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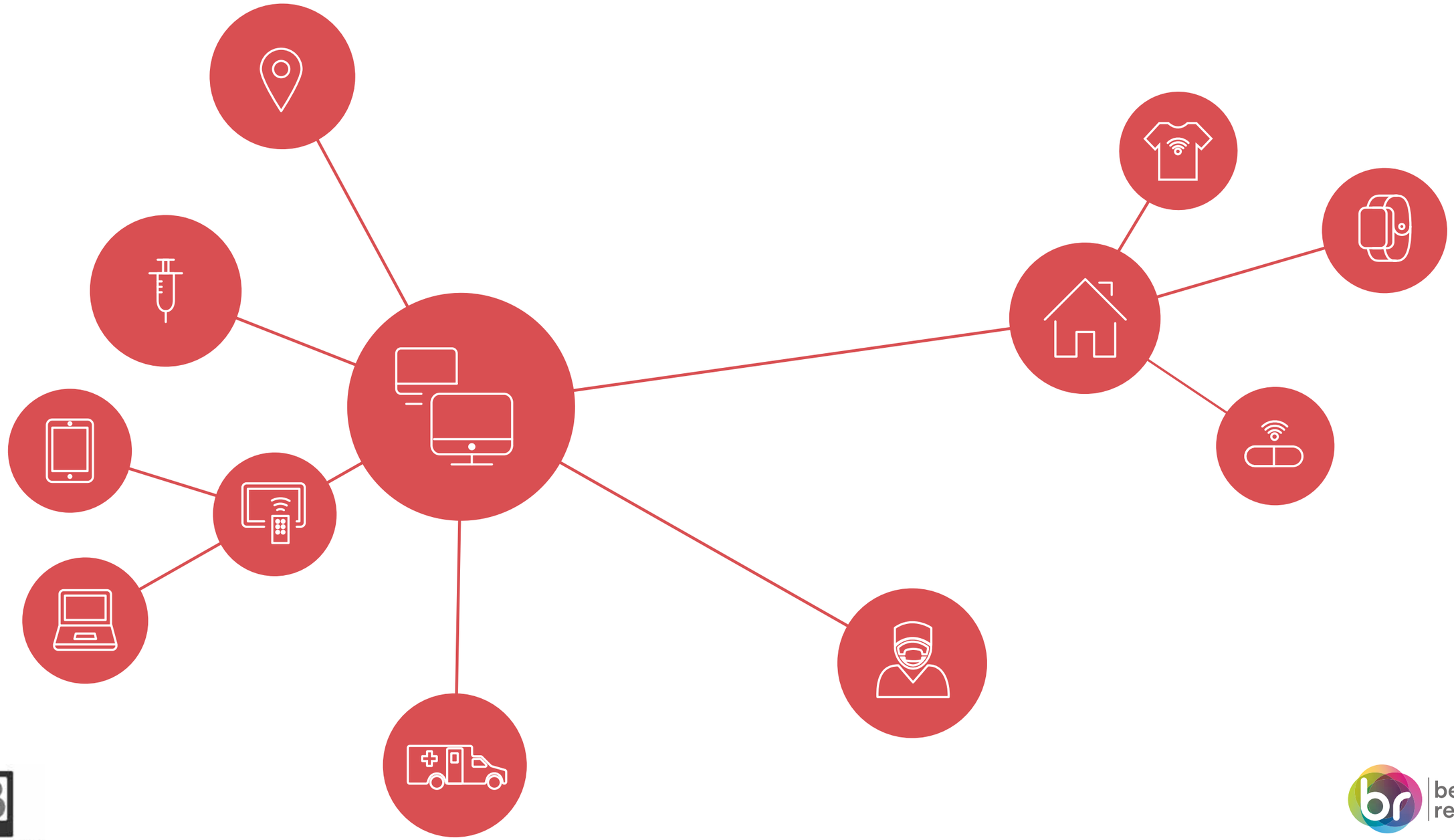

