

THE FUTURE OF ADULT IMMUNISATION

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SANOFI 

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How can new technology improve vaccination access and uptake?

This think piece explores how technology is beginning to influence the delivery and uptake of vaccination.

We highlight good and innovative practice, particularly drawing on examples where technology is being used to increase uptake of adult vaccination.

We specifically focus on influenza but many of the ideas will be relevant to other vaccine preventable diseases.

We explore the potential for future innovation to help increase the uptake of adult vaccination. And we also set out a series of policy questions and implications.

This think piece will be used to motivate debate at a futures workshop being organised by ILC-UK on 26th June 2018 in Brussels. Following the workshop, ILC-UK will produce a final report for launch in autumn 2018.

In this think piece we split innovations into 8 categories.

- Using data better
- Gamification
- The Internet
- The Internet of Things
- The Sharing Economy
- Artificial Intelligence and Robotics
- Blockchain
- Materials Science

Have your say

We will be publishing a final report in Autumn 2018 and we want your comments.

1. Give us your thoughts on this think piece.
2. Let us know of other examples of where new technology is being used to support increased uptake of or access to, adult vaccination.
3. Please give us your views on any of the issues or questions we have posed in this think piece.

Send your comments to David Sinclair: davidsinclair@ilcuk.org.uk

Or by post to David Sinclair, ILC-UK, 11 Tufton Street, London, SW1P 3QB

Please contribute your thoughts by 13 August.



The International Longevity Centre - UK (ILC-UK) is an independent, non-partisan think-tank dedicated to addressing issues of longevity, ageing and population change. It develops ideas, undertakes research and creates a forum for debate.



Sanofi is a global healthcare leader. Every day, Sanofi's 100,000 employees are committed to improve the lives of people around the world, with sustainable and responsible solutions and initiatives.

Financial support for this project has been provided by Sanofi

Why does adult vaccination matter?

“Vaccination can provide cost-effective protection against a host of diseases throughout life, but remains an underused public-health strategy in adults for the promotion of healthy ageing. Without specific vaccination programmes for the adult population aged >50 years infectious diseases will continue to be a cause of substantial morbidity and mortality in late adulthood”¹.

- Whilst vaccine preventable diseases can often affect people of all ages, the biggest health impact is often felt by younger and older people.
- More adults in the US die from vaccine preventable diseases each year than children².
- In the EU, between 40,000 and 220,000 deaths per year might be attributed to influenza infection, depending on the pathogenicity of the circulating viral strain³.
- The highest prevalence of influenza complications occurs among older adults, especially those with chronic medical conditions or immunological disorders, resulting in increased mortality⁴.
- “In France, during influenza 2014–15 season, there were about 2.9 million medical consultations, 30,000 emergency room visits and more than 3100 hospitalizations (47% in patients aged over 65 years) for influenza or influenza-like illness”⁵.
- New ILC-UK Research⁶ (England) published in June 2018 finds that:
 - Over 6.2 million “at risk” individuals had not been vaccinated against influenza during the 2016/17 influenza season.
 - The influenza vaccination averts between 180,000 and 626,0000 cases of influenza per year in England
 - The influenza vaccination helps save between 5,678 and 8800 lives
 - The vast majority of hospital cases caused by influenza are among older adults. Over 1,800 individuals hospitalised were aged between 80 and 84 - higher than any other age group.

Whilst this think piece focusses mainly on influenza vaccination, many of the points and issues are relevant to other vaccine preventable diseases facing adults such as pneumococcal disease and herpes zoster. Many of the points will also be relevant to immunisation across the life course.

- “In 2014, 17,528 confirmed cases of invasive pneumococcal disease were reported by 28 EU/ EFTA countries. The age-specific incidence rate of invasive pneumococcal disease was highest in these aged over 65 years”⁷.
- “The lifetime incidence of herpes zoster is estimated to be about 20 to 30% in the general population, and up to 50% among those living to at least 85 years of age”⁸.

¹Michel, J. -P., Gusmano, M., Blank, P.R. and Philp, Ian (2010) Vaccination and healthy ageing : how to make life-course vaccination a successful public health strategy. *European Geriatric Medicine*, Vol.1 (No.3). pp. 155-165.doi:10.1016/j.eurger.2010.03.013

²Fingar AR, Francis BJ. American College of Preventive Medicine Practice Policy Statement: adult immunizations. *Am J Prev Med* 1998;14:156-8; Poland GA, Jacobson RM, Ovsyannikova IG. Trends affecting the future of vaccine. *Development and delivery: The role of demographics, regulatory science, the anti-vaccine movement, and vaccinomics.*

³Vaccine (2009), doi:10.1016/j.vaccine.2009.01.069.

