news/iaea-looks-to-expand-successful-global-nuclear-power-capacity-building-projects

World Health Organization. (n.d.-a). *Cancer*. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/cancer

IAEA. (n.d.-a). *Reports*. IAEA. https://www.iaea.org/publications/reports

Maistrenko, O. (n.d.-a). *What is directory of Radiotherapy Centres (dirac)?*. Division for Human Health: DIRAC (DIrectory of RAdiotherapy Centres). https://dirac.iaea.org/

Midgley, E., & Agency, I. A. E. (2025, July 15). *Rays of Hope Forum: Bringing hope in Africa and beyond*. IAEA. https://www.iaea.org/newscenter/news/rays-of-hope-forum-bringing-hope-in-africa-and-beyond

IAEA. (2016b, June 8). *Sustainable development goals (sdgs)*. IAEA. https://www.iaea.org/about/overview/sustainable-development-goals

IAEA. (2022a, February 1). *Rays of hope*. IAEA. https://www.iaea.org/services/key-programmes/rays-of-hope

Lemoine, M., et al. (2021). *Access to Cancer Care in Low-Income Countries: Challenges and Strategic Responses*. *The Lancet Oncology*, 22(5), 605–617.

IAEA. (n.d.-a). *Reports*. IAEA. https://www.iaea.org/publications/reports

IAEA. (2016a, June 8). *Nuclear safety and security*. IAEA. https://www.iaea.org/topics/nuclear-safety-and-security

IAEA. (2016a, April 13). *Water Resource Management*. IAEA. https://www.iaea.org/topics/water-resource-management

IAEA. (2016a, April 13). *Food irradiation*. IAEA. https://www.iaea.org/topics/food-irradiation

II. Preventing Nuclear Terrorism

Preventing nuclear terrorism represents one of the most critical and complex challenges facing the international community today. The IAEA plays a central role in coordinating global efforts to secure nuclear materials and facilities, but its mandate is complicated by fundamental tensions between state sovereignty and international oversight. How much authority the IAEA should have to inspect, verify or intervene in a nation's nuclear security measures remains deeply contested.[30] While states bear primary responsibility for securing nuclear materials within their borders, accountability mechanisms, especially when lapses occur, raise difficult questions about sanctions, restrictions, and collective enforcement.[31]

The evolving threat landscape further complicates this challenge. Traditional concerns over the theft of fissile material (a type of nuclear material that can sustain a nuclear chain reaction) have been compounded by emerging risks such as dirty bombs, drone-enabled attacks, insider sabotage, and increasingly sophisticated cyber threats powered by artificial intelligence.[32] The rise of AI-driven disinformation campaigns and deepfake technologies introduces new dimensions to crisis scenarios, potentially undermining trust in official communications during nuclear incidents.[33]

At the same time, perceptions of nuclear security risks are often divided along global economic lines. Many Global South states view nuclear terrorism as primarily a "rich-country" problem, reflecting differing threat perceptions and priorities.[34] This divergence influences how technical assistance and security investments are distributed, underscoring the need for more equitable and context-sensitive approaches.

As these dynamics evolve, the IAEA's Nuclear Security Series must adapt to address emerging threats and geropolitical complexities.[35] Determining how to balance respect for

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[30] Agency, I. A. E. (2013, February 13). Objective and essential elements of a state's nuclear security regime. https://www.iaea.org/publications/10353/objective-and-essential-elements-of-a-states-nuclear-security-regime

[31] Perkovich, G., & Acton, J. M. (2017). *Abolishing Nuclear Threats: Why the U.S. and the World Need a New Approach to Nuclear Security*. Carnegie Endowment for International Peace.