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Shaping the IoT future

Introduction »

» The Internet of Things (IoT) is becoming an enabling technology in the healthcare and pharma sectors. Broadly speaking, healthcare is delivered across a broad range of locations and interventions, but the information held regarding the subject in question is stored separately and not joined up. Here we aim to explore how IoT technology can enable an interconnected system of healthcare spaces – which range from hospitals and clinics, through GP surgeries, ambulances equipped to preserve life - to healthcare in home environments. This system must support patients and those providing treatment throughout these connected spaces, with up to date information regarding their condition and interventions.

These interventions cover treatments in institutional clinical environments (hospitals and clinics), surgeries and the patient's home. Ideally, all the information should be held in the patient's electronic health record (EHR) or electronic medical record (EMR). This information must be kept up to date so that interventions at all stages in the patient's care are documented for viewing and updating by all involved. We see the patient's electronic health record (EHR) or electronic medical record (EMR) as central to all entities having dealings with the patient. For several years now healthcare services are being computerised and digitised. Large quantities of all kinds of data are being collected from patients and stored in disparate systems. Most people think of the EHR as their only source of patient information, but patient data can be in a word processing document or a billing report, in emails or text messages.

For their part, patients themselves are now more IT and health savvy; they want to understand their conditions and participate in their treatment.

In this market brief, we are also going back in the supply chain to consider IoT possibilities upstream from patient care. These include the research and development and testing activities that lead to the discovery of medicines prior to their manufacture. «

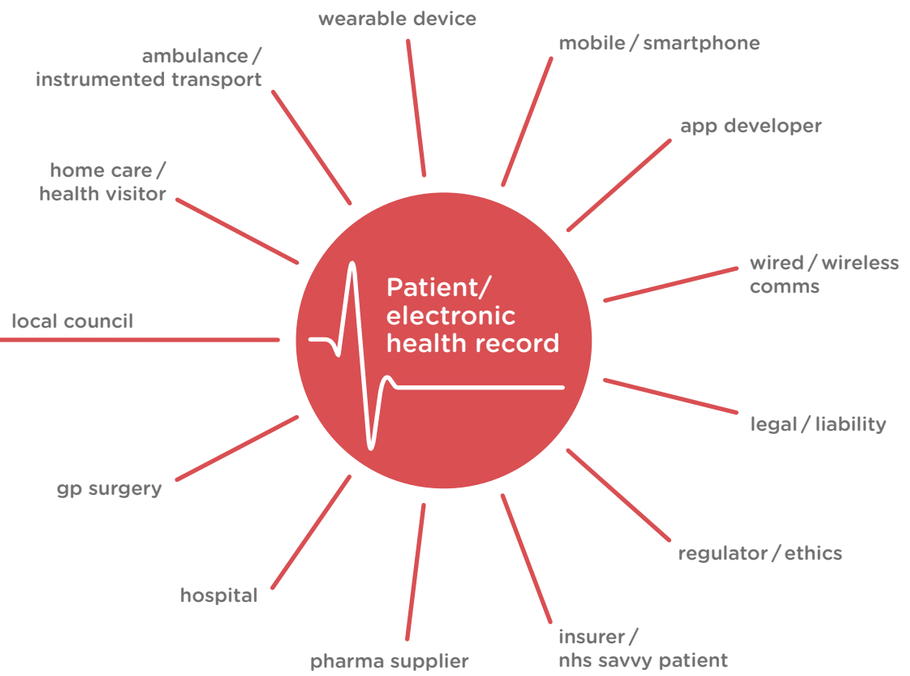


Fig. 1 Entities involved in the treatment of patients.

IOT | SECURITY | DATA ANALYTICS

Six areas of healthcare enabled by IoT

» We have identified six areas of healthcare, from medical research through pharma manufacturing to total patient care.