⁴European Centre for Disease Prevention and Control (ECDC). The hard facts are often overlooked: Influenza remains a threat. http://ecdc.europa.eu/en/healthtopics/spotlight/spotlight_influenza/key_message_2/pages/full_key_message_2.aspx

⁵Influenza vaccines. *Wkly Epidemiol. Rec.* 80, 279–287 (2005). [Medline]

⁶Esposito, S et al (2018) The public health value of vaccination for seniors in Europe *Vaccine* 36 (2018) 2523–2528

⁷An economic analysis of flu vaccination (2018) International Longevity Centre -UK

⁸Esposito, S et al (2018) The public health value of vaccination for seniors in Europe *Vaccine* 36 (2018) 2523–2528

⁹Esposito, S et al (2018) The public health value of vaccination for seniors in Europe *Vaccine* 36 (2018) 2523–2528

How might technology help improve access to and uptake of adult immunisation

Some older adults might find it difficult to physically get to the doctors or pharmacy to be vaccination.

The sharing economy might make vaccination more accessible through for example, the efficient use of transport services⁹.

Some people don't realise they should have a vaccination

Real time information services similar to Google Flu Trends can highlight the immediate risk of vaccine preventable diseases. Technology can also help “nudge” or prompt people to think about vaccination.

Some adults may be worried about what to believe in a world of fake news.

Blockchain could help give people more confidence in online information and counter “fake news” about vaccination

Social media could help people learn from others about their condition and how to best manage it. It can also be used to promote the value of vaccination.

Policymakers don't know “what works”

New smart data analysis can better determine which approaches to encouraging vaccination were most successful.

Policymakers struggle to reach the “difficult to reach”

New digital records have the potential to automatically generate lists that identify under-vaccinated populations, determine which vaccines are overdue, and generate reminders for doctors and the public.

Some adults might be scared of the needle

Nanotechnology could deliver new ways of delivering vaccines which address the fear of the needle (e.g. oral/nasal/Nanopatch)

A humanoid robot might distract us from the pain. A virtual reality immersive experience could distract and calm fears, possibly even reducing the perceived pain and even increasing the immune response.

Some adults might not keep a good record of their immunisation history

A ‘digital necklace’ or app could helping store our vaccination history.

Adults might not know that their health condition means that they should consider a specific vaccination

Services like PatientsLikeMe allow patients share information about adult vaccination with their peers and with medical practitioners.

⁹<http://www.adultimmunisation.eu/adult/ubers-health-service-offered-free-on-demand-flu-vaccinations-and-wellness-packages/>

Using data better

“Extremely large data sets that may be analysed computationally to reveal patterns, trends, and associations, especially relating to human behaviour and interactions”¹⁰.

What is being done/explored?

Twenty-one European countries have developed, or are in the process of creating **systems to digitally record vaccination information**, according to a new ehealth survey by the European Centre for Disease Prevention and Control (ECDC). “Five of the systems include automated reminders. The ECDC says these programs have the potential to automatically generate lists that identify under-vaccinated populations, determine which vaccines are overdue, and generate reminders for doctors and the public”¹¹.

Google Flu trends used search terms to predict influenza outbreaks. It has been claimed that the service was quicker at predicting influenza outbreaks than other official sources¹².

The NHS is developing a **“sickness surveillance system”** which predicts winter pressures on health services by collating information from GPs, hospitals, the NHS 111 helpline and weather alerts¹³.

The Duke Clinical Research Institute Adult Immunisation Project will “analyse data from primary care practices before, during, and after the deployment of educational interventions to **determine which approaches were successful** in helping patients understand the benefits and risks associated with various vaccinations”¹⁴.

The UK Department of Health and Social Care collates weekly information on uptake of the influenza vaccination, allowing for focussed initiatives to target uptake in areas where uptake is relatively low. A similar initiative by the Iowa Clinic uses big data to stratify risk groups and to help manage uptake “*Maybe there is a specific provider or clinic that’s doing a great job, and maybe there’s someone that needs more reminding. We needed analytics to see where our deficits were so we could figure out how to focus our efforts. We also needed to develop special processes for high-risk patients under the typical age threshold who should get the pneumococcal vaccine*”¹⁵.

How could data help?