[32] *Nuclear terrorism and nuclear security: Matthew Bunn*. Harvard Kennedy School. (n.d.). https://matthewbunn.scholars.harvard.edu/nuclear-terrorism-and-nuclear-security

[33] Brundage, M., et al. (2020). *The Malicious Use of Artificial Intelligence: Forecasting, Prevention, and Mitigation*. Future of Humanity Institute. https://arxiv.org/pdf/1802.07228

[34] *Latest documents*. Latest Documents | African Union. (2025, October 29). https://au.int/en/documents/statement-nuclear-security

[35] International Atomic Energy Agency (IAEA). (2025, August 1). *Official Web site of the IAEA*. https://www.iaea.org/

sovereignty with the necessity of effective international cooperation will be crucial to strengthening global nuclear security and preventing catastrophic terrorism.

Statement of the issue:

The threat of nuclear terrorism remains one of the most pressing challenges to international peace and security. Non-state actors, including terrorist organizations, continue to seek access to nuclear and radiological materials, exploiting gaps in global security infrastructure. The detonation of an improvised nuclear device (IND) or a radiological dispersal device (RDD or "dirty bomb") would cause devastating human, environmental, and political consequences, undermining public trust, disrupting economies, and triggering long-term contamination and displacement.[36]

The IAEA has taken a leading role in coordinating international efforts to prevent nuclear terrorism, particularly through its Nuclear Security Plan and support for the Convention on the Physical Protection of Nuclear Material (CPPNM) and its 2005 Amendment.[37] These frameworks provide essential legal and technical guidance, but many member states continue to face challenges in implementation. Disparities in national capacity, regulation, training, and access to technology make it difficult to ensure consistent global standards.[38]

Preventing nuclear terrorism is not just a security challenge, it is a political and developmental issue. Nuclear security systems require sustained investment, yet many countries lack the financial or institutional means to build and maintain robust protective measures. Moreover, mistrust among states, particularly nuclear-armed ones, hinders the sharing of intelligence and best practices. The dual-use nature of nuclear technologies further complicates nonproliferation efforts: while peaceful nuclear applications expand in energy, medicine, and

[36] European Police Office, I. A. E. A. (2011, February 4). Nuclear security recommendations on nuclear and other radioactive material out of regulatory control. https://www.iaea.org/publications/8622/nuclear-security-recommendations-on-nuclear-and-other-radioactive-material-out-of-regulatory-control

[37] Agency, I. A. E. (2006, September 14). Amendment to the convention on the physical protection of nuclear material. https://www.iaea.org/publications/7598/amendment-to-the-convention-on-the-physical-protection-of-nuclear-material

[38] IAEA. (2024, September 12). *Annual report for 2023*. IAEA. https://www.iaea.org/publications/reports/annual-report/2023

industry, the risk of material diversion increases, especially in countries with weak oversight, such as Iran, Syria, and North Korea.[39]

Recent years have seen a rise in incidents of illicit trafficking of nuclear materials, attempted cyberattacks on nuclear facilities, and heightened regional tensions that place nuclear infrastructure at risk.[40] The emergence of small modular reactors (SMRs) and other decentralized technologies, while promising for clean energy, introduces new security considerations, especially in unstable regions. The IAEA offers valuable tools such as Integrated Nuclear Security Support Plans (INSSPs) and peer reviews, but its work is often limited by voluntary funding and lack of enforcement authority.[41]

Without a stronger, more unified commitment to nuclear security, the international community risks a preventable catastrophe. The question facing the IAEA and its member states is no longer whether to act, but how to implement sustainable, equitable, and forward-looking strategies to protect against nuclear terrorism. This includes bridging capacity gaps, fostering trust, and strengthening the legal and institutional frameworks that uphold nuclear security globally.

