

COVID-19: The Internet of Things and Health

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The COVID-19 pandemic has inspired a range of Internet of Things (IoT) innovations to help stop the spread of the virus. This is a sector-specific edition of COVID-19: IoT and Cybersecurity looking collecting and storing data in the Health and Wellbeing sector.

Past editions are found on the [PETRAS website](#).

The COVID-19 pandemic places an enormous strain on health systems and services. COVID-19 patients' data, that could be collected by Internet of Things (IoT) devices and then stored in Electronic health records (EHRs), are highly important for medical practitioners. Medical personnel and researchers need access to instant and reliable patient data as well as access to data from thousands of patients to understand how the virus operates.

Yet EHRs platforms have a high level of fragmentation, with many lacking the ability to access data from other providers, or to share and use data internally and externally. They can also be an easy target of cyberattacks.

Collecting the data: The role of IoT devices

Consumer wearables such as the Apple Watch, FitBit, [Oura](#)¹ (which tracks activity via a ring) and [WHOOP](#)² (which uses a wristband) can measure fitness statistics such as heart rate. [Further developments](#) in home wearables can now allow

Overview

- IoT devices such as commercial wearables could track essential parameters for monitoring COVID-19 patients or detecting new cases
- Electronic health records (EHRs) are the systematised collection of patients' health data in digital form
- Using EHRs data, UK researchers have found that people from Asian and Black ethnic backgrounds are at higher risk of in-hospital death from COVID-19
- US Epic's EHRs software received an update in January 2020 to help doctors spot COVID-19 patients by standardising a new travel screening questionnaire
- At Northwick Park and Ealing Hospitals in London, software is being developed as an auxiliary to EHR to help emergency rooms track the progress of COVID-19 patients and make the data immediately available to medical staff at the change of shifts
- Hospitals in Germany and Czech Republic experienced cyberattacks in May and March
- Experts call for cybersecurity provisions for NHS to be considered critical and that the private cybersecurity sector should be called in for assistance
- In March the US Department of Health and Human Services (HHS) finalised the interoperability and patient access rules, hailed as a victory for patient rights
- Duke University researchers propose 5 steps for a better resilience of EHRs in the COVID-19 era

tracking metrics such as body temperature, blood oxygen levels and respiratory rate - all essential parameters for monitoring COVID-19 patients or detecting new cases³. Consumer wearables could in theory track these parameters but the quality of the measurements in their current form do not

recommend them for clinical purposes, according to a [study](#) done at the University of Oxford and published in April 2020⁴.

Several studies were launched to achieve clinical validation for wearables:

US: Stanford Healthcare Innovation Lab

The [study](#) uses data collected from a variety of commercial wearables, including FitBit and Apple Watch, and algorithms trained to detect immunological changes⁵. The project is based on previous research in the same lab that detected an infection based on changes in heart rate.

Germany: smartwatch app

Public health authorities in partnership with Thryve, a health-care start-up, have launched a [smartwatch app](#) to monitor the spread of COVID-19⁶. The app gathers measurements on pulse, temperature and sleep to analyse whether users have COVID-19 symptoms.

UK: John Radcliffe Hospital

Researchers have been testing a virtual High-Dependency Unit (vHDU). In it, patients are monitored using wearable sensors that measure pulse, respiratory rate and blood oxygen saturation. Data is then sent to Bluetooth-linked tablet computers and analysed by algorithms. The aim is to reduce the burden on nursing staff and to improve early detection of abnormal parameters. [The technology](#) is now being applied to the isolation ward for COVID-19 patients who do not need to be ventilated⁷.

Box 1: OpenSAFELY current directions of research

- Assess the benefits and risks of particular treatments for COVID-19
- Use modelling to predict the local spread of the virus to be used for the design and evaluation of exit strategies from lockdown.
- Measure and mitigate the indirect health impacts of COVID-19, such as vaccinations and cancer referrals
- Evaluate the impact of national interventions, especially on particular patient groups

Remote healthcare and monitoring

Monitoring COVID-19 patients remotely can reduce costs and even improve clinical decision-making on early infection and learn more about the disease. [Telehealth, remote patient monitoring, and even AI \(Artificial Intelligence\)-based chatbots](#) can reduce the spread of the virus by reducing the number of patients coming to clinics or hospitals⁸.

At the Kanyinya COVID-19 treatment facility in Rwanda, [three robots have been deployed](#) to minimise contact between patients infected with the coronavirus and doctors and nurses. The robots carry out tasks like taking temperatures and monitoring patients⁹.

Storing the data: Electronic Health Records

Electronic Health Records (EHRs) are the systematised collection of patients' health data in digital form. EHRs can include medical history, laboratory test results, immunization status, medication, or personal characteristics, like age or height. It is the [most used digital technology in UK healthcare](#)¹⁰.

Use of EHR data to spot coronavirus trends and beneficial treatments

To test the efficacy of drugs or vaccines, medical researchers prefer highly reliable data from clinical trials. Yet such trials take months or years to complete and during the current pandemic medical professionals need to take decisions often in a matter of hours. [EHRs can supply 'real-world' evidence](#), in the form of rapid information on which treatments work best or which groups are more vulnerable to the infection¹¹.

UK conducts the largest study to date involving EHRs

In the UK, a team of software developers, clinicians, and academics created an analysis platform, [OpenSAFELY](#), to find what contributes to the number of COVID-19 deaths¹². This is the largest study to date, analysing more than 17 million EHRs of adult patients in the UK. On their [first analysis](#), published on 6 May¹³, the team concluded that people from Asian and Black ethnic backgrounds are at higher risk of in-hospital death from COVID-19, yet this is only partially attributable to pre-existing medical conditions or deprivation. The study found that factors relating to COVID-19

death included being male, older age, uncontrolled diabetes and severe asthma. The team is already working on further uses of the data set (Box 1).