Institutional Clinical Environments - Bed occupancy sensors; pressure sensors; RFID tracking for drug containers; augmented reality for clinicians; body worn devices

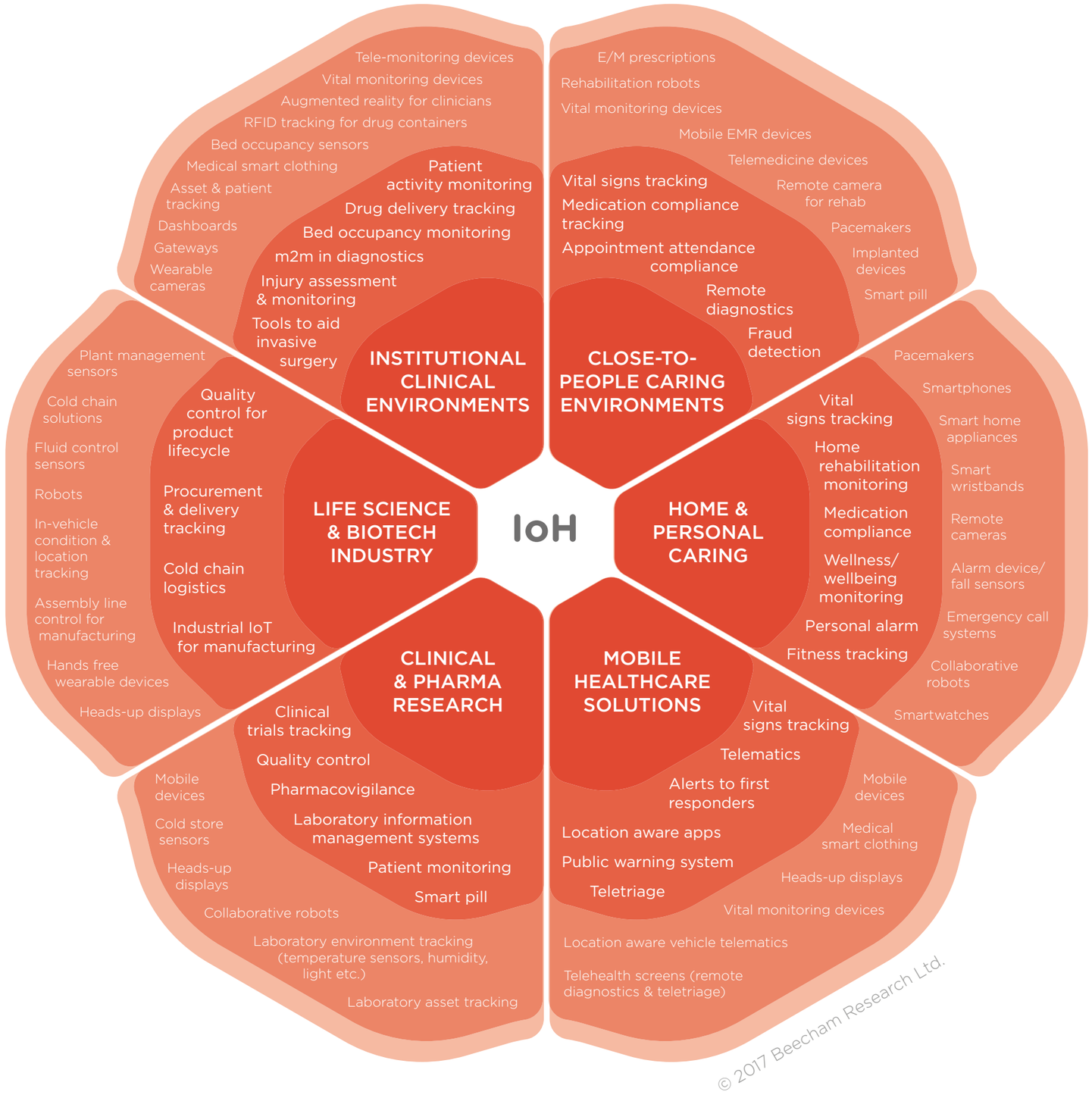
Close to people caring environments – Pacemakers; body worn devices; implanted devices; smart pill; remote camera for rehab

