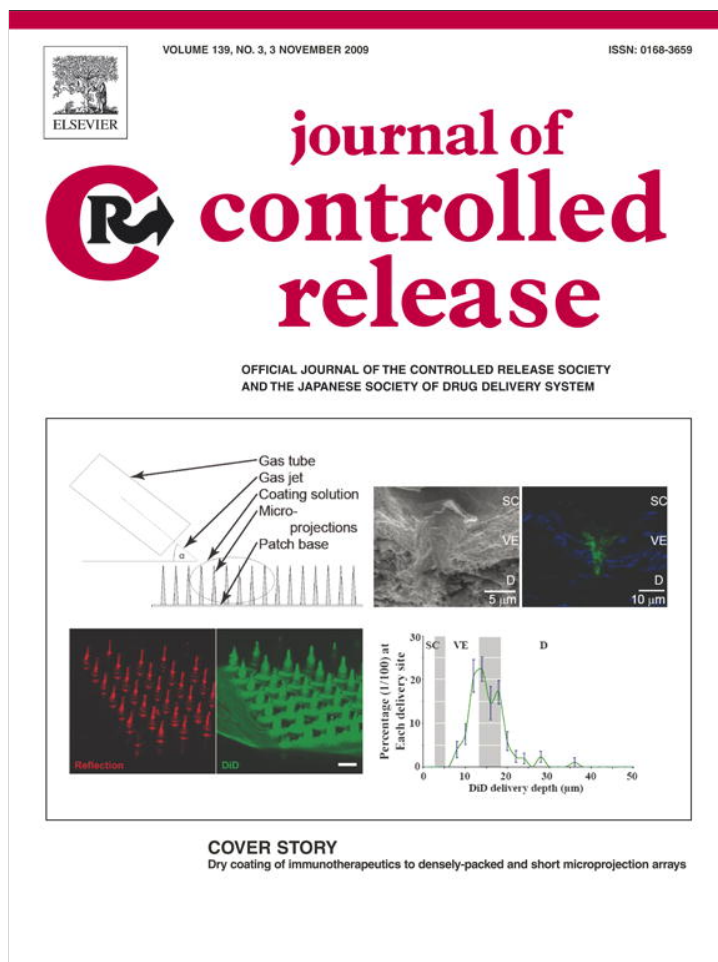


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Cover Story

Dry coating of immunotherapeutics to densely packed and short microprojection arrays

Since the first vaccination performed by Edward Jenner, vaccination has become one of the most effective means of preventing diseases. The importance of vaccination became abundantly clear by the recent flu pandemic in 2009. Vaccines are most commonly administered using a needle and syringe, a method first invented in 1853. The needle and syringe is effective, but unpopular for obvious reasons, and creates a risk of iatrogenic disease from needle-stick injury or needle reuse as a consequence of the billions of administrations each year [1]. Furthermore, the needle and syringe does not deliver the vaccine ingredients optimally to the antigen presenting cells, which alone can respond to the combination of antigen and adjuvant (innate immune stimulus), for successful vaccination [2]. Many alternative approaches using physical delivery means (e.g., diffusion/permeation delivery, liquid jet injection, and biolistic microparticle injection) have been pursued to meet these delivery challenges, but their ability to consistently and directly deliver vaccines to a high population of cells with minimal cell damage is limited.

The paper from Professor Kendall and his co-workers in this issue [3] introduces a new concept of depositing vaccines directly to a high population of skin immune cells, using arrays of micro-projections that are very densely packed ($\sim 20,000 \text{ cm}^{-2}$) and short ($\leq 90 \mu\text{m}$ length) with tip designs often at the nanoscale. They realized that the projection geometry of this device (termed 'micro-nanoprojections', or 'Nanopatches', in short) presented unique vaccine coating challenges, which were not met by existing means. The current methods, such as micro-dip-coating [4], do not work well for densely packed microneedles due to efficient and non-uniform coating. For this reason, Professor Kendall and his colleagues invented a simple and rapid coating method based on gas-jet drying, and demonstrated that the method indeed could achieve the desired uniform coating on compounds representative of a range of immunotherapeutics (e.g., DNA, and proteins). Furthermore, the dry coating was shown to remain intact during skin insertion followed by release within the wet skin cellular environment within just 3 min. And importantly, this local delivery in skin via Nanopatches resulted in successful increase in immune responses in mice, with comparable

antibody levels as needle and syringe intramuscular injection, with only a fraction of the delivered dose.

This study by Professor Kendall's group paves a path for Nanopatches for eventual use in human vaccination. It is expected to overcome many key problems of the needle and syringe, such as difficulty in targeted delivery of vaccines to a large population of immune cells, needle-stick injuries, needle phobia, cross-infection, and the need for specialist training for vaccine administration (because the patch application process is simple). Furthermore, the work presented by Professor Kendall shows a means to load vaccines uniformly onto the densely packed and short microneedle array in a reproducible manner, ensuring the efficacy of each Nanopatch. It will be only a matter of time before their microneedle array system can be used clinically to make a vaccination process a pleasant experience for all of us.

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