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AI for Quality Assurance in Pharmaceutical Manufacturing

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ABSTRACT

Global health and well-being largely depend on the pharmaceutical and medical devices industries. This article explores the integration of Artificial Intelligence (AI) in pharmaceutical quality control and manufacturing processes. AI helps in the early detection of defects, produces higher-quality products, reduces costs, and provides greater flexibility and scalability. Research has also been conducted on emerging trends, future developments, and regulatory issues. AI has the disruptive potential to transform patients' lives through innovations in pharmaceutical science, drug development, clinical trials, and manufacturing. The findings suggest that AI significantly improves accuracy, efficiency, and consistency in pharmaceutical manufacturing, aligning with regulatory initiatives such as Process Analytical Technology (PAT) and Quality by Design (QbD). The study further investigates the impact of AI on real-time release testing, predictive maintenance, and supply chain optimization. Additionally, it explores the potential of AI in enhancing drug formulation design and stability prediction, contributing to improved product quality and reliability. Technologies including Machine Learning (ML), Natural Language Processing (NLP), and predictive analytics enable more accurate data analysis, real-time decision-making, and effective predictive maintenance. These innovations have led to reduced operational costs, faster time to market, and enhanced regulatory compliance. The future of AI and automation in pharmaceutical quality assurance promises further advancements, including AI-driven quality control and block chain integration for improved traceability.

Keywords: Artificial Intelligence (AI), Pharmaceutical Quality Assurance, Medical Devices Manufacturing, Data Analysis.