Some people don’t realise they should have a vaccination

An idea: Real time information services similar to Google Flu Trends can highlight the immediate risk of vaccine preventable diseases. Technology can also help “nudge” or prompt people to think about vaccination.

¹⁰<https://www.cbronline.com/what-is/what-is-big-data-and-why-is-it-important-4172588/>

¹¹<https://www.vaccinestoday.eu/stories/can-big-data-help-end-preventable-deaths/>

¹²https://en.wikipedia.org/wiki/Google_Flu_Trends

¹³<https://www.telegraph.co.uk/news/2017/12/18/nhs-use-sickness-surveillance-system-predict-pressure-points/>

¹⁴August 2016 - New Collaborative Effort Aims to Improve Adult Vaccination Rates Within Primary Care Setting <http://www.newswise.com/articles/new-collaborative-effort-aims-to-improve-adult-vaccination-rates-within-primary-care-setting>

¹⁵<https://healthanalytics.com/news/adult-vaccine-project-produces-population-health-best-practices>

Policymakers don't know “what works”

An idea: New smart data analysis can better determine which approaches to encouraging vaccination were most successful

The better use and management of existing data about uptake of e.g. the influenza vaccine can help target resources on areas where low numbers of people have benefitted from the vaccination. Such data could also help improve reminder systems and deliver more targeted communication to health care professionals

Real time information based on big data analysis could help with early identification of the spread of a vaccine preventable disease.

Big data could also, for example, allow policymakers and manufacturers to assess the benefit-risk of vaccination.

Improved data sharing could help ensure “at risk” groups are aware of the vaccinations they are eligible to receive.

Big data could help improve the efficiency and effectiveness of vaccine manufacture. One manufacturer uses a sophisticated data service “to crunch huge amounts of data so it can develop vaccines faster¹⁶.

Issues to explore

“Big data raises new ethical dilemmas, though its analysis methods can bring complementary real-time capabilities for monitoring epidemics and assessing vaccine benefit-risk balance”¹⁷.

How can we reduce the fear that any **misuse of data** could allow for individual data to be revealed to policymakers and or the private sector?

How can we tackle individual concerns about **privacy**?

Do we need a debate on **data ownership** if we are to maximise the potential of big data?

Should new models of data capture allow for **opt out**? And if an unrepresentative sample chooses to opt out, does this undermine the data?

¹⁶ <https://www.informationweek.com/strategic-cio/executive-insights-and-innovation/merck-optimizes-manufacturing-with-big-data-analytics/d/d-id/1127901?>

¹⁷ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4287086/#sec1-1title>

Gamification

“The process of adding games or gamelike elements to something (such as a task) so as to encourage participation”¹⁸.

What is being done/explored?

The game, **Plague Inc** simulates the spread of an infectious disease where the player attempts to control (and encourage) its spread. The Centre for Disease Control and Prevention in the US has said of the game “it uses a non-traditional route to raise public awareness on epidemiology, disease transmission, and diseases/pandemic information. The game creates a compelling world that engages the public on serious public health topics”¹⁹.

An online **Fake News Game**²⁰ from the University of Cambridge puts “players in the shoes of an aspiring propagandist to give the public a taste of the techniques and motivations behind the spread of disinformation—potentially “inoculating” them against the influence of so-called fake news in the process”²¹.

The game **POX** helps teach the concept of herd immunity as the player tries to stop a spreading outbreak by vaccinating individuals²².

Vax Pack Hero from The Children’s Hospital of Philadelphia teaches the history of vaccination while having the user fight up to 21 different vaccine-preventable diseases²³.

A **comic called Viral Attack** shows kids using immune system weapons like cytotoxic guns to fight viruses. Another comic, aimed at both children and parents, debunks the myths about vaccines²⁴.

How could Gamification help?

Some people don’t realise they should have a vaccination

An idea: Games could help “nudge” or prompt people to think about vaccination.

“Gamification and the creation of apps can use the criteria of story genre, immersion, fantasy, design, and gameplay to create positive concepts about vaccination”²⁵ It could also raise awareness of the value of vaccination for younger people and help move the “social norm”.

Gamification could play a role in helping children convince parents about the value of vaccination.

Gamification has potential to change behaviours (e.g. increase the likelihood of vaccination).

Gamification can help give us feedback on choices and monitor how we respond to certain scenarios.

