Managing Complexity in Combination Product Development and Delivery

Biologic therapies are reshaping the pharmaceutical landscape. Their growing complexity is creating new challenges for combination product development and delivery. Therapies are becoming more viscous, larger in volume and increasingly designed for self-administration. This means the demands placed on delivery systems, testing strategies, manufacturing infrastructure and regulatory coordination are intensifying.

These dynamics are emerging across oncology, immunology and other high-value biologic categories. Success is no longer defined solely by the efficacy of the drug itself, but by how effectively the integrated drug, device, packaging and supporting ecosystem perform together in the real world, including adherence, delivery reliability and patient usability.

Expanding Complexity Across Biologic Therapies

The rapid growth of biologics has transformed both therapeutic innovation and patient expectations. Across multiple disease areas, therapies are designed for long-term administration outside traditional clinical settings, placing greater emphasis on convenient and reliable self-injection systems. Patients and providers alike are seeking delivery options that reduce treatment burden while maintaining consistency, safety and ease of use.

Much of the current conversation has focused on GLP-1 therapies due to their unprecedented growth and manufacturing demands. However, the same challenges are relevant across other high-growth injectable therapies. Many of these products involve concentrated formulations, larger injection volumes and/or increased viscosity, which lead to more complex administration requirements than current injectable drugs.

As a result, device selection, injection performance, usability and manufacturability are increasingly important to the viability of the therapy itself. This shift is driving pharmaceutical and biotechnology companies to rethink how combination products are developed, approved and integrated across the product lifecycle.

The evolution toward device-dependent therapeutic systems is also reshaping how development functions operate together. Engineering, analytical testing, manufacturing and supply chain activities can no longer operate as isolated stages without introducing downstream risk; they are interdependent components of a single development pathway. When these functions are not aligned early, risks may remain hidden until later phases, when changes are more complex and costly. This dynamic is driving a broader shift toward development models that prioritise connectivity and cross-functional alignment from the outset.

Technical Constraints and Challenges

The technical challenges associated with modern biologic therapies have become more difficult to manage as formulations evolve. Higher-viscosity drugs often require increased injection force and time, and larger-volume therapies can extend injection time, influencing patient usability, device engineering requirements and overall treatment experience.

These considerations are especially critical in self-administration settings. A delivery system that performs well under laboratory conditions may still present usability challenges for patients managing chronic therapies at home. Injection dynamics and administration time can influence adherence, treatment consistency and, ultimately, therapeutic outcomes. Caregivers must also be considered, as their needs and capabilities differ significantly from those of healthcare professionals in clinical environments.

Primary packaging and device compatibility introduce more complexity. Components such as prefillable syringes, auto-injectors, pens and wearable injectors must function reliably with increasingly demanding formulations.

Even small variations in factors such as silicone interactions or container closure performance can affect both product stability and delivery performance. In many cases, these interactions are not fully identified until late-stage testing, creating risk for redesigns, additional validation work and delayed timelines.

