Nguyen et al., J Pharmacovigil 2018, 6:3
DOI: 10.4172/2329-6887.1000e174

Journal of Pharmacovigilance
ISSN: 2329-6887

Editorial Open Access

Economic Evaluation of Microneedles for Vaccinations

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Received date: May 26, 2018; **Accepted date:** June 02, 2018; **Published date:** June 09, 2018

Editorial

In the United States, influenza epidemics cost approximately $87.1 billion annually in which $10.4 billion is attributed to direct medical cost [1]. Nearly 13 million influenza cases occur every year, costing $1.4 billion to third-party payers and $11.3 billion to the society [2]. Despite the recommendation for annual influenza vaccinations, a significant number of people fail to get vaccinated due to their concerns about vaccine effectiveness, adverse reactions, inconvenience, and needle phobia [3,4]. Thus, a novel, cost-effective, minimally invasive, and patient-compliant delivery technology-microneedles (an array of micron-sized solid-coated or polymeric dissolving needles) could address some of these issues [5-7]. The Centers for Disease Control and Prevention has named this technology the potential "game changer" of global vaccination. Preclinical studies have demonstrated that the use of microneedles could lead to long-lasting, robust antibody response, and improved efficacy of various vaccines against influenza, malaria, Alzheimer's disease, and measles [8-10]. The usability and acceptability of microneedles were also assessed to reveal that 100% of the public and 74% of the healthcare providers surveyed were positive and showed a strong support for microneedle technology [11,12]. Furthermore, if patients could self-administer vaccines using microneedles, the vaccination intent would increase from 44% to 65% [13].

Microneedles offer multiple superior advantages such as enhancement of drug delivery, patient compliance and adherence [14-16]; minimization of sharps handling and drug waste; elimination of vaccine reconstitution prior to administration; and avoidance of needle-related risks (pain, infection, and needle-stick injuries) [2,17,18]. The simple application of microneedles could facilitate the vaccinations with minimally trained health caregivers and potential self-administration by patients [2,8,13]. Additionally, vaccines were found to be significantly more thermo-stable in the microneedle patches than in currently available formulations on the market, which reduce the need for a cold chain, simplify the logistical system (storage, distribution, and disposal), and expand vaccine coverage to hard-to-reach populations [2,8,19].

The use of microneedle patches could substantially reduce costs of vaccinations [17]. In general, the cost-effectiveness of microneedle patch would depend on the recipient acceptability and vaccine efficacy, compared with the existing conventional vaccinations [17]. The higher number of antigen-presenting cells in the skin led to a greater immune response with lower antigen levels [20]. This observation was attributed to the dose-sparing effect of skin vaccination and the reduction in the cost and dose of vaccines. The economic value of microneedles depends on the market price and the success rate of self-administration [2]. Lee et al. have established an economic model to assess the value of microneedle delivery of influenza vaccine. The authors reported that when microneedles were administered only by health care providers and were comparable in efficacy and compliance to existing vaccination methods, the use of microneedles was found to be cost-effective at all price points ranging from $9.50 to $30 with market share more than 20% [2]. If self-administration were offered and microneedles had the similar efficacy as existing vaccines, the patient compliance would need to increase by more than 3% to be economically dominant. If the treatment efficacy increased by more than 3%, microneedle-used vaccination would be cost-saving for all price below $30 [2]. Adhikari et al. estimated the cost of measles vaccination using microneedles for the first dose to be $0.95 as compared to $1.65 for the first dose in subcutaneous vaccination [17]. At 95% vaccination coverage, a measles case averted would cost $1.66 by microneedle patch vaccination, which was significantly lower than that by subcutaneous vaccination ($2.64) [17]. Also, the use of microneedle-based vaccine in children and elderly would improve the acceptance of vaccination and cost-effectiveness of vaccination program [18,21]. Microneedles could potentially save $950 million to third-party payers and as much as $2.6 billion to the society over an influenza season [2]. Microneedle technology is a painless, cost-effective, and promising platform for vaccinations.

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