¹⁸ <https://www.merriam-webster.com/dictionary/gamification>

¹⁹ <https://blogs.cdc.gov/publichealthmatters/2013/04/plague-inc/>

²⁰ <http://www.fakenewsgame.org>

²¹ <https://phys.org/news/2018-02-fake-news-vaccine-online-game.html#jCp>

²² Wilson K, Atkinson K, Crowcroft N. Teaching children about immunization in a digital age. *Human Vaccines & Immunotherapeutics*. 2017;13(5):1155-1157. doi:10.1080/21645515.2016.1271519.

²³ Wilson K, Atkinson K, Crowcroft N. Teaching children about immunization in a digital age. *Human Vaccines & Immunotherapeutics*. 2017;13(5):1155-1157. doi:10.1080/21645515.2016.1271519.

²⁴ Wilson K, Atkinson K, Crowcroft N. Teaching children about immunization in a digital age. *Human Vaccines & Immunotherapeutics*. 2017;13(5):1155-1157. doi:10.1080/21645515.2016.1271519.

²⁵ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5443382/>

Issues and questions to explore

Do they work? On the one hand, one group of UK researchers have argued that there is limited evidence that games can improve health: “We were not able to assess the clinical benefits or potential harms from using the apps since none have been rigorously evaluated.”²⁶. Research published in the BMJ found that the smartphone game, Pokémon Go “improves physical activity, but the effect is only moderate and no longer observed after six weeks”²⁷.

There is however, some emerging evidence that gamification can make a difference. A randomised controlled trial targeting parents and children in Italy explored the use of smartphone apps incorporating gamification on knowledge about MMR (measles/mumps/rubella) and likelihood of vaccination. The researchers found that those who received the intervention targeting knowledge reported significantly higher intention to vaccinate²⁸.

The researchers argued that “Parent-centered, gamified mobile interventions aimed at providing parents with vaccination-related information can be used to increase their knowledge, their intention to vaccinate as well as their confidence in the vaccination decision”²⁹.

Other researchers have also found that “game based interventions using social incentives to reward behaviours increased physical activity”³⁰. Analysis of a paper version of <http://www.fakenewsgame.org> found that the “perceived reliability of fake news to be diminished in those that played compared to a control group”³¹.

How can we assess their impact when relatively few health apps incorporate gamification? Research which explored top rated health apps found that just “64 of 1680 (4%) health apps included gamification”³².

How can we increase the number of “games” targeted specifically at adults? Most examples of gamification in relation to vaccination target children and parents rather than adults or older adults. That said, the growth of wearables by adults to monitor participation in physical activity has benefitted from the development of online platforms which create competition and reward success (e.g. Strava, Garmin Connect).

Do the rewards/incentives work for adults? Might more research may be needed to better understand how adults react to rewards and incentives within games?

²⁶Edwards EA, Lumsden J, Rivas C, et al Gamification for health promotion: systematic review of behaviour change techniques in smartphone apps *BMJ Open* 2016;6:e012447. doi: 10.1136/bmjopen-2016-012447

²⁷BMJ 2016;355:i6684

²⁸Marta Fadda, Elisa Galimberti, Maddalena Fiordelli, Luisa Romanò, Alessandro Zanetti & Peter J. Schulz (2017) Effectiveness of a smartphone app to increase parents' knowledge and empowerment in the MMR vaccination decision: A randomized controlled trial, *Human Vaccines & Immunotherapeutics*, 13:11, 2512-2521, DOI: [10.1080/21645515.2017.1360456](https://doi.org/10.1080/21645515.2017.1360456)

²⁹Marta Fadda, Elisa Galimberti, Maddalena Fiordelli, Luisa Romanò, Alessandro Zanetti & Peter J. Schulz (2017) Effectiveness of a smartphone app to increase parents' knowledge and empowerment in the MMR vaccination decision: A randomized controlled trial, *Human Vaccines & Immunotherapeutics*, 13:11, 2512-2521, DOI: [10.1080/21645515.2017.1360456](https://doi.org/10.1080/21645515.2017.1360456)

³⁰Slomski A. Gamification Shows Promise in Motivating Physical Activity. *JAMA*. 2017;318(24):2419. doi:10.1001/jama.2017.19987

³¹ <https://phys.org/news/2018-02-fake-news-vaccine-online-game.html#jCp>

³²Edwards EA, Lumsden J, Rivas C, et al Gamification for health promotion: systematic review of behaviour change techniques in smartphone apps *BMJ Open* 2016;6:e012447. doi: 10.1136/bmjopen-2016-012447

The Internet

a global computer network providing a variety of information and communication facilities, consisting of interconnected networks using standardized communication protocol.

