Comprehensive Review of AI Integration in Nuclear Medicine – Current Techniques, Limitations, and Future Innovations

Layman's summary

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Artificial Intelligence (AI) is transforming the field of nuclear medicine, and this literatura review explores its integration in Positron Emission Tomography (PET) and Single-Photon Emission Computed Tomography (SPECT). These technologies use radioactive tracers to visualize physiological processes in the body at a molecular level, which is crucial for diagnosing diseases and planning treatments. Traditionally, interpreting nuclear imaging results has been complex and time-consuming for clinicians. However, recent advancements in AI offer promising solutions to improve and automatize these processes. The paper discusses various AI methods, such as Machine Learning and Deep Learning, and their applications in improving different aspects of nuclear imaging.

For instance, AI algorithms can improve image quality by reducing noise and artifacts, leading to clearer and more accurate images. They can also assist in image reconstruction, helping to create detailed 3D representations of the body's internal structures from raw imaging data. Furthermore, AI plays a role in image analysis by automating tasks like segmentation, which involves identifying and delineating specific areas or structures within an image. This automation not only saves time but also helps reduce variability in results, leading to more consistent and reliable interpretations. One of the most exciting possibilities is the potential for AI to enable "ultra low-dose" imaging, where high-quality images can be obtained using minimal amounts of radioactive tracer. This not only reduces radiation exposure for patients but also eliminates the need for additional imaging scans, such as CT scans, which can further minimize risks and costs.

Despite these advancements, there are still challenges to overcome. These include ensuring the accuracy and reliability of AI algorithms, standardizing data collection and analysis methods, and addressing concerns about the interpretability of AI-generated results. To address these challenges, the paper suggests the development of guidelines for data standardization and the implementation of Explainable AI (XAI) techniques. XAI methods aim to make AI algorithms more transparent and understandable to clinicians by providing insights into how decisions are made.

In conclusion, while there are still challenges to overcome, the integration of AI into nuclear imaging holds big promise for revolutionizing healthcare. By promoting research, collaboration, and education, AI has the potential to enhance diagnostic accuracy, improve patient outcomes, and ultimately save lives.