Home and personal caring – pacemakers; smart home appliances; smartphones; body worn sensors; alarm device

Mobile healthcare solutions – Location aware tracking device; telehealth screens for remote diagnostics and teletriage; mobile phones for public warnings

Clinical and Pharma research – Cold store sensors; sensors for laboratory asset tracking; body worn sensors

Life Science and Biotech industry – In vehicle temperature sensors; RFID substance tracking; assembly line control for drug manufacturing. «



Institutional clinical environments »

» These environments include public and private hospitals and clinics where in-patients reside for a spell. Doctors and nurses are available around the clock, with all facilities equipment needed for care and interventions, including surgery.

In the UK, the growing shortage of hospital beds, and the cost of hospital stays are placing an increasing burden on health services. There were 16.252 million total hospital admissions in 2015/16, 28 per cent more than a decade earlier (12.679 million).

The highest need and highest cost patients comprise elderly persons and those with multiple and complex conditions. Up to 70 percent of hospital beds are occupied by older people. They use a wide range of services, including in-patient care, primary care, specialist outpatient services, community nursing, and social care. Mental health is also a growing cause of hospital admission, particularly for older people.

Ways are being sought to encourage patients to avoid hospital admissions and re-admissions where possible, and shorten stay times; however for those with highest risk of emergency hospital admission, there is a need to create value from the better use of health information technology. New methods to measure human medical parameters are being researched and commercialised, and this has resulted in an explosion of new techniques and sensors to measure these parameters.

The explosive growth in medical monitoring applications is being driven by:

- The need for new types of measurements for the advancement of medical treatments
- A reduction in the size and cost of devices, together with a proliferation of device types
- The availability of semiconductor and MEMS (micro-electromechanical systems) technologies
- Adoption by the public of wearable fitness and medical products, e.g. smart watches, bracelets, clothing).

There is a raft of areas where IoT technology can be applied within hospitals – and where new ways are being sought to understand what is happening to the patient in real time and how hospital facilities (e.g. beds, machines) can be optimally utilised. They include:

- Smart pill
- Asset tracking – e.g. equipment, beds
- Patient activity tracking
- Tools to aid doctors and surgeons (robotics, augmented reality)

Many remote monitoring and other applications are still largely experimental, but there are some solutions available commercially. The US appears to be more advanced in this respect. However, there are serious issues to consider regarding security of the information and privacy (see later).

Examples of some available solutions are as follows:

- Honeywell offers an electronic patient tracking solution (for evacuation, moving patients in hospitals, tracking patients in transit, evacuating patients in an emergency).
- BodyCap, a French company, has developed an ingestible connected pill which can be used to continually monitor patients under care. e-Celsius wirelessly communicates an accurate measurement of core temperature. The e-Viewer monitor collects and stores data, and sends alarms if the temperature is under or above a set threshold. Another use of the pill is to monitor sporting and elite athletic activities to reduce risk of injury by the athlete.
- Augmented reality devices are being developed at institutions and organisations that include the National Physical Laboratory. These include headsets worn by surgeons during operations to provide them with live health data from the patient.
- Remote diagnostics – measurement and recording of heart rate and blood sugar now well established. These applications are becoming ever more sophisticated. For example, it is now possible to analyse a patient's breath to detect disease; US and Israeli researchers are developing sensors that can detect compounds in exhaled breath samples that indicate the presence of cancer in the subject. «

A new hospital design for the 21st Century

» The hospital-based model of care delivery has been unchanged for over 100 years, with the same workflows and limited bed space. Hence, the industry is ready for disruption. Since healthcare is a man-made concept, it has the potential for radical overhaul.