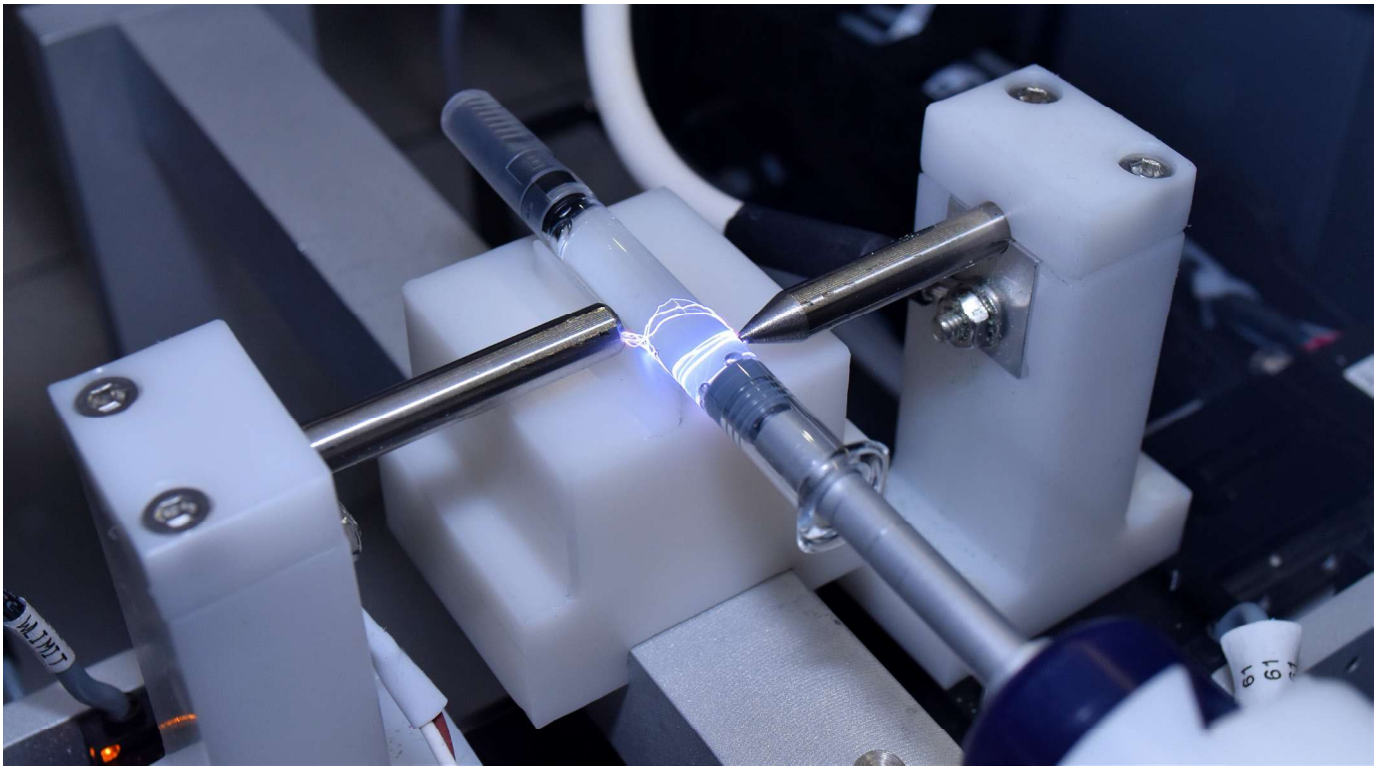
At the same time, manufacturers face increasing pressure to scale production capacity for biologics and associated delivery systems. Supporting global demand requires reliable access to device components, testing infrastructure, filling capacity and resilient supply chains. Constraints in any part of the combination product ecosystem can introduce downstream delays that disrupt both development timelines and product availability.

Collectively, these pressures highlight a critical shift within the industry: combination product development is becoming a systems engineering challenge, rather than a series of isolated technical activities.

Where Combination Product Programmes Break Down

Many combination product programmes encounter inefficiencies not because of singular failures, but due to fragmentation across the development process. Functions often operate independently during early stages, with alignment occurring only after key product decisions have already been made.

This fragmentation can emerge across several critical areas, including formulation, device selection, testing strategy, regulatory planning, human factors and manufacturing readiness. When these workstreams evolve in parallel rather than in coordination, inconsistencies may not become apparent until later stages of development, when timelines are less flexible and changes are more costly to implement.



Late-stage alignment frequently results in additional testing requirements, redesign activities and expanded regulatory documentation. For example, a device selected early for commercial convenience may require modification after usability testing reveals patient handling challenges. Similarly, a formulation optimised for therapeutic performance may present unforeseen delivery constraints once integrated into a final device platform.

Supply chain readiness can also become a limiting factor. As demand for biologics increases, manufacturers must ensure that filling operations, component sourcing, testing capacity and distribution infrastructure can scale in parallel. This includes managing risks related to single-source components, fill-finish capacity constraints and regional supply variability.

Gaps in any of these areas can introduce operational risk that extends beyond development into commercialisation and long-term supply reliability.

The growing interdependence of these functions means that combination product success is increasingly tied to organisational coordination. Companies that continue to treat engineering, testing, manufacturing and regulatory planning as separate activities may struggle to manage the complexity of modern biologic delivery systems.

Integration as a Risk Reduction Strategy

In response to these challenges, many organisations are adopting more integrated development models designed to improve coordination across the combination product lifecycle.

An integrated approach improves visibility in how decisions in one area influence downstream development requirements. For example, connecting formulation data with device performance testing early in development can help identify injection force limitations, usability concerns or container compatibility risks before commercial scale-up begins.

Combination product development increasingly depends on end-to-end visibility, the ability to connect product data, performance testing, manufacturing readiness, regulatory strategy and supply chain planning within a unified framework.

This integration also supports more efficient decision-making. Development teams that share performance data and technical insights earlier in the process can reduce the likelihood of late-stage redesigns or duplicative testing activities. In highly competitive therapeutic areas, even modest reductions in development delays can translate into meaningful commercial advantage.

Integration is not solely a technical objective. It reflects a broader operational shift toward closer collaboration between pharmaceutical companies, device manufacturers, testing providers and specialised development partners.

In addition to improving coordination, integrated models enable more structured use of data across the product lifecycle. Organisations are increasingly working to connect analytical testing results, device performance metrics and human factors insights into a unified understanding of product behaviour. This approach supports earlier identification of potential failure modes and provides a stronger foundation for regulatory submissions. Rather than relying on sequential validation, development is gradually shifting toward more iterative, data-driven processes that allow for continuous refinement.