What is being done/explored?

The NHS England **#flufighter** campaign combines online and offline material with a social media hashtag to get the message out about the value of vaccination³³.

Break Dengue is an open platform which crowdsources information “on the ground” with a view to accurately predicting dengue fever cases around the globe³⁴.

How could the internet help?

Policymakers struggle to reach the “difficult to reach”

An idea: New digital records have the potential to automatically generate lists that identify under-vaccinated populations, determine which vaccines are overdue, and generate reminders for doctors and the public.

The internet is the most comprehensive source of information on health and vaccination and could help raise awareness of the need to vaccinate.

Mobile technology combined with location data could remind us of where and when we should be vaccinated.

Social media could help people learn from others about their condition and how to best manage it. It can also be used to promote the value of vaccination.

Health dashboards and apps could help us manage our health and keep electronic records of our vaccination record.

Developments in on demand printing could result in the development of personalised information leaflets for targeted groups of individuals.

New online communications (including visual communications) and smart messaging can get messages out quickly to remind people about vaccination.

Issues and questions to explore

How can we get more accurate information about adult vaccination online?

Whilst there are a number of “apps” which allow people to record their vaccine history, few are officially sanctioned. And even fewer focus on adult records rather than those for children. Should Government develop “official” vaccine record apps?

Will a speeding up of Electronic Patient Records help maximise the potential of the internet? What needs to be done to deliver this?

Fake stories spread via WhatsApp have been accused of risking progress on vaccinating against Yellow Fever in Brazil³⁵ and Polio³⁶ and Measles in India. How can Governments tackle fake news online?

³³<http://www.nhsemployers.org/flufighter>

³⁴<https://www.breakdengue.org/break-dengue/>

³⁵<https://www.wired.com/story/when-whatsapps-fake-news-problem-threatens-public-health/>

³⁶<https://www.ibtimes.co.in/tamil-nadu-fake-anti-vaccination-messages-circulated-widely-whatsapp-facebook-fuelling-fears-713902>

The Internet of Things

The interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data.

What is being done/explored?

A 'digital necklace' is helping to store vaccination information in villages in India³⁷.

How could the internet of things help?

Some adults might not keep a good record of their immunisation history

An idea: A 'digital necklace' or app could help store our vaccination history?

An idea: Smart packaging could connect with electronic patient records when a vaccination is delivered.

Connecting our homes³⁸, cities³⁹ and even ourselves⁴⁰ to the internet will offer increasing opportunities for improving access to health services. Business Insider predicts that 10% of the world's population will be wearing wearable devices by 2022⁴¹.

Wearable devices could help monitor our health and let us know if we should consider a specific vaccination. They can also help us track our vaccination history.

3D printing offers potential to improve the manufacture and delivery of vaccinations which could reduce the costs and increase access to adult vaccinations. Geneticist Craig Venter is working towards a future where medicines and biological structures could be created in digital form, emailed to wherever they are needed in the world and eventually produced using local 3D printing technology⁴².

The Internet of Things could help motivate changes in behaviour or nudge people into action.

Smart cities in China track residents, their activities on social media and what they buy. Real time AI is used to reduce traffic congestion, accidents and crime⁴³. Efficient towns and cities could make it easier for people to physically access vaccination services.

Issues and questions to explore

How can we ensure wearables offer added value to individuals and healthcare professionals, rather than a distraction?

How can we better understand how the Internet of Things can drive positive behaviour change?

How can we ensure "interoperability" to maximise the potential of the internet of things?

³⁷<https://www.vaccinestoday.eu/stories/the-digital-necklace-saving-lives-in-india/>

³⁸A *smart home* is a residence that uses internet-connected devices to enable the remote monitoring and management of appliances and systems <https://internetofthingsagenda.techtarget.com/definition/smart-home-or-building>

³⁹the effective integration of physical, digital and human systems in the built environment to deliver sustainable, prosperous and inclusive future for its citizens". <http://www.centreforcities.org/reader/smart-cities/what-is-a-smart-city/1-smart-cities-definitions/#fn-67>

⁴⁰Wearables: blanket term for electronics that can be worn on the body, either as an accessory or as part of material used in clothing <https://www.investopedia.com/terms/w/wearable-technology.asp>

⁴¹<http://uk.businessinsider.com/21-technology-tipping-points-we-will-reach-by-2030-2015-11?r=US&IR=T/#1-trillion-sensors-will-be-connected-to-the-internet-by-2022-3>

⁴²<https://3dprintingindustry.com/news/3d-printing-a-vaccine-3259/>

⁴³<http://www.iflscience.com/technology/smart-city-china-controlled-artificial-intelligence/>

The Sharing Economy

The sharing economy is an economic model often defined as a peer-to-peer (P2P) based activity of acquiring, providing or sharing access to goods and services that are facilitated by a community based on-line platform⁴⁴.