History:

Since its establishment in 1957, the IAEA has prioritized the peaceful use of nuclear technology, but its role in nuclear security has evolved significantly over time. In its early decades, the IAEA's focus was largely on safety, preventing accidents, and promoting secure handling of nuclear material. However, the end of the Cold War, the rise of non-state actors, and high-profile nuclear trafficking incidents in the 1990s prompted a shift toward security-focused

[39] United Nations. (n.d.). *Chemical, biological, radiological and nuclear terrorism | Office of Counter-Terrorism*. United Nations. https://www.un.org/counterterrorism/chemical-biological-radiological-nuclear-terrorism

[40] Agency, I. A. E. (2024, May 21). *IAEA database on trafficking of nuclear and other radioactive Material Records 4243 incidents since 1993*. IAEA. https://www.iaea.org/newscenter/pressreleases/iaea-database-on-trafficking-of-nuclear-and-other-radioactive-material-records-4243-incidents-since-1993

[41] IAEA. (2018a, October 4). *Integrated Nuclear Security Sustainability Plan (INSSP)*. IAEA. https://www.iaea.org/topics/temporary/integrated-nuclear-security-sustainability-plan-inssp

initiatives.[42] The 9/11 attacks in 2001 marked a turning point. Suddenly, the threat of nuclear terrorism, once considered improbable, became central to international security discourse.[43]

In response, the IAEA accelerated the development of a comprehensive nuclear security framework. The Nuclear Security Series, launched in 2006, now serves as the agency's core guidance mechanism, comprising more than 30 publications covering physical protection, regulatory measures, detection, and response.[44] This framework operates alongside voluntary instruments like the Amended Convention on the Physical Protection of Nuclear Material (CPPNM-A), which legally binds states to secure nuclear facilities and materials.[45] Still, participation and implementation vary widely, especially among states with limited resources or differing threat perceptions.

Over the past two decades, new threats have emerged, including cyberattacks on nuclear control systems, drone intrusions, and the possibility of radioactive dispersal devices ("dirty bombs").[46] Insider threats, where individuals with authorized access exploit vulnerabilities, have been linked to multiple incidents of attempted theft or sabotage, prompting calls for more rigorous personnel vetting and behavioral monitoring.[47] Simultaneously, emerging technologies like artificial intelligence, deepfake video manipulation, and automated drones have introduced unprecedented risks, which the IAEA and its partners are only beginning to address.

Despite these developments, nuclear security remains largely the sovereign responsibility of individual states. This principle has limited the IAEA's authority: it cannot conduct inspections for security compliance without state consent, and it lacks enforcement mechanisms beyond diplomatic pressure and technical advice.[48] Some countries, especially in the Global

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[42] IAEA. (2018a, October 4). *Integrated Nuclear Security Sustainability Plan (INSSP)*. IAEA. https://www.iaea.org/topics/temporary/integrated-nuclear-security-sustainability-plan-inssp

[43] *Nuclear terrorism and nuclear security: Matthew Bunn*. Harvard Kennedy School. (n.d.-a). https://matthewbunn.scholars.harvard.edu/nuclear-terrorism-and-nuclear-security

[44] IAEA. (2017, July 7). *Nuclear security series*. IAEA. https://www.iaea.org/resources/nuclear-security-series

[45] IAEA. (2014, October 17). *Convention on the physical protection of nuclear material (CPPNM) and its Amendment*. IAEA. https://www.iaea.org/publications/documents/conventions/convention-physical-protection-nuclear-material-and-its-amendment

[46] NTI | Advancing Global Nuclear and biological security. (n.d.-p). https://www.nti.org/

[47] *Insider threat mitigation guide: CISA*. Cybersecurity and Infrastructure Security Agency CISA. (2024, July 25). https://www.cisa.gov/resources-tools/resources/insider-threat-mitigation-guide

[48] Abolishing nuclear weapons: Why the United States ... (n.d.-a). https://npsglobal.org/esp/images/stories/pdf/abolishing_nuclear_weapons.pdf

South, view extensive international involvement in nuclear security as intrusive or biased, and argue that funding and policy development are dominated by advanced nuclear states.[49]

As global threats continue to evolve, the IAEA faces growing pressure to modernize its security framework, foster more equitable participation, and close dangerous gaps in the global regime. Whether through expanded technical cooperation, strengthened norms, or more assertive multilateral engagement, the agency's role in preventing nuclear terrorism will depend on its ability to navigate the enduring tension between international accountability and national sovereignty.