In the Netherlands, for example, the Orbis Medish Centrum in Sittard has been redesigned as the hospital of the 21st century. Its main features are patient centricity and ubiquitous communications. Its state of the art technology addresses both healthcare quality and security and safety of patients, including:

- Patient terminals and electronic medical records
- Patient and equipment monitoring via RFID chips
- Security installations such as access control, intrusion detection, and video surveillance
- Building automation for heating, ventilation, and air conditioning.

For complex treatments, a system of optimised workflow improves cost efficiency. This requires integrated processes, along with a seamless exchange of information. Data must be collected quickly and made available at any time, whilst being also traceable.

The project is claimed to have been successful in terms of optimised patient care and higher patient throughput with fewer resources, and a better overview and central operation of all building technology installations. «

New technology partnerships enable new models of clinical care delivery

» University Hospitals Bristol NHS Foundation Trust is working with a partnership between Microsoft, System C & Graphnet Care Alliance to transform patient engagement and clinical communications. Microsoft Azure Machine Learning and analytics will bring together patient data from a variety of sources including wearables to detect trends in people's health. The solution will use machine learning to drive new models of care and will be promoted throughout the NHS. «

Close-to-people caring environments

» These environments include general practice surgeries, day hospitals where patients visit, but also residential care homes where older patients reside, and which are equipped with some medical facilities but not to the extent of hospitals.

We can identify uses of IoT similar as well as additional to those in institutional clinical environments. For example,

- Vital signs tracking
- Medication compliance tracking
- Medical appointments attendance compliance.

Ambient Assisted Living is a methodology that gathers information about the daily life activities of the elderly at home or in a care home, in a semi supervised manner.

Caring4U is termed a study on people activity in private spaces towards a multisensory network that meets privacy requirements. It is an EU sponsored focusing on assistive solutions that enhance quality of life, including elderly persons in care homes, without impinging on their privacy. Sensors are worn by the person or embedded in their environment; these detect the activity around a physical or cognitive situation and forward appropriate data.

The system analyses the behaviour of people in private environments, using a multi-sensor network, which may involve installing cameras – it is believed that people would accept these intrusions if their privacy was assured. There are different levels of alarm triggering possibilities in different visualisations.

We also mention fraud detection, though not strictly a healthcare application. In the United States for example as well as the UK there are cases where some practitioners make fraudulent claims for reimbursement, or claim they have more patients on their books than they actually have. This has a direct effect on funding for health services and needs to be stopped. «

Home and personal caring (remote monitoring, quantified self)

» There are two types of application in use here:

- Continuous tracking of patient health – this includes remote diagnostics, assuring compliance with medication, remote consultation and remote tracking of vulnerable people (e.g. elderly)
- General wellness apps to aid living, including health conscious young persons.

There is some overlap between the two, particularly in the case of wearables. Wearables utilised for critical health monitoring may be based on the same technology as those used for general wellbeing, but they must be certified to a high level of reliability and security.
As populations continue to age and hospitals come under increasing stress, the demand for remote patient monitoring is intensifying. Remote monitoring at home is helpful during the phase of life where living alone becomes gradually more difficult but still possible, before they need to move to residential care homes. Patients who are able to remain in their own homes prefer to do so.

Smartphones and tablets are making a real difference in helping patients monitor their own health remotely. The older generation as well as the younger have embraced these technologies and can make full use of them.

In addition to ageing populations, long term chronic diseases are on the rise, often with patients having two or more concurrent conditions. It is estimated that 75 percent of the UK NHS' cost of £116 billion per annum (2015) is spent on treating chronic diseases. In addition, healthcare costs will rise to 35 per cent of UK GDP by 2050 unless innovative methods of diagnosis and treatment are found.

Whilst the government supports hospital based and primary healthcare, social care at home is provided differently, by local councils in the UK. Just as there is a looming crisis in the NHS, there is also a severe shortage of trained social care workers.

