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# Risk Assessment and Mitigation Strategies for $^{18}$F-FDG Transport from Cyclotron to PET-CT Centers in Bangladesh

Introduction
PET-CT has become an indispensable imaging modality in modern medicine particularly for oncology, cardiology and neurology. The most commonly used tracer, $^{18}$F-Fluorodeoxyglucose ($^{18}$F-FDG), is produced in a medical cyclotron and then delivered to PET-CT centers for patient imaging. This synopsis evaluates the risk factors associated with $^{18}$F-FDG transport and proposes mitigation strategies within the Bangladesh context.

18F-FDG Transport to PET-CT Centres in Bangladesh
The commissioning of the 18/9 MeV IBA Cyclotron at National Institute of Nuclear Medicine and Allied Sciences under the Bangladesh Atomic Energy Commission in 2021 marked a breakthrough for nuclear medicine in Bangladesh. It enables local production of $^{18}$F-FDG yielding 2000–3000 mCi per batch to supply 11 PET/CT centers across Dhaka covering both public and private PET-CT centres. Safe and timely transport of $^{18}$F-FDG is crucial due to its 110-minute half-life. Any delay rapidly decreases activity, risking inaccurate PET/CT imaging and optimizing clinical outcomes.

Radiological and Logistical Risks
The two most pressing challenges in transporting $^{18}$F-FDG are radiation safety and time sensitivity. In terms of exposure, even though the material is shipped in shielded Type-A containers, mishandling, vial leakage, or accidents can cause external exposure and contamination. Equally important is the decay of radioactivity during transit.
The decay can be expressed mathematically as:
A(t)= A_0 e^(-λt)⋯..(1)
If a batch of 2000 mCi is produced and the transport time is 90 minutes, the remaining activity is:
A(90)=2000×e^(-.0063×90)≈1135mCi
This simple calculation shows nearly a 43% activity loss before reaching the patient, underscoring the importance of rapid and predictable transport.

Security and Regulatory Challenges
Beyond radiological and decay concerns, the risk of unauthorized access or diversion must also be addressed. While $^{18}$F-FDG is not a high-security isotope like $^{235}$U, its transport is still regulated under IAEA and Bangladesh Atomic Energy Regulatory Authority guidelines. Non-compliance, such as improper labeling, missing documents, or lack of trained couriers poses significant regulatory risks.

Risk Assessment Approach
A structured framework based on hazard identification, likelihood, and consequence evaluation is applied. Risks such as traffic congestion, vial leakage and documentation errors are considered in terms of probability (P) and severity (S). A simplified risk index can be calculated as
R=P ×S⋯⋯(2)
If traffic congestion has P=4 (high likelihood) and S=3 (moderate impact), then R=12, requiring urgent mitigation. Conversely, theft may have low probability (P=1) but higher severity (S=4), giving R=4, still demanding security precautions.

Mitigation Strategies
Several strategies can minimize risks. Radiological safety can be reinforced through shielded containers, regular leak testing and use of personal dosimeters. Logistical delays may be mitigated by route optimization, GPS tracking and motorbike couriers in congested Dhaka.
For regulatory compliance, strict standard operating procedures (SOPs) should govern packaging, labeling and documentation and regular audits. Security can be enhanced with tamper-proof seals, real-time communication and coordination with authorities.
Emergency preparedness is also vital. Every transport vehicle should carry a spill kit, personal protective equipment and a contamination monitor. Drivers and couriers should be trained in basic radiation safety and emergency response ensuring safe management of accidents or natural disruptions.

Contextual Relevance for Bangladesh
Bangladesh's dense population and frequent traffic congestion make these challenges more acute. Hence, the

risk assessment must be localized rather than adopting international models blindly. Incorporating mathematical decay models into scheduling, investing in redundant transport systems and strengthening regulatory frameworks are crucial steps forward.

Conclusion
The transport of $^{18}$F-FDG from cyclotron facilities to PET-CT centers in Bangladesh involves intertwined risks of radiation exposure, activity decay, logistics, security and regulatory compliance. Through mathematical modeling of decay, structured risk assessment and the application of layered mitigation strategies, a more resilient transport system can be developed.

## Country or International Organization

## Instructions

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