What is being done/explored?

In October 2016, the ride-hailing company Uber offered free, on-demand influenza vaccination in more than 35 US cities, accompanied with care packages including a water bottle, tissues, hand sanitiser, a totebag and a lollipop. **The UberHealth** service launched in 2014, and allows users to request a registered nurse visit them wherever they are to administer the vaccination. The service usually costs 10 USD, and nurses can immunise up to 10 people per visit. However, between 11:00 to 15:00 on 25th October 2016, the service was offered for free.⁴⁵

Pager.com, allows users to see a doctor within two hours in the patient's home^{17 46}

Circulation.io is linking ride-sharing with health care services.

How could the sharing economy help?

Some older adults might find it difficult to physically get to the doctors or pharmacy to be vaccination.

An idea: The sharing economy might make vaccination more accessible through for example, the efficient use of transport services⁴⁷.

The sharing economy could make vaccination more accessible through for example, the efficient use of transport services⁴⁸.

New sharing economy platforms could give adults quick access to a qualified practitioner.

Services could help patients share information about adult vaccination with their peers and with medical practitioners. See for example, PatientsLikeMe.⁴⁹

Issues and questions to explore

Some sharing economy models result in **increasing decentralisation** and run the risk that Governments lose some control and access to information. They could also undermine funding and delivery models of traditional services.

Can these services be cost effective? Whilst potentially convenient to end users, is it possible to find a way of sustainably funding such services?

Governments will need to consider **whether new regulation is needed** to support service delivery in this new economy. How for example can the Systems to ensure that practitioners are qualified. Who will provide insurance?

Whilst we are often willing to trust our some of our peers, there can sometimes be some **scepticism about trusting strangers**. This could be particularly the case in vaccination where individuals or groups with ulterior motives could aim to undermine consensus science. There is also the potential for manipulation of data in some systems. Tripadvisor has, for many years, struggled with allegations of “fake” reviews.

⁴⁴<https://www.investopedia.com/terms/s/sharing-economy.asp>

⁴⁵<http://www.adultimmunisation.eu/adult/ubers-health-service-offered-free-on-demand-flu-vaccinations-and-wellness-packages/>

⁴⁶<https://www.arabhealthonline.com/magazine/en/latest-issue/Issue-4/What-Will-the-Sharing-Economy-Mean-for-Healthcare.html>

⁴⁷<http://www.adultimmunisation.eu/adult/ubers-health-service-offered-free-on-demand-flu-vaccinations-and-wellness-packages/>

⁴⁸<http://www.adultimmunisation.eu/adult/ubers-health-service-offered-free-on-demand-flu-vaccinations-and-wellness-packages/>

⁴⁹<https://www.patientslikeme.com/>

Artificial Intelligence (AI) and Robotics

What is being done/explored?

Researchers have experimented with using a humanoid robot when vaccinating children - as a way of **distracting from the pain** of an injection⁵⁰.

On the Island of Vanatu, **Drones are now being used to deliver vaccinations**⁵¹.

Sanofi and Berg will use AI to assess “different populations, races, different ages, different geographies” to gauge whether certain vaccines are more effective in “say, Asia versus Africa versus the US or the UK”. John Shiver, senior vice-president of R&D for vaccines at Sanofi: “We are hoping this will get us closer to the next-generation of influenza vaccine”⁵².

How could AI and Robotics help?

Some adults might be scared of the needle

An idea: A humanoid robot might distract us from the pain. A virtual reality immersive experience could distract and calm fears, possibly even reducing the perceived pain and even increasing the immune response.

“pharmaceutical companies are increasingly embracing the potential of AI to identify drug targets, new uses for existing drugs or to secure faster approval of medicines”⁵³.

Improved Robotics and AI could help improve the efficiency of manufacturing processes and the end cost of vaccines.

Robotics can help deliver vaccinations promptly and efficiently to individuals, pharmacies and doctors.

Robots can help mask vaccination pain in children (see above).

Issues and questions to explore

Would more targeted vaccinations risk the development of inequalities in access?

Would robots also help vaccine pain hesitant older people?