Analysis:

The threat of nuclear terrorism, while still hypothetical in its most catastrophic form, has become increasingly plausible due to the convergence of several destabilizing factors: the proliferation of radiological materials, the growing capabilities of non-state actors, and the rise of emerging technologies that challenge traditional security models.[50] The IAEA, while not a policing body, has assumed a critical role in shaping norms, providing technical assistance, and building capacity among member states. However, the agency's ability to prevent nuclear terrorism is constrained by its reliance on state cooperation and its limited authority to inspect or intervene when security lapses occur.[51]

A central tension lies in balancing national sovereignty with the need for enforceable international safeguards. Unlike the IAEA's authority under the Non-Proliferation Treaty (NPT) to verify the peaceful use of nuclear materials, its nuclear security functions are largely voluntary.[52] This creates gaps in oversight, particularly in countries that either reject international scrutiny or lack the capacity to fully implement security measures. When a state fails to adequately secure its materials, there is currently no formal mechanism for accountability beyond diplomatic pressure or voluntary peer reviews. This absence of enforcement raises

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[49] *Latest documents*. Latest Documents | African Union. (2025a, October 29). https://au.int/en/documents/statement-nuclear-security

[50] Bunn, M., & Wier, A. (2021). *The Evolving Nuclear Terrorism Threat*. Belfer Center for Science and International Affairs.

[51] IAEA. (2023). *Nuclear Security Series: Towards Strengthening Global Nuclear Security*. https://www.iaea.org/publications/nuclear-security-series

[52] IAEA. (2019). *Nuclear Security Fundamentals: Objective and Essential Elements of a State's Nuclear Security Regime*.

difficult questions: Should the IAEA be empowered to impose sanctions or restrict nuclear cooperation, or would such actions provoke backlash and deter cooperation from already hesitant states?

Emerging threats amplify these dilemmas. Radioactive dispersal devices ("dirty bombs") remain a primary concern due to the relative accessibility of radiological sources used in medicine and industry. But the landscape has rapidly expanded to include drone intrusions at nuclear facilities, insider sabotage facilitated by inadequate personnel screening, and AI-driven cyberattacks that can target digital control systems or public communication channels during emergencies.[53] The potential for deepfake videos to simulate leadership messages during a crisis could paralyze emergency responses or cause mass confusion.[54] Yet many existing national security frameworks and IAEA guidelines remain outdated or unequipped to address such hybrid threats.

The Global South's perspectives also shape how nuclear security is prioritized. Many developing states argue that the nuclear terrorism agenda disproportionately reflects the threat perceptions of nuclear-armed or technologically advanced countries, while diverting attention and funding from more immediate public health or development concerns.[55] This dynamic can generate resistance to expanded security norms, especially if they are perceived as top-down or conditional. The result is a fragmented global regime in which some states invest heavily in nuclear security infrastructure, while others remain underprepared and under-resourced. For technical cooperation to be effective, the IAEA must navigate these sensitivities by ensuring that assistance is needs-based, inclusive, and accompanied by long-term support.[56]

The IAEA's Nuclear Security Series has been instrumental in guiding physical protection, transport security, detection of illicit trafficking, and response to radiological emergencies. However, as new threats continue to emerge, the framework must evolve. Future revisions must account for non-traditional risks like AI-powered misinformation, cyber-sabotage, and autonomous threat vectors. Moreover, the agency must consider whether to move toward

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[53] Perkovich, G., & Acton, J. M. (2017). *Abolishing Nuclear Threats*. Carnegie Endowment for International Peace.
[54] NTI. (2022). *Emerging Technologies and the Future of Nuclear Security*. https://www.nti.org
[55] Brundage, M., et al. (2020). *The Malicious Use of Artificial Intelligence: Forecasting, Prevention, and Mitigation*. Future of Humanity Institute.
[56] African Union. (2020). *Statement on Nuclear Security and Regional Cooperation*.

binding commitments in key areas, especially the security of radiological sources, while still respecting the voluntary nature of its broader mandate.[57]

Ultimately, nuclear terrorism prevention will hinge not only on technology or infrastructure, but on trust, transparency, and political will. The IAEA must continue walking a narrow path, strengthening global security without eroding sovereignty, holding states accountable without alienating them, and preparing for future risks without provoking unnecessary fear or division. Whether it can rise to that challenge will shape the safety of the nuclear age in the decades to come.

