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Opinion

Dissolvable Microneedles for Effective Immunization During Pandemic Outbreaks

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Recent advent of COVID-19 pandemic has plagued both health and economic sectors. Pandemic spread globally, infecting approximately 105 million people with more than 2.3 million fatalities and substantially declining global economic growth by many folds [1,2]. The genome sequence of COVID-19 or SARS-CoV-2 was released in mid-January 2020, leading to exceptional progress towards the development of a safe and effective vaccine against SARS-CoV-2 infection [3,4]. Different biotechnology platforms using various candidates such as live/inactivated virus, recombinant protein and live viral vectored antigen were employed in to rapidly develop vaccines against COVID-19 vaccine [5-7]. Achieving herd immunity is a key strategy in controlling any pandemic, and this is possible only by the implementation of meticulous immunization campaigns. It has been reported that in previous pandemics, difficulties in accessing vaccines and other essential health products, high demand of vaccines, and inadequate/low manufacturing facilities hampered pace of controlling the spread [8]. It is hence imperative to device effective immunization strategies so as to foster mass immunization at a faster pace.

In the last two years many vaccines have been developed against COVID-19. Most of these vaccines required multiple doses of administration by trained health care workers using hypodermic needles. Furthermore, these vaccines need cold chain for storage, which calls for organization and planning for effective administration of vaccines [9]. A survey conducted by WHO revealed that hesitancy for vaccination was one of important reasons for the ineffective in controlling any pandemic 2019 [10]. Vaccine hesitancy mainly stems from needle-phobia and pain. In this scenario, it would be wiser to employ novel vaccine delivery mechanisms that could address most of the existing challenges and limitations.

Dissolving Microneedle (DMN) patches have been proposed to improve vaccination in developing countries and are the subject of increasing research in academia and industry. Dissolving Microneedle patches contain micron-sized needles made out of water-soluble biodegradable polymers that dissolve in the skin to deliver the vaccine.

This new vaccine delivery vehicles are expected to

1. simplify and improve vaccine application
2. eliminate the need for cold chains,
3. reduce plastic and sharp wastes (created from the hypodermal needles),
4. reduce the need for trained healthcare providers for administering vaccine and
5. offer pleasant experience for paediatric patients and people suffering from needle phobia.

Literature reports many interesting and promising studies on the administration of vaccine using dissolvable microneedles. For example Yang et al. [11] developed microneedle patch wherein Ebola DNA vaccine was incorporated into PLGA-PLL/γPGA nanoparticles and administered to skin [11]. The investigators found that embedding the vaccine in a nanoparticle delivery system led to an increase in vaccine thermostability. The immunogenicity of these embedded vaccines was much better than the free intramuscularly administered free vaccine and resulted in stronger immune responses. Another group of researchers embedded receptor-binding domain of SARS-CoV-2 spike protein in dissolvable microneedles and administered it intradermally in mice [12]. It was found that the vaccine delivered through microneedles induced significant B-cell and significant T-cell responses against S-RBD and the outcomes were comparable to that of conventional bolus injection. Kolluru et al. [13] reported the development of a Dissolving Microneedle (MN) patch for administration of Inactivated Polio Vaccine (IPV) and concluded that embedding appropriately formulated IPV in microneedle patches not only improved the thermostability but also enabled the distribution of IPV with less reliance on cold chain storage.

The strategies based on microneedles clearly suggest that these could be used for effective immunization and eradication programs as they could ease many of the limitations associated with traditional method of vaccinations. In the wake of pandemic, obtaining herd immunity should be the priority. This is achievable only through mass vaccination, which requires massive work force to rapidly distribute and administer the vaccines. Microneedle patches could easily overcome many of the limitations posed by the conventional vaccination methods. Microneedle patches for COVID-19 vaccination are currently unavailable and requires regulatory infrastructure for rapid development. A better investment and planning is the call of the hour to be prepared for future pandemic needs.

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