Abstract

A dynamic, patient-specific drug library overlay (DPL) is integrated into a smart infusion pump system to enable closed-loop medication control. The system combines a multi-variable patient sensor array with a hierarchical control architecture that adjusts intravenous drug dosing in real time. Each medication infusion module (or "smart cartridge") carries on-board memory storing a drug class identifier, patient-tailored dose limits, micro-dose threshold bands (μ-bands), cumulative dosing logs, and cryptographic credentials. A multi-tier controller – including a vital-sign override layer, a guard-railed dose arbitration layer, an optimization layer (e.g. PID/MPC), and a learning layer – reads this metadata and adaptively (i) blocks infusions that would breach hard safety limits, (ii) enforces drug-interaction constraints, (iii) titrates doses to patient-specific targets, and (iv) injects periodic micro-dose "probe" slugs within the μ-band to learn the patient's individual dose–response (Jacobian)[1][2]. All sensor readings, infusion commands, dosage adjustments and any manual overrides are time-stamped, cryptographically signed, and logged to a tamper-evident audit trail. The result is a closed-loop infusion system that continuously self-optimizes drug therapy for each patient while preserving rigorous safety guardrails, and can seamlessly integrate with existing hospital pharmacy workflows and standards.