Because of this, the UK government has highlighted that the 'management of chronic conditions is a necessary and key part of achieving sustainable, effective and efficient health and social care services'. Remote monitoring of patients at home through wireless technology is an ideal way for managing chronic conditions, whilst minimising hospital visits and stays.

Sensors placed on the right part of the body can provide detailed, real-time information. Health related information gathered via body worn wireless sensors is transmitted to the caregiver via an information gateway such as a mobile phone; caregivers in turn can use this information to implement interventions as needed. Patients can be continuously monitored away from the hospital and if there is a warning sign, for example high blood pressure, medical professionals can be alerted. Remote diabetes monitoring and cardiovascular disease are the most common of these applications in current use.

Data collected remotely from patients based at home can also offer valuable insights into the effectiveness of the treatments offered by clinicians. This information can be used to craft better and more personalised recovery plans.

For elderly persons, sensors embedded in beds can detect bedsores, and fall sensors are activated if the patient falls. Sleep monitors monitor the subject's sleep patterns and other parameters. Sensors in the soles of shoes detect pressure when the patient is standing or walking, which is particularly useful for patients with diabetic neuropathy affecting the feet.

In addition to the above, new monitoring applications are continually under development. In an example provided by Fraunhofer Institution, video monitoring can be utilised to track progress in patient rehab in their homes. New training equipment and software will facilitate the adoption of this type of self care; in this way, recovering patients may actively engage in their own rehabilitation as and when it fits their own schedule.

Home and personal caring (remote monitoring, quantified self) cont.

A new wearable option currently being researched by the National Physical Laboratory and Coventry University is printing conductive circuits directly onto fibres of complete garments. This means they become part of the clothing, and allow fabrics to stretch and be washed.

UK based Kemuri offers a Wellbeing Monitor for elderly or vulnerable people living alone. Its service combines passive sensors with predictive monitoring. The KemuriSense Smart Power Socket is placed where the kettle is normally used. It measures temperature, power usage, motion, and power supply. Data is sent continuously via the Internet to a designated carer using GSM, without broadband and even during power cuts. The service learns daily activity patterns for the patient and predicts likely behaviour. If something changes, a telephone call is initiated to the carer.

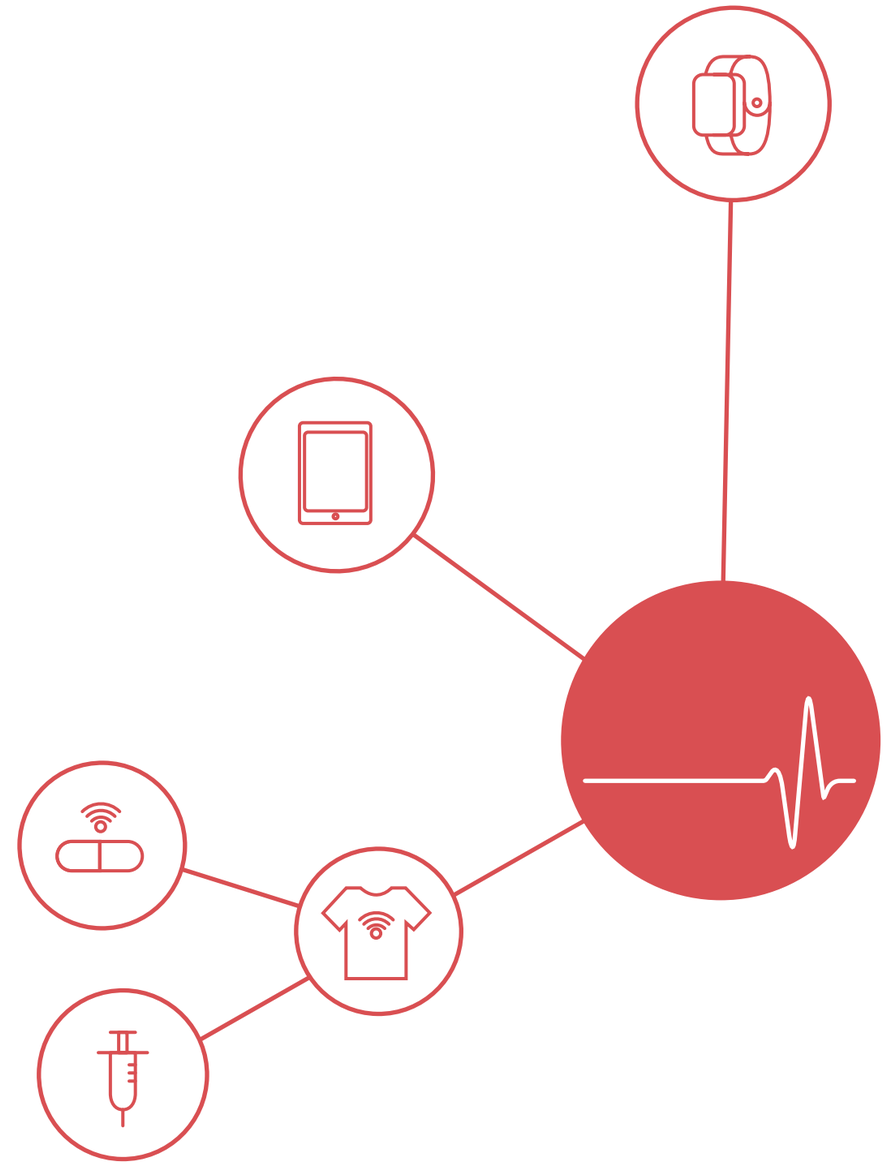
Phillips offers arrange of wearable products that include a watch that doubles up as a healthcare monitor. Fitness monitors (worn as a band) are commonly available from several sources.