⁵⁰ <https://www.journals.elsevier.com/vaccine/news/robots-help-mask-vaccination-pain-for-children>

⁵¹ <http://www.bbc.co.uk/news/world-asia-40270838>

⁵² Sanofi turns to artificial intelligence to beat flu - Financial Times

⁵³ Sarah Neville, Financial Times, October 30, 2017 [<https://www.ft.com/content/a2cc8f54-bd47-11e7-9836-b25f8adaa111>]

Blockchain

Blockchain is a shared, immutable record of peer-to-peer transactions built from linked transaction blocks and stored in a digital ledger⁵⁴.

What is being done/explored?

Medicalchain and Groves Medical Group is beginning to pilot a **blockchain platform for patients**. Medicalchain uses blockchain technology to facilitate the “transparent exchange of medical records by patients and doctors”⁵⁵.

ImmunoTracker is a digital blockchain-based solution which makes vaccination records, and in the future all health-related records, secure yet accessible and reliable. The app seeks to ensure citizens stay informed and up-to-date on their vaccinations and provides medical professionals and authorities to both share and access important immunization data in real-time, whilst not compromising privacy. The back-end system consists of two databases: a blockchain accessible to the UAE government and citizens, and a private database system for storing the full health records.

Statwig combines sensor and blockchain technology to improve the supply chain management of vaccines⁵⁶.

How could blockchain help?

Some adults may be worried about what to believe in a world of fake news.

An idea: Blockchain could help give people more confidence in online information and counter “fake news” about vaccination

Blockchain could help ensure that electronic medical records contain up to date, accurate information about vaccination history⁵⁷. This could help with coordination and information sharing between health care professionals.

The innovation could put greater power into the hands of the individual to manage their own health and own their own information

Tools could be developed which could give people more confidence in online information and counter “fake news” about vaccination⁵⁸.

Blockchain could improve supply chain management and reduce the cost of delivering adult vaccinations. A blog for the World Bank claimed that the technology could increase efficiency, maintain quality and reduce costs as well as delivering improvements in real time⁵⁹.

Issues and questions to explore

Many European Governments have been slow to deliver Electronic Patient Records. It has been more than 20 years since the UK Government promised the introduction of electronic patient records. Yet progress has been extremely slow. Blockchain could either offer opportunities to speed up progress on the development of records. But on the other hand, Governments may be simply too slow to understand the potential of the new technology. The promise that blockchain will tackle interoperability and different systems of data collection and storage may not be realised.

⁵⁴<https://www2.deloitte.com/us/en/pages/public-sector/articles/blockchain-opportunities-for-health-care.html>

⁵⁵<https://www.telegraph.co.uk/business/business-reporter/blockchain-trial-in-healthcare/>

⁵⁶<https://www.techinasia.com/startup-blockchain-tech-vaccines-safe>

⁵⁷<https://medium.com/crypt-bytes-tech/medicalchain-a-blockchain-for-electronic-health-records-eef181ed14c2>

⁵⁸<https://www.goodrebels.com/could-blockchain-help-solve-the-fake-news-crisis/>

⁵⁹<http://blogs.worldbank.org/health/how-blockchain-technology-delivers-vaccines-saves-lives>

How can data be legally protected in blockchain environments? European regulators will be concerned about how data can be legally protected when it isn't stored in a single place, rather in hundreds or thousands of computer networks.

There is potential for inequalities in access to health across Europe. There is a risk that the main (initial?) beneficiaries of this technology will be those accessing private rather than public healthcare services.

Materials Science

The scientific study of the properties and applications of materials of construction or manufacture (such as ceramics, metals, polymers, and composites)⁶⁰.

What is being done/explored?

Mark Kendall from the University of Queensland, is developing a **postage stamp size nanopatch** with thousands upon thousands of tiny spikes on its surface which could be used as an alternative to the needle for delivering vaccination⁶¹.

“A **graphene-based tattoo** that could function as a wearable electronic device to monitor health has been developed at the University of Texas”⁶².

How could Materials Sciences help?

Some adults might be scared of the needle

An idea: Nanotechnology could deliver new ways of delivering vaccines which address the fear of the needle (e.g. oral/nasal/nanopatch)

Nanotechnology could deliver new ways of delivering vaccines which address the fear of the needle (e.g. oral/nasal/nanopatch)

Innovations in materials sciences could help realise the potential for new adult vaccinations (e.g. HIV, Cancer)

Graphene could improve the potential for new and much better monitoring devices or sensors⁶³

Issues and questions to explore

Will individuals welcome the potential for improved monitoring of their health which may become possible? Have European regulators considered the possible ethical, access or policy issues which might emerge?

