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## Letter to the Editor

### Emerging technologies and COVID-19 digital vaccination certificates and passports



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#### Dear Editor

The coronavirus disease (COVID-19) continues to overburden many health systems despite the successful development and distribution of World Health Organization (WHO) approved vaccines [1]. Several measures and restrictions including social distancing [2], face masking, blanket lockdown [3] and travelling ban have been implemented but the emphasis now shifted towards immunization of populations, targeting priority groups to reduce secondary transmission and to accelerate post-pandemic recovery, especially when restrictions are relaxed. However, the universal immunization of populations faces tremendous challenges such as inequitable vaccine distribution [4], weak health systems, shortage of healthcare professionals to administer the vaccines, lack of awareness and lack of public trust among the affected populace, limited financial resources to secure vaccines [5], pre-existing health inequalities [6], vaccine refusal, inequalities in vaccine coverage, ignorance, COVID-19 conspiracy theories [7] as well as short supply of vaccines and emerging of new variants that are partially resistant to vaccines [8]. Despite all these impediments, vaccination is in progress in at least 171 countries as of April 14, 2021. The vaccinated people are given COVID-19 vaccination certificates or cards that contain information such as personal details, health facility, vaccination dates and dosage [9]. Historically, immunization was successfully implemented to alleviate the upsurge of diseases such as smallpox, yellow fever (which is mandatory for travellers to and from endemic countries) and diphtheria-tetanus-pertussis for children [10]. However, these traditional immunization card or certificates are vulnerable to forgery [11], corruption, alterations, difficult to read by non-health experts, they can easily get lost, and also susceptible to weather conditions such as rain [10].

Therefore, there is a need to develop secure COVID-19 electronic-based vaccination certificates or passports to counter the limitations of traditional vaccination cards. COVID-19 digital vaccination certificates should be tamper-proof, remotely accessible, secured and preserving the privacy of people (design-by-ethics). This is achieved by incorporating emerging technologies in the development processes as they have been implemented to tackle COVID-19 in various domains. These technologies include artificial intelligence, geographical information systems,

Internet of Things, Internet of Medical Things, 5G technology, Blockchain, additive manufacturing, robotics and virtual reality [12,13]. Such technologies have been utilized to develop smart applications such as contact tracing apps [14], social distancing tools, and smart wearable devices.

In the context of COVID-19 electronic vaccination certificates, these technologies could be utilized to perform various functions. Firstly, artificial intelligence could be used to detect fake COVID-19 vaccination certificates, easily identify and map non-vaccinated regions or populations for strategic planning, cluster migrants' migration patterns based on data stored in the verification app(s) and aid in contact tracing. Secondly, Internet of Medical Things and blockchain technology will be useful in remote access to COVID-19 vaccination certificates while allowing for additional health services such as remote counselling to be integrated into apps that generate electronic certificates. Blockchain technology specifically associates person's identification with blockchain records for authentication purposes [9] and improves electronic health data and communication link security using blockchain-based systems, especially when accessing and sharing COVID-19 data. Thirdly, 5G cellular technology can support high bandwidth and data transfer rate to support real-time verification of COVID-19 vaccination certificates and sharing of health data while big data can store and process COVID-19 certificates verification data with real-time updates and remote access. Fourthly, Quick Response (QR) technology will allow authorities to check people's health status record and verify COVID-19 digital certificates by using quick response [12,15,16]. The role of emerging technology in supporting regional and international synchronization of health data and verification of COVID-19 digital vaccination certificates is therefore evident.

Notably, several countries have been utilizing emerging technologies to develop applications (apps) that generate and validate COVID-19 electronic vaccination certificates. For instance, in the context of COVID-19, the United Kingdom developed a mobile phone application to document people that have been tested for COVID-19 and soon to be used to keep the track record of people immunized against the virus [15]. Also, China launched a digital COVID-19 vaccination certificate for its citizens planning cross-border travels [16]. WHO launched the Smart Vaccination Certificate consortium to monitor national COVID-19

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vaccination programmes and facilitates cross-border vaccination activation guided with International Health Regulations [17]. Greece [20] and Israel have also implemented COVID-19 vaccination certificates. In Africa, the Africa Centres for Disease Control and Prevention launched Trusted Travel, a tool to simplify verification of public health documentation for travellers during exit and entry across borders. Various other digital tools and apps are being employed in different parts of the world help travellers to store and manage their verified certifications for COVID-19 tests or vaccination.

Digital tools and apps that generate COVID-19 electronic vaccination certificates may encounter several impediments such as heterogeneous communication protocols, lack of certificates (data) standardization and interoperability issues with other apps, privacy and security issues [18], lack of clear international regulations and policies guiding the use of electronic vaccination certificates amid COVID-19, data sharing without user-consent violates ethical issues. Also, there is no clear framework guiding the integration of blockchain technology in health systems and the issuance of electronic vaccination certificates [4]. Further, COVID-19 vaccination certificates pose considerable scientific, practical, equitable, and legal challenges [19].

The issuance of COVID-19 vaccination certificates raises some ethical concerns that need to be fully understood and addressed. For instance, the Nuffield Council on Bioethics raised concerns on the proposed introduction of immunity or vaccination passports in the UK citing that this could enable coercive and stigmatising workplaces, thereby compounding current structural disadvantages in that country. Additional concerns on whether privacy protections of people will be guaranteed and that the health data will only be used for the intended purpose must also be addressed. In the context of limited-resource settings, COVID-19 vaccines are scarce and access remains unequal within the countries. People with serious health conditions and allergies have been advised not to take the vaccines. This means people facing vaccination access problems will be unable to obtain vaccine passports and therefore deprived of their civil rights. While vaccine passports are permissible under international health regulations, the implementation of COVID-19 vaccine passports should be tailored to address these ethical concerns and digital tools and apps used should offer means for enhanced security and privacy protection.

In conclusion, there is a need to homogenize digital solutions and standardization of regional and international electronic platform to document and validate COVID-19 electronic vaccination certificates [20]. The outbreak of pandemics in the future is imminent; therefore, it is imperative to develop a framework and policies guiding the integration and synchronization of digital solutions especially digital vaccination certificates in case of international public health emergencies. However, such technological interventions should be guided by ethical guidelines.

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#### Declaration of competing interest

Authors declares no competing interests.

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