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Bridging the Bench and Bedside: Regulatory Challenges in Drug Device Combination Products

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Introduction

The convergence of pharmaceuticals and medical devices has led to the development of innovative drug device combination products that promise significant improvements in patient care. These hybrid products such as insulin pumps, drug-eluting stents, pre-filled syringes, transdermal patches and inhalers represent a growing segment of the healthcare market. They are designed to deliver drugs more effectively, improve patient adherence and offer new modes of therapy that were previously unimaginable. However, with innovation comes complexity and the regulatory landscape for these products remains one of the most intricate areas in healthcare development today. Bridging the gap between the scientific research carried out in the laboratory (the "bench") and the application of these innovations in clinical practice (the "bedside") involves navigating a maze of regulatory requirements that differ from traditional drug or device pathways [1].

The challenge is compounded by the dual nature of combination products, which must meet the safety, efficacy and quality standards of both drugs and devices. Regulatory agencies like the U.S. Food and Drug Administration (FDA), the European Medicines Agency (EMA) and others across the globe are faced with the task of evaluating products that do not fit neatly into pre-existing categories. Coordination across different regulatory centers, clear guidance on primary modes of action and consistent classification criteria are essential but still evolving. As the boundaries between drugs and devices continue to blur, developers must grapple with legal, technical and administrative hurdles that can delay product approvals and increase costs. In this context, understanding the regulatory challenges associated with drug device combination products is not only critical for manufacturers and regulators, but also for clinicians and patients who rely on timely access to these life-enhancing innovations [2]

Description

The regulation of drug device combination products presents a unique set of challenges due to their inherently dual nature, blending pharmacological and mechanical functionalities. These products include a wide range of innovations such as drug-eluting stents, insulin pumps, pre-filled syringes and inhalers. Each component drug and device is governed by different regulatory frameworks, creating ambiguity in classification and approval pathways. Regulatory authorities, such as the FDA, determine the Primary Mode of Action (PMOA) to assign the appropriate review center, whether CDER, CDRH, or CBER. However, when the PMOA is unclear or debatable, companies can face delays and resource-intensive negotiations to determine the proper classification. Further complexity arises because drugs and devices are subject to distinct sets of approval criteria. Drugs are evaluated based on pharmacokinetics, safety, efficacy and manufacturing standards, while devices focus more on engineering performance, usability and biocompatibility. A single combination product must meet the rigorous standards of both, including demonstrating the integrity of integration how the drug affects device performance and vice versa. For instance, developers of a transdermal patch must show how the drug diffuses through the skin without compromising the adhesive properties or material stability of the patch. These overlapping expectations require careful coordination of preclinical, clinical and manufacturing data in a comprehensive regulatory dossier. Additionally, developers must prepare for unique post-market responsibilities, merging traditional pharmacovigilance methods with device surveillance to detect and assess adverse events that could result from the drug, the device, or their combined use [3].

Globally, the regulatory environment becomes even more complicated due to variations in regional requirements and frameworks. While the FDA and EMA share similar goals of ensuring safety and efficacy, they differ significantly in processes, expectations and documentation. The EMA's Medical Device Regulation (MDR), for example, mandates stricter oversight for the device component, especially in terms of clinical evaluation and post-market surveillance, even when integrated into a drug product. Developers must work with notified bodies in Europe to assess device compliance before a Marketing Authorization Application (MAA) can proceed. Meanwhile, in the U.S., the FDA might require a single New Drug Application (NDA) that integrates all relevant device data, but oversight may come from multiple centers depending on the PMOA. In other jurisdictions like China, Japan, or Brazil, separate approval processes for the drug and device components may be required even when they are sold as a single product. This lack of harmonization compels manufacturers to develop multiple parallel regulatory strategies, increasing time to market and resource demands. Further, innovative technologies like wearable injectors, smart inhalers and implantable drug reservoirs often lack established regulatory pathways, forcing companies to rely on case-by-case consultations and pre-submission meetings. These approaches, while helpful, introduce uncertainty and may not always yield consistent interpretations. Developers must often provide novel scientific justifications for testing methods, human factor considerations and integration models. In the absence of clear guidelines, these novel products risk delayed approvals or incomplete assessments. Thus, regulatory uncertainty continues to act as a bottleneck, particularly for the most cutting-edge therapeutic-device hybrids [4].