Are there regulatory or legal barriers which are preventing innovation in materials sciences in relation to vaccination?

⁶⁰<https://www.merriam-webster.com/dictionary/materials%20science>

⁶¹<http://theconversation.com/skin-patches-instead-of-needles-can-nanotechnology-vaccinate-the-world-68492>

⁶²<http://www.bbc.co.uk/news/av/technology-41669803/how-a-graphene-tattoo-could-monitor-your-health>

⁶³<http://www.bbc.co.uk/news/av/technology-41669803/how-a-graphene-tattoo-could-monitor-your-health>

Policy and Practice Barriers to Debate

How do we ensure that new technology isn't just a gimmick, or worse, a distraction from evidence based interventions?: Gamification might sound novel, but does it actually work?:

“A recent scoping review also found that there is a scarcity of evidence on the cost-effectiveness of media usage in public health messaging and relatively little on the use of visual methodologies, despite their potential to overcome literacy and language barriers”.⁶⁴

How can new technologies tackle inequalities in access and uptake as opposed to increasing them? There is a risk that new technologies outlined in this report will not be of equal benefit to all European citizens. Some technologies may only be accessible in the private marketplace. At the same time, more excluded European citizens may not know about the potential for new technologies or may find themselves unable to use them.

How can we “win the hearts and minds” of citizens? Some adults are sceptical about the value of technological interventions. If policymakers want to introduce innovation in this space, it is vital that they build trust.

How can we ensure that regulation protects consumers but does not prevent innovation? Regulators across Europe are extremely concerned to ensure that new innovation does not do harm to consumers. There are also significant public concerns about privacy and data use. Some of the more innovative ideas outlined require significant sharing of information. The fact that some of the gamification “solutions” insist on public availability of results could be a deterrent to some.

There remains a question as to whether regulation is appropriate in the new digital world. For example, is the regulation of medical devices appropriate in a world where people will be accessing health services via smartphones. Is the GDPR adequate a step to protect the data of individuals or will it stifle healthcare innovation?⁶⁵

Should policymakers be looking for better evidence of effectiveness or regulation of “apps”, games, or other solutions? In relation to gamification, one researcher argued: “there is no requirement to demonstrate effectiveness in modifying either behavioural or clinical outcomes or that the app complies with regulatory frameworks”⁶⁶. In the absence of regulation, are there other ways citizens can be confident in new technologies?

Inclusive Design – Might a European Accessibility Act help? The British Standards Institute (2005) defines **Inclusive Design** as The **design** of mainstream products and/or services that are accessible to, and usable by, as many people as reasonably possible... Without the need for special adaptation or specialised **design**.”

Significant strides have been made over the past decade in terms of ensuring new technologies and innovations are designed to the highest standards of design. However, it remains the case that older adults and people with disabilities may find new technologies difficult to use.

The European Commission has adopted a proposal for a directive “European Accessibility Act”. However, whilst the Council has published three progress reports, it has yet to agree on its position. Might such an Act ensure that new technologies are as inclusively designed as possible?

How can we tackle digital exclusion among older adults? Older adults continue on average, to be more digitally excluded than younger people. Some of the ideas outlined above may require investment in initiatives to tackle digital exclusion. How should policymakers go about this?

How can we ensure a greater innovation focus on adults. Many of the interventions we have identified so far have been focussed on children rather than adults. Can industry, startups and innovators do more to innovate for adults and older people. How can the EU's work on health and its investment in R&D support innovation for adults and older people?

⁶⁴<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5443382/>

⁶⁵<https://eureka.eu.com/gdpr/gdpr-healthcare/>

⁶⁶<http://bmjopen.bmj.com/content/6/10/e012447>

Have your say

We will be publishing a final report in Autumn 2018 and we want your comments.

1. Give us your thoughts on this think piece.
2. Let us know of other examples of where new technology is being used to support increased uptake of or access to, adult vaccination.
3. Please give us your views on any of the issues or questions we have posed in this think piece.

Send your comments to David Sinclair: davidsinclair@ilcuk.org.uk

Or by post to David Sinclair, ILC-UK, 11 Tufton Street, London, SW1P 3QB

Please contribute your thoughts by 13 August.

*The UK's specialist think
tank on the impact of
longevity on society,
and what happens next.*

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