Applying appropriate metrics to evaluate the reliability and performance of a medical linear accelerator

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Aim & Objective:
This study evaluates the performance and reliability of a TrueBeam LINAC (Varian Medical Systems, USA) installed at our hospital over one year (2024). The objective is to assess key metrics, including beam output consistency, downtime percentage, mean time between failures (MTBF), and mean time to repair (MTTR), to identify areas for operational improvement and optimize maintenance Protocol.

Materials & Methods:
The TrueBeam LINAC was monitored using routine quality assurance (QA) checks, fault logs, and service records. Performance metrices were measured through daily, monthly, and annual QA tests, adhering to regulatory, professional forums, and hospital guidelines. Downtime data, MTBF And MTTR were collected from Field Service Reports (FSRs) and equipment logs.

Over the study period, 608 patients underwent approximately 15,200 treatment sessions at 60% machine utilization. The LINAC maintained beam output consistency within ±2% tolerance. It experienced 59 breakdowns, with 38 FSRs generated (excluding software issues, third-party equipment, and minor staff interventions). The average MTBF was 126 hours, and MTTR was 9.5 hours. Downtime was 3.14%, primarily due to Table & Pendant errors.

Results & Discussion:
The MTBF of 126 hours (5.4 operating days) falls below the reported 342 hours (14 operating days), indicating suboptimal reliability leading to patients' dissatisfaction. Frequent Table & Pendant faults suggest a need for improved vendor services. The MTTR of 9.5 hours exceeds acceptable limits, highlighting the need for better-trained staff and spare parts management. While the 3.14% downtime is within the agreed 5% limit, proactive preventive maintenance could further reduce it.

Conclusion:
LINAC demonstrated moderate reliability with acceptable uptime. However, operational efficiency can be enhanced through infrastructure upgrades, streamlined maintenance, and improved spare parts logistics. This study underscores the importance of comprehensive performance evaluations to ensure high-quality radiotherapy services. Future efforts will focus on integrated maintenance records and patient satisfaction score to better assess LINAC reliability and performance.

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