Dr Now is a UK based service where patients may access to NHS registered doctors through video-based consultation, through Apple and Android devices. Prescriptions are dispensed and delivered overnight nationwide via its Now Pharmacy prescription hubs, thus saving patients a great deal of time and the need to visit a GP surgery.

In Finland, Helsinki University Central Hospital has set up a Mental Health Hub, in response to the fragmented nature of the mental health services available in the country. The online portal includes a questionnaire to understand the patient's needs. It offers advice as to where to go for professional help if they need it, but also provides self-help tools for those who do not. The system offers computer-assisted cognitive behavioural on-line therapies for depression, alcohol misuse and a wide range of anxiety disorders.

A project run by the University of Swansea is forming part of the City's creating a 5G test hub for digital innovation. This is trialling 'smart bandages' which use real-time 5G wireless technology to monitor how a wound is healing and help doctors keep track of patients' activity levels. By combining all the intelligence on the performance of the specific wound and of the patient at any time, the clinician can tailor the treatment accordingly.

Finally, developers of remote monitoring devices must be aware of new regulations, which come into force in 2017. These will affect all devices manufacturers looking to sell products in the EU, with stricter requirements being introduced in order for these products to be approved. «



Mobile healthcare solutions

» This section covers patients which have fallen ill at home or in public places, patients in transit in ambulances, as well as systems in emergency situations to assist patients on their way to hospital. These applications would include:

- Remote injury assessment
- Telematics, ambulance tracking and scheduling in case of a city-wide emergency or national disaster, and identifying the shortest or least congested route
- Government sponsored systems of public warnings in the case of an emergency, including where wireless operators will send text messages to their subscribers.

In the US, the terrorist attacks on New York in 2001 have hastened the development of better systems to help cities respond to emergencies and reach injured people in minimal time. It is said that if a person is reached within one hour of an accident, the person has far greater chance of survival. As far back as 2008, US regulators approved a plan to create a nationwide emergency alert system using text messages delivered to cellphones.

