To best serve the warfighter, medical practitioners in a hostile area need tools designed from the ground up to meet extraordinary requirements. In theater, medics need hardware ready to operate under challenging environmental conditions, tailored for an operational setting, where low weight and power requirements are crucial to mission success. The CONOPS for Expeditionary Medical Support (EMEDS) is based on practical effectiveness, speed, and efficiency. Key among the tools required by EDMS is a highly portable, inexpensive, rugged and reliable drug infusion pump.

**Lynntech Technology Solution and Current Status**

Lynntech has developed a battery-powered infusion pump (MedPump) for expeditionary medical support, focusing on size and weight, cost-effective disposability, and rugged reliability. MedPump was designed to meet these combined constraints, as no other infusion pump on the market can, through the enabling technology of electrochemical actuation. Leveraging years of fuel cell research, Lynntech designed a miniature pump without an electric motor. Instead of rotors and gears, a small quantity of hydrogen liberated through water electrolysis at startup is alternately driven across a membrane, pneumatically actuating diaphragms that deliver the drug to the patient. The electrochemical cell generates and controls the driving gas pressure and vacuum. This high efficiency pumping mechanism provides precise control of the flow rate with a battery life of more than 24 hours. The pump flow rate is verified by an adjunct, installed flow meter. This simple approach makes highly reliable and accurate dosing possible across a wide range of flow rates, while maintaining a small device envelope at a modest cost.

MedPump is tailored for military field use and can better serve medics and warfighters compared to a pump designed for state-side hospitals or home use. Small size and low weight enable portability and agility; troops remain readily transportable, even when under continuing medical care. Low cost enables disposability; pumps remain in sterile packaging until needed. Rugged design enables survivability through high shock and vibration transport and storage conditions; the pump is ready on-demand when needed. Safety and reliability ensures that an infusion pump is one less thing to worry about when expediency is paramount.

| **Portable and Compact** | • No driving motor means reduced system envelope to less than 150 ccm and less than 200 g  
|                          | • Non-intrusive function and use with greater than 24-hour battery operation  |
| **Inexpensive and Disposable** | • Better reliability and accuracy than comparable peristaltic pumps at the same cost  
|                          | • Utilization of low-cost manufacturing techniques to further reduce unit cost  |
| **Rugged and Reliable** | • Reliable dosage accuracy from 0.1 - 500 ml/hr with redundant direct and indirect flow monitoring  
|                          | • Electrochemical means very few mechanical parts and is not prone to mechanical failure  |
| **Simple Operation** | • Simple, secure, remote administration interface for simultaneous control and monitoring of multiple pumps  
|                          | • Direct (non-remote) control can be implemented for point-of-care utilization  |
Lynntech MedPump - Disposable Drug Infusion Pump

Commercial and Defense Market Opportunities

MedPump has utility in both military and civilian markets. A number of civilian applications are envisioned including chemically-induced stress testing (e.g. detecting coronary artery disease), ambulatory, EMT and air/Medevac transport (e.g. trauma), pain management (e.g. IV-controlled analgesia), chemotherapy, neonatal and pediatric IV drug delivery (e.g. small dosages), or wherever a light-weight disposable pump is needed. Small size and light weight enable a modular design in which multiple pumps can be stacked together to conveniently administer the appropriate combination of medications needed by the patient. The entire infusion pump is disposed safely after use, eliminating the possibility of cross contamination or carry-over of previous settings. Ultimately, MedPump is envisaged as a compact, accurate, inexpensive alternative to the disposable peristaltic pumps currently used domestically and, for the military, in theater.

The current ambulatory infusion pump market segment is approximately $1.5 billion and growing 3-4% annually. Primary suppliers include the following pumps and manufacturers: Cardinal Health / Alaris (accounting for 30% of the market), Hospira, Baxter, Medtronic, B. Braun, Medsystem III, Sorenson ambit, Delphi, IVantage, and the McKinley WalkMed. Each of these devices is designed for a traditional hospital or domestic setting. In addition to size, cost, and reliability advantages, MedPump operates silently without whirring motors or rotating pump heads. MedPump has simultaneous redundant flow monitoring capability, ensuring accurate delivery and providing an internal mechanism for fault detection. Current systems cost $3,000 – $5,000 per unit and use combinations of expendable materials and fixed reusable pumping systems. The projected cost for MedPump will be comparable to the replacement cost for cartridge consumables on these non-disposable pumps. MedPump is poised to displace many of the current offerings due to its advanced features and lower total operating cost. Lynntech’s fully-functioning prototype integrated drug infusion pump is expected to begin the FDA 510 (k) process by 2014 with development being completed by 2016.

Other Applications of Electrochemical Pumping Technology and Medical Device Expertise

The electrochemical pumping technology can easily be re-designed for other applications. Lynntech has developed several variants of the electrochemical pump over the last decade for various applications including a spacecraft electronics coolant pump, a spacesuit life support thermal control pump, a satellite active heat pipe pump, a water purification pump for civilian use, a vacuum assisted blood sampling pump as a replacement for needles etc.

Lynntech has a strong interdisciplinary team of scientists, engineers and business professionals that have developed the MedPump. The team has expertise in diverse backgrounds in medical device development including biomedical research, point-of-care diagnostic development, mechanical, electrical, chemical, and electrochemical engineering and commercialization of technology developed by Lynntech. Lynntech has teamed with Becton Dickinson Technologies (BDT), one of the largest global medical technology companies that manufactures and sells medical supplies, devices, laboratory instruments, antibodies, reagents and diagnostic products to bring this electrochemical pumping technology to market for various applications.