Patient privacy when using EHR for research

To protect privacy, the data is usually pseudonymised or anonymised. However, with 'some background information about the individuals, you can easily reidentify some of them in the anonymised records' says Erman Ayday, a security and privacy researcher¹⁴. The solution found by the [OpenSAFELY](#) team was to build the platform to run inside the data centres where the EHRs were kept, thus also taking advantage of their security provisions. This way, the analysis is done on site and the only data to leave the centre is in the summary tables of the analysis.

New EHR technology developments in response to COVID-19

In the US: EHRs software receives an update to help spot COVID-19

In January 2020, the US-based software company Epic, the maker of one of the most widely used EHR in the US, released a new update to help doctors spot COVID-19 patients by standardising a [new travel screening questionnaire](#)¹⁵. Yet researchers at Duke University point out that further, rapid updates to EHR would be needed to keep track of 'new symptoms, comorbidities, risk factors, and the relevance of geographic location'¹⁶ for COVID-19 patients. Such rapid software updates, the norm for other fields, are very slow and expensive for EHRs.

In the UK: auxiliary software to help emergency room personnel

In two hospitals in London, Northwick Park and Ealing Hospitals, software is being developed as an [auxiliary to EHR](#) to help emergency rooms track the progress of COVID-19 patients and make the data immediately available to medical staff at the change of shifts. The software, Pathpoint ICU, can also group patients into cohorts based on changes in their condition.¹⁷

Cybersecurity threats to EHR

EHRs and the overall hospital information systems have been indicated as [one of the weak links](#) in the hospital cybersecurity¹⁸. The [reasons](#),

according to Urte Jakimaviciute, Senior Director at a leading data and analytics company, are: 'the interconnectedness of hospital operations, multi-institutional data sharing, the lack of appropriate safety measures and outdated information technology infrastructure'¹⁹. Hackers can make profits from selling the stolen data or asking for ransom to holding the healthcare systems hostage.

Several attacks this year either directly compromised patient data or made the entire hospital IT system non-operational.

Germany

The German company Fresenius, Europe's largest private hospital operator, announced in early May that it was the target of a cyberattack which resulted in the [publication of confidential patient data](#)²⁰.

Czech Republic

In March, Brno University Hospital in the Czech Republic, the country's second largest hospital, had to shut down its entire IT network and move its acute patients to another facility as a result of a [cyberattack](#)²¹.

COVID-19 as a stress test for EHR: protecting the EHRs and fulfilling the potential of their benefits

Collaboration with the private sector to enhance cybersecurity

At a time when health systems are stretched to the maximum, they are particularly vulnerable to cyberattacks. Joyce Hakmeh, senior research fellow at Chatham House's International Security Programme, warned that cybersecurity provisions for NHS should be considered critical and that the [private cybersecurity sector](#) should be called in for assistance²².

Resilience

Cyber resilience is '[the ability to prepare for, respond to and recover from cyber attacks](#)'²³ Perakslis and Huang, at Duke University, propose [5 steps for a better resilience of EHRs in the COVID-19 era](#)²⁴ (Box 2).

Box 2: Five steps for better resilience for electronic health records ([Perakslis and Huang, 2020](#))

1. Ensure that business continuity plans are up to date;
2. Computer system administration procedures should have a better oversight (that might include the need to stop nonessential projects and ensure data backups are in place);
3. Increase cybersecurity awareness, preparedness, and activity;
4. Consider using apps to improve or supplement information contained in EHRs;
5. The responsibility for data input could be given to personnel hired specifically for the task or designated on the spot, to reduce the burden on medical staff

Detecting medical errors

Each hospital often needs to customise the EHR software to their own IT network, which in turn can make it more difficult to keep up with changes in drug safety. Thus, even if EHRs are designed to spot medication errors, [they often fail to do so](#)²⁵.

Limits in electronic data collection systems hinder public health efforts

Bringing together data from electronic health records across thousands of hospitals is a technical challenge. [In some cases](#), forms need to be manually filled in and faxed, information cannot be sent electronically so it needs to be printed and then re-entered in databases, forms can be incomplete or take too long to fill in²⁶.

Interoperability

Interoperability is the data sharing across different platforms and sometimes among different institutions. A problem in the current pandemic, indicated by Perakslis and Huang, at Duke University, is that in usual hospital settings EHR would need to be accessible on different platforms for perhaps dozens of patients. In the current conditions posed by COVID-19 [the numbers rise to hundreds or thousands](#)²⁷.

A [study](#) done in 2019 at Imperial College London found that in the UK the NHS uses 21

different systems for EHRs and most of the NHS trusts do not share EHR information either efficiently or at all²⁸.

A major step forward for interoperability between healthcare organizations and between clinical systems was achieved in the US in March 2020 through the finalisation by the US Department of Health and Human Services (HHS) of the [interoperability and patient access rules](#)²⁹. These rules are expected to be implemented over the next two years. The rules were seen as a victory for patient rights, as previously EHRs vendors opposed efforts on interoperability fearing a loss in market share.

Top US EHR manufacturers joined a data-sharing coalition to fight COVID-19

Although not going as far as the interoperability and patient access rules passed by HHS, the US [COVID-19 Healthcare Coalition](#), a business-sponsored group, is promoting coronavirus data-sharing and analysis³⁰. Initiated by Mayo Clinic, Leavitt Partners, and several Massachusetts Institute of Technology faculty, the coalition includes healthcare organizations, tech, and non-profits.

Endnotes

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