Meeting the Demand for Ambulatory Infusion: From Hospital to Home Care Settings

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Purpose and Background

Recent advances in biologics and subcutaneous therapies, often more viscous or requiring prolonged delivery, are reshaping the infusion landscape and increasing demand for innovative delivery platforms.

The growing sophistication of chemotherapy and pain management formulations, combined with the benefits of oncology and palliative treatment outside hospitals, highlights the need for drug delivery technologies that are economical, easy to use, and responsive to patient needs.

Conventional infusion technologies, such as elastomeric devices and basic mechanical pumps, lack the feedback control, accuracy and dynamic flow control required for these formulations.

Image 1 - Context of Use: Ambulatory, From Hospital to Home

Safe and accurate delivery of costly, cytotoxic, and powerful formulations requires precise, controllable flow rates, rapid detection of occlusions or faults, compact wearable form factors for mobility, and interfaces suitable for nurses, carers, and patients.

To address these challenges, a reusable body-worn ambulatory infusion platform was developed and studied under laboratory and simulated-use conditions.

The system includes:

- 20 or 50mL syringe reservoir with manual loading
- Microcontroller-regulated actuation for programmable flow (0.1–400mL/h)
- Integrated sensing for occlusion detection
- Compact enclosure suitable for body-worn use (approx. 380g, 400cc)
- Dual AA or AAA-cell battery operation, supporting 30+ days of typical use
- Simple button interface with easily visible display and alarms

This system was developed as a flexible evaluation platform to investigate ambulatory infusion independent of commercial specification. This study presents original research into the design and evaluation of this platform intended to meet emerging clinical and patient needs.

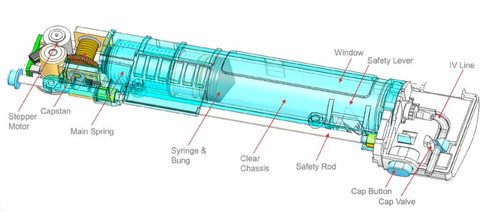

Image 2 - Overall Principles

Methods

Oncology remains one of the most infusion-intensive clinical areas, therefore this study prioritised an understanding of delivery requirements specific to oncology care. Chemotherapy and cancer pain treatments are predominantly administered by infusion, often requiring prolonged inpatient sessions [1]. Ambulatory care reduces hospital bed occupancy, improves patient activity levels, and reduces nosocomial infections [2, 7]. Patients receiving treatment at home report improved psychological wellbeing and quality of life [5, 6]. These insights informed the clinical priorities and performance benchmarks used in system design and evaluation.

Usability and Clinical Application Research

User research was conducted with oncology clinicians,community nurses, carers, and individuals simulating patient use (n=23). Methods included interviews and structured usability walkthroughs, exploration of learnability, alarm comprehension, and confidence during unattended operation.

Participants interacted with visual and functional models during mock scenarios including transport, dosing, and troubleshooting. Research progressed iteratively from opportunity and concept generation to hands-on interaction. Early experimental units evolved into ‘looks-like’, ‘used-like’, ‘works-like’ models for formative usability testing and technical evaluation.

Image 3 - Usability Research: Device Preparation

Technical Evaluation

A range of research methods was used to understand the nature of the problem, identify opportunities to improve device design, and build to validate an ambulatory infusion system. Initial literature review of oncology healthcare provision, logistics, and economics supported the clinical context [4, 8].This was complemented by research involving healthcare professionals (HCPs) from hospitals, clinics, and care homes in the EU, UK, and China.

Technical evaluations included: flow rate accuracy across water-like and viscous formulations; occlusion detection at flow rates from 1 to 100mL/h; battery endurance under continuous low-rate infusion; and safe operation under simulated fault scenarios and conditions.

Results

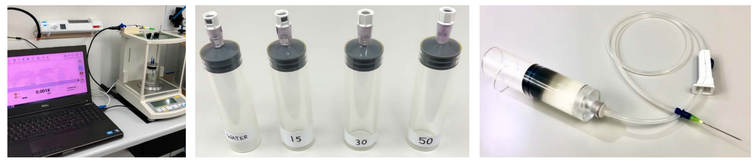

Image 4 - Flow Accuracy and Viscosity Tests

Technical testing confirmed:

- Flow accuracy across the full range: (0.1–400mL/h)
- Pressure: 120 – 60 kPa
- Accuracy: +/- 2%
- Constancy: 2-3 minutes at 1mL/h
- Occlusion detection: At 120mL/h, detection < 30seconds, and at 1mL/h, detection < 5 minutes
- Viscosity range: Up to 50cP with 27G needle

Viscosity tests showed better than +/-2% volumetric performance irrespective of viscosity up to 50cP and pumping up to 9psi back-pressure.

Overall, the test outcomes demonstrate performance comparable to hospital-grade syringe pumps. In addition, participants valued the minimal interface, clear alarms, self-contained syringe and compact, ergonomic form factor. Most non-clinicians (6 of 8) indicated confidence in operating the system following a brief orientation.

Conclusion

Ambulatory infusion systems, if appropriately engineered, will play a critical role in shifting care beyond hospitals and meet the emerging demand for flexible, high-performance delivery that provides:

- Programmable, accurate flow rate and volumetric control
- Real-time, rapid monitoring of delivery faults
- Robust delivery of various viscous formulations
- Extended operational life with minimal maintenance
- Usability suitable for patient and carer administration

By prioritising usability, safety, accuracy and versatility, this class of infusion systems can reduce hospital dependency and cost, while supporting better medical outcomes and wellbeing at home. The system evaluated here, while not commercially specified, showed high delivery accuracy and user acceptability. Future work would explore adherence monitoring, wider usability testing, digital connectivity and regulatory conformity.

References: [1] Carver, A.C., & Foley, K.M. (2003). Therapeutic Approaches to Cancer Pain. Holland-Frei Cancer Medicine, 6th edition. [2] Cleveland Clinic. (2025). Chemotherapy Treatment Overview. [3] Healthline Media LLC. (2025). Infusion Therapy Explained. [4] Hawasli, R.S.D., Barton, S., & Nabhani-Gebara, S. (2021). Ambulatory Chemotherapy: Past, Present, and Future. Journal of Oncology Pharmacy Practice. [5] Wu, I.Q., Lim, F.L.W.I., & Koh, L.P. (2021). The Comprehensive Cancer Center: Outpatient Care. NCBI Bookshelf. [6] Joo, E.-H., Rha, S.-Y., Ahn, J.B., & Kang, H.-Y. (2010). Economic and Patient Outcomes of Home-Based Chemotherapy. Health Policy. [7] CDC (2024). Outpatient Oncology Infection Control Guidelines. [8] 1.Global Industry Analysts, Inc. (2025). Chemotherapy At-Home Services - Global Strategic Report.