To address these issues, regulators and industry stakeholders are working to develop more integrated, science-based frameworks. Agencies like the FDA have issued guidance documents to clarify classification, manufacturing standards and premarket expectations for combination products. The European Medicines Agency and national authorities are similarly working to align drug and device evaluation standards under the MDR. Public-private partnerships and cross-disciplinary collaborations are helping to generate consensus on best practices and identify gaps in regulatory science. However, further progress is needed to ensure that regulatory systems keep pace with rapid technological advancements. Engaging clinicians, patients and payers in regulatory discussions can provide critical insights into real-world utility, safety priorities and unmet needs. For example, a smart insulin pump may offer precision dosing and data tracking but may raise affordability or privacy concerns that impact its broader adoption. Including real-world evidence and patient-reported outcomes in regulatory submissions can improve relevance and help bridge the gap between laboratory research and clinical application. Training the next

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generation of regulatory professionals in both pharmacology and biomedical engineering is also essential. Ultimately, the successful translation of drug-device combination products from bench to bedside depends on developing adaptive, integrated and globally aligned regulatory approaches. These must safeguard public health while fostering innovation and ensuring that patients have timely access to advanced, effective therapies [5].

Conclusion

Drug device combination products represent a critical frontier in modern medicine, promising to improve outcomes, enhance patient adherence and unlock new therapeutic possibilities. However, the regulatory challenges they pose are substantial and multifaceted. From classification ambiguities and divergent global requirements to post-market surveillance and the regulation of emerging technologies, the path from bench to bedside is fraught with complexity. Developers must navigate overlapping requirements for drugs and devices, often without the benefit of clear guidance or established precedents. Regulatory agencies, in turn, must evolve their frameworks to accommodate innovation while safeguarding public health. Bridging the gap requires concerted action from all stakeholders regulators, manufacturers, clinicians, patients and policymakers. Enhanced regulatory coordination, increased transparency and a commitment to regulatory science are essential. By developing more integrated, responsive and forward-looking regulatory pathways, the healthcare ecosystem can better support the development and deployment of combination products. In doing so, we not only accelerate access to life-saving technologies but also ensure that they are safe, effective and responsive to the needs of real-world patients. Ultimately, the successful regulation of drug-device combination products hinges on our ability to move beyond rigid categorical thinking and embrace a more nuanced, systems-based approach. As the line between drugs and devices continues to blur, so too must the boundaries between the institutions that regulate them. Only then can we truly bridge the bench and bedside in a way that meets the challenges and fulfills the promise of 21st-century medicine

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Conflict of Interest

There are no conflicts of interest by author.

References

1. Liao Xiwen, Chen Yao, Feifei Jin and Jun Zhang, et al. "Barriers and facilitators to implementing imaging-based diagnostic artificial intelligence-assisted decision-making software in hospitals in China: A qualitative study using the updated Consolidated Framework for Implementation Research." *Br Med J Open* 14 (2024): e084398.

2. Miyazawa, Makoto, Mototsugu Tanaka, Yusuke Tanaka, Ryohei Terashima and Mio Ezura, et al. "Concordance between pharmaceuticals and medical devices agency review and ministry of health, labour and welfare decision among new drug applications in Japan." *Clin Pharmacol Ther* 117 (2025): 544-553.

3. Chettri Bijaya and Ramya Ravi. "A comparative study of medical device regulation between countries based on their economies." *Expert Rev Med Devices* 21 (2024): 467-478.

4. Zhou Qing, Xiao-Yuan Chen, Zhi-Min Yang and Yi-Long Wu. "The changing landscape of clinical trial and approval processes in China." *Nat Rev Clin Oncol* 14 (2017): 577-583.

5. Noguchi Atsushi, Hideki Hanaoka and Yoshiaki Uyama. "Potential future drug development lag in Japan based on an analysis of multiregional clinical trials in the US, Europe and East Asia." *Ther Innov Regul Sci* 56 (2022): 523-529.

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