Conclusion:

The persistence of nuclear terrorism as a global threat underscores systemic limitations in the implementation and enforcement of international nuclear security frameworks. Despite the establishment of binding instruments such as the Convention on the Physical Protection of Nuclear Material (CPPNM) and the International Convention for the Suppression of Acts of Nuclear Terrorism, many states continue to face resource and capacity constraints that hinder the full execution of these agreements.[58] Moreover, the complexity of dual-use nuclear technologies, the evolving tactics of non-state actors, and regional disparities in regulatory oversight continue to expose significant vulnerabilities.

According to the IAEA's Incident and Trafficking Database, over 1,200 confirmed incidents involving nuclear or other radioactive materials have been reported since 1994, including several involving highly enriched uranium or plutonium.[59] While the IAEA has supported over 100 member states through its Integrated Nuclear Security Support Plans (INSSPs), the pace of implementation remains uneven, with challenges ranging from inadequate physical protection measures to insufficient legal infrastructure.[60]

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[57] IAEA. (2022). *Technical Cooperation Programme: Addressing Member States' Needs*.
[58] WINS. (2023). *Enhancing Radiological Security Through Binding Norms: Policy Options for the IAEA and Member States*.
[59] IAEA. (2014a, October 17). *Convention on the physical protection of nuclear material (CPPNM) and its Amendment*. IAEA. https://www.iaea.org/publications/documents/conventions/convention-physical-protection-nuclear-material-and-its-amendment
[60] Agency, I. A. E. (2024a, May 21). *IAEA database on trafficking of nuclear and other radioactive Material Records 4243 incidents since 1993*. IAEA. https://www.iaea.org/newscenter/pressreleases/iaea-database-on-trafficking-of-nuclear-and-other-radioactive-material-records-4243-incidents-since-1993

The international community's response has been further complicated by inconsistent political will, funding limitations, and the absence of binding verification or enforcement mechanisms. These historical gaps in strategy suggest the need for more adaptive and regionally contextualized approaches, ones that balance technical guidance with legal accountability and long-term sustainability.[61]

As nuclear technology continues to expand into new sectors and regions, the urgency of preventing its misuse intensifies. Strengthened international cooperation, enhanced information-sharing protocols, and increased transparency in national security practices are essential to mitigating the risk of nuclear terrorism. The IAEA, with its dual mandate of promoting peaceful nuclear use and safeguarding against misuse, remains a central actor in this effort. Its technical authority and convening power are vital to shaping a coordinated global response, one that prioritizes not only prevention, but resilience, preparedness, and equitable access to nuclear security resources.

Questions to consider:

1. How can the global community build more trust among countries to share information and work together on nuclear security?
2. How do peaceful uses of nuclear technology (like in medicine or energy) increase the risk of nuclear terrorism, and how can we manage that risk?
3. How could new technologies, like AI, change the future of nuclear security?

[61] Liou, J., & Agency, I. A. E. (2024, September 9). *15 years of the Integrated Nuclear Security Support Plan: IAEA assists 112 countries to identify security needs*. IAEA. https://www.iaea.org/newscenter/news/15-years-of-the-integrated-nuclear-security-support-plan-iaea-assists-112-countries-to-identify-security-needs

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IAEA. (2018a, October 4). *Integrated Nuclear Security Sustainability Plan (INSSP)*. IAEA. https://www.iaea.org/topics/temporary/integrated-nuclear-security-sustainability-plan-inssp

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