

Novel Imaging Platform for Predicting Efficacy of Nipple Shield Delivery System Designs via High-Speed Photography

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Abstract— This novel imaging platform utilizing high-speed photography and customized image analysis algorithms was developed for predicting efficacy of a novel medical device designed to deliver medicines to breastfeeding infants. It provides a whole new platform for experiments that previously were not possible.

I. INTRODUCTION

According to the World Health Organization (WHO), in 2013, 6.3 million children under the age of five died worldwide, of which 74% occurred during infancy (within the first year), with more than half of those fatalities resulting from preventable or treatable conditions that require simple, affordable interventions [1]. To solve this crisis, the novel nipple shield drug delivery system (NSDS) was created to accurately and easily deliver medication [2].

To optimize delivery, various NSDS prototypes needed to be analyzed and assessed for efficiency of breast milk throughput and drug delivery. This was accomplished by creating a novel imaging platform to conduct dye flow visualization studies.

II. MATERIALS AND METHODS

The novel imaging platform utilized a US Pharmacopeia 4 22.6mm dia. Flow Through Cell (Sotax, Aesch, Switzerland) modified to contain the various NSDS designs, illuminated by a VD-7000LP High-Power LED light source (HSM, Reutlingen, Germany), with images captured by a FastCAM UX100 high-speed CCD camera (Photron, San Diego, CA, USA). Dye, and water, was pumped through the cell by piston pump calibrated to an average volumetric flow rate of 8 mL/min pumping at 120 strokes/min. Images were then analyzed by an adaptation of the random walker algorithm customized to measure dye concentration in a given image, which captured multiplanar jets allowing for a quantification of flow through each NSDS design.

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III. RESULTS AND DISCUSSION

Dye flow visualisation studies with the piston pump were conducted on all eight NSDS designs. The flow patterns varied greatly between each of the NSDS designs as seen in Figure 1, while vast quantitative differences can be seen in Figure 2, due to differences in internal geometry, number, size, and position of holes, and presence of occlusions.

Figure 1. A-H: Each NSDS design showing dye jet via high speed camera

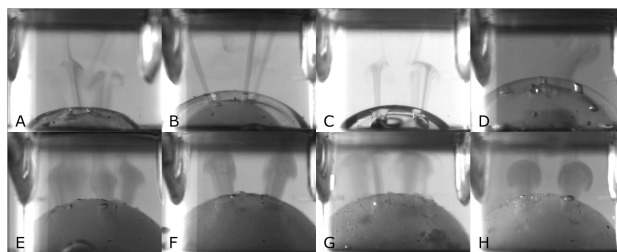
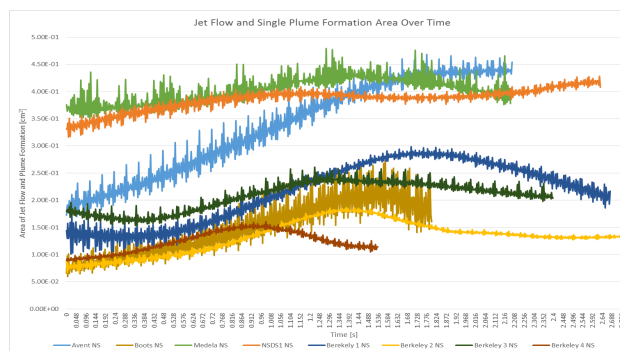


Figure 2. Dye concentration over time for each NSDS design



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