Evolving Development Models and Industry Partnerships

To address growing complexity, the industry is increasingly adopting collaborative development models that bring together specialised expertise across the combination product lifecycle.

These approaches aim to reduce fragmentation while improving coordination between formulation development, device engineering, analytical testing and manufacturing.

Recent partnerships across the industry illustrate this trend. By combining consulting capabilities, device expertise, testing support and regulatory guidance, such partnerships aim to help organisations navigate increasingly complex development requirements more effectively.

Device-focused collaborations are also expanding as companies seek delivery systems capable of supporting high-viscosity biologics and evolving patient needs. Combination products are composed of a variety of sub-assembly components, devices and the drug to enable safe and effective delivery of therapeutics. Pharmaceutical companies are accountable for demonstrating the quality, safety and robustness of the assembled end combination product. Independent development and siloes across the supplier ecosystem can create challenges.

Infrastructure investment is evolving alongside these partnership models. As demand continues to grow, manufacturers require reliable access to high-quality primary packaging systems, scalable production infrastructure and compatible delivery solutions.

These developments reflect a broader industry reality: no single organisation can independently manage every aspect of modern combination product development at the level of specialisation now required. As a result, partnerships are becoming less transactional and more strategically integrated across the product lifecycle.

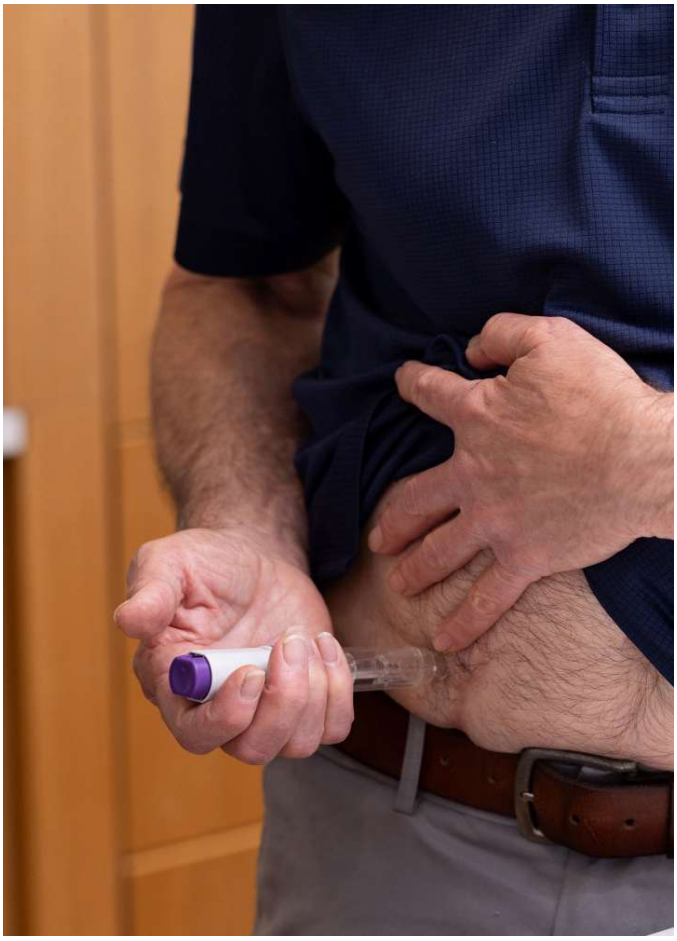
Toward a More Integrated Combination Product Model

As biologic therapies continue to evolve, the future of combination product development will depend on how effectively organisations manage integration across increasingly interconnected systems. The challenge is no longer limited to designing a drug or selecting a device independently. Success depends on aligning formulation science, delivery performance, usability, manufacturing infrastructure, testing strategy and supply chain readiness within a coordinated development framework.

This shift is driving greater emphasis on integrated development models that connect stakeholders earlier and enable more effective use of product and performance data throughout the lifecycle. Organisations that achieve stronger alignment across technical, operational and regulatory functions are better positioned to reduce development risk, accelerate commercialisation timelines and improve long-term scalability.

At the same time, the growing complexity of biologic delivery systems reinforces the importance of data-driven decision-making. Product performance data, human factors insights, device compatibility findings and manufacturing readiness indicators are most valuable when evaluated collectively rather than in isolation.

Combination product development is evolving into a broader systems challenge that extends beyond traditional pharmaceutical



development models. Execution, coordination and integration are becoming defining differentiators as the industry adapts to increasingly demanding therapies and delivery requirements.

Organisations that succeed in this environment will be those capable of building connected development ecosystems that align technical expertise, operational infrastructure and strategic collaboration around a shared objective, delivering increasingly complex therapies safely, reliably and efficiently to patients.

REFERENCES

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