Criteria for Teletherapy Unit Exchange

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The National Nuclear Security Administration is considering an initiative to replace cobalt-60 teletherapy units, used for treating cancer in developing countries, with more capable but more expensive and complex linear accelerators (LINACs), which do not use radioactive material. Cobalt-60 machines are a significant security concern because they rely on the highly radioactive isotope cobalt-60 as a gamma-ray source for use during radiation treatments. Research has shown that in quantities as small as several thousandths of a gram this material can pose a great risk to public health if it falls under the control of a terrorist organization that seeks to deploy it in a radiological dispersal device, or "dirty bomb."

What We Did

We considered the criteria necessary for transferring a donated LINAC within the three-fold framework illustrated below that includes technical feasibility, security risk, and medical need. Within our framework, technical feasibility includes the physical, human, financial, and institutional resources required to effectively use the machine. Security risk is the current and future risk of theft or diversion of the radioactive source. Medical need compares the cancer fighting resources within a country to the resources it needs to respond to an emerging cancer epidemic. Additionally, we compiled a list of intergovernmental, non-governmental, and private organizations with expertise relevant to the proposed initiative. These stakeholders can provide valuable assistance throughout this initiative's lifetime, increasing the probability of a successful transfer.
What We Found

The technical considerations for transferring a LINAC are substantial and must be an integral part of the process of selecting a receiving institution. LINACs are more sophisticated and delicate than the Cobalt-60 units they would replace and therefore require new infrastructure to support successful operation. Each element levies a series of long-term financial, technical, and logistical requirements on the receiving institution, all of which affect the long-term sustainability of the transferred device. Our analysis indicates that a recipient country’s network of individuals already experienced with LINAC operation will likely be able to provide significant assistance and advice to the receiving institution before the device is installed and once operations have begun. To estimate a country’s technical ability to receive a LINAC, we used gross national income per capita to estimate a country’s underlying economic capacity. We then compared these data to the number of LINACs already in operation within a country to estimate the level of expected in-country support available.

The primary objective of this NNSA initiative is to reduce the risk of theft or diversion of radioactive sources. Therefore, examination of the potential security risk at the receiving institution will be an important part evaluating how to transfer a donated LINAC. This examination should include the current situation and developing trends, such that currently stable countries at risk of becoming unstable in the near future will be considered very strong candidates for receiving LINACs. Our analysis uses the Risk Environment Score from the Nuclear Threat Initiative's Nuclear Materials Security Index to derive a point of reference for evaluating the threat of theft or diversion from individual countries.

The prevalence of cancer in developing countries is rapidly increasing, and different countries maintain differing abilities to cope with this new threat to public health. To assess each country's capacity to fight cancer, we relied on medical literature to estimate the number of radiotherapy machines required in each country under consideration. We then compared this number to the number of operating radiotherapy units to estimate a country's current medical need.

Finally, in planning this initiative, the NNSA should leverage the skills and expertise of the well-developed global cancer control community. An extensive community of intergovernmental, non-governmental, and private organizations already exists to combat the rapidly increasing incidence of cancer in the developing world. In our analysis, we identify a number of organizations that may be able to aid several aspects of a proposed LINAC transfer, including pre-transfer evaluation, installation, training, operation, and maintenance of the LINAC. By leveraging the diverse expertise of a broad group of stakeholders, NNSA may be able to bridge minor to moderate technical and institutional hurdles, thereby greatly increasing the scope of possible partners and the likelihood of a successful transfer.

What We Recommend

While the primary goal of the proposed initiative is to reduce the threat of theft or diversion of radiological materials, the NNSA should consider a broad array of factors when matching donated LINACs with receiving partners. We recommend the following:

1. NNSA should leverage provided proxies (medical need, technical feasibility, and security threat ranking) to inform and prioritize potential voluntary recipient countries. Technical
feasibility is likely the most limiting factor and therefore should take precedence over the other two proxies. Once a country is chosen, the summary of key considerations posed in the full report (Appendix A) will assist in additional donor prioritization. However, these guiding questions found in the summary are simply advisory. Context, time, place and other factors will play a more significant role.

2. NNSA should generate buy-in among diverse stakeholders within the global cancer control community. Our analysis identifies a variety of organizations that can play an important role in the long-term success of a LINAC transfer. These organizations include private-sector corporations, actors within the medical community, international governmental organizations, national governments, and non-governmental organizations. Each has a stake in controlling cancer and can provide valuable expertise and assistance throughout the transfer process.

3. NNSA should seek to transfer relatively simple-to-use LINACs. Technical requirements for individual LINACs can vary widely, so NNSA should allocate more complicated or delicate machines to institutions with greater technical capacity. Furthermore, as the market for cancer therapy in the developing world expands, NNSA should consider working with private-sector corporations to incentivize the development of relatively simple and robust LINACs designed for the rigors of the developing world. Current LINAC producers can look to the experience of General Electric's deployment of specialized cardiograph machines as a model of successfully adapting medical equipment for effective operation in this environment.