Developing a Rapidly Dissolving, Biodegradable Microneedle Patch and Standard Curve for Minimally Invasive Filtration Marker Delivery and Point-of-Care Renal Analysis

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Around 800 million individuals worldwide are estimated to have chronic kidney disease (CKD), with most cases being undiagnosed. Diagnosing CKD and other renal dysfunctions requires an assessment of renal function, which can only happen in research facilities and hospitals via invasive hypodermic injections. Dissolvable microneedle (MN) patches are a low-cost and minimally invasive alternative which dispense a fluorescent filtration marker into the interstitial fluid (ISF) of a patient. Patches constructed from carboxymethylcellulose (CMC) were found to have the highest molecule-releasing capacity and biodegradability. Small (1 square inch) patches were fabricated by drying solutions containing different concentrations of CMC and FITC-dextran, a fluorescent filtration marker analogous to glucose in structure. Each kind of patch was placed on 5 mice, and the fluorescent intensities of FITC-dextran immediately after ISF dissolution and patch removal were measured with a fluorescence reader. Using a standard curve created from sample FITC concentrations and their fluorescent intensities, a linear model was generated and used to calculate the FITC concentrations in serum samples from the mice. Based on the results gathered from the three groups of patches, 3% w/v CMC in water and 10 mg/mL FITC-dextran are the optimal concentrations of polymer and filtration marker needed to dispense the greatest amount of filtration marker in the ISF. The combined use of the standard curve and the dissolvable MN patches demonstrates that point-of-care diagnostics for renal diseases is possible, allowing many patients worldwide to know when to seek further treatment.

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