In Europe, the EU European Parliament has adopted new legislation that aims to improve the co-ordinated response to cross border health threats (Decision 1082/2013/EU). Measures include ad hoc monitoring and coordination of public health measures following serious cross border threats to health from biological, chemical and environmental events. This will entail linking relevant platforms into one overarching higher level risk management IT platform called the Early Warning Response System (EWRS), which will link to sectors within the European Commission (EC) to public health agencies for example.

European governments are also mandating mobile operators to deploy the infrastructure and technical solutions able to broadcast simple mobile messages to all their subscribers in the case of emergency scenarios. Using mobile broadcast technology or ubiquitous SMS, appropriate messages can be sent to large numbers of people in seconds regardless of the network to which they are connected. Such systems are already in use in some countries, including the Netherlands and France.

In the US, Honeywell and Iomedex have developed field-based emergency responders with hospital personnel and to enable real-time transfer of critical victim information directly from the incident site. The solution combines ruggedised mobile computers featuring advanced imaging and wireless technologies, and the IRIS (Incident Response Information System) application, providing a common platform for information exchange and emergency situation management.

Finally, NATO has developed a multinational telemedicine system that enables medical specialists to provide real-time recommendations to first responders at emergency scenes or in combat zones. The telemedicine system can be used both by the military and civilian paramedics; it allows medical specialists located in different parts of the world to assess, diagnose patients and offer real-time recommendations for treatments. First responders at the scene can connect to the system to receive expert advice from medical specialists. «

Clinical and Pharma Research

» Remote monitoring techniques similar to those used in clinical settings are also useful in some clinical trial settings. A successful clinical trial is vital prior to a drug being licensed for medical use.
Pharmacovigilance (PV) is defined by the World Health Organisation as the science and activities relating to the detection, assessment, understanding and prevention of adverse effects or any other drug-related problem.
A continuous stream of data from sensors in clinical trials will improve research efficiencies and understanding. Data collected remotely from patients being cared for at home or can also offer valuable insights into the effectiveness of the treatments offered by clinicians. This information can be used by the drug companies themselves to better understand how their drugs perform outside the lab.

In the field of the research laboratory, operations are increasingly being digitised. Information formerly recorded on paper, e.g. laboratory notebooks, is now recorded and stored electronically. Some the data recorded and stored could originate from data collected via wireless sensor networks. Analysing data collected in many ways from different sources could open up new understandings for researchers.

Capturing all laboratory data digitally allows it to be managed and accessed at any point in the laboratory workflow, from product design through downstream processes. Electronic laboratory notebooks enable safe and centralised storage and access by all interested parties, and do not belong to any individual staff member. A standardised and connected information system is also valuable for improving materials management, and a unified inventory management system creates a firm foundation for demonstrating compliance and lab safety. «

Examples of remote monitoring in clinical trials

» Remote monitoring via sensors also assists in the secure collection of patient data in clinical trials. US based Parexel provides an analytics platform which visualises subject data which has been captured remotely. The collection of clinical data via wearables and sensors in real time or more frequently can reduce the number of visual clinical assessments and/or on-site visits during clinical trials, potentially decreasing costs, whilst not sacrificing valuable data. The analytics enables real time meaningful insights into the subject's behaviour and health outside of visits. Clinical trials are subject to strict rules to maximise safety of the patient.

Medidata Solutions is an American-based global SaaS (software as a service) technology company that specialises in a cloud-based platform of applications and data analytics. It has partners Garmin in offering a location-aware solution for clinical trial monitoring. Garmin offers a wearable called vívofit which measures steps taken, distance, calories burned and hours slept. The partners are working on proof-of-concept trials and exploring the opportunity to gather new types of data and understand the relationship between that data and trial endpoints.

US-based Litmus Health is developing a clinical data science platform to assist in clinical trial management. This uses data collected at the point of experience from wearables, smart devices and home sensors. Litmus is initially focused on phases I and II clinical trials. The decision faced by pharma companies to move forward from phase II to III is an expensive one, as large sums are at stake. Pharmas seeking to get their breakthrough treatments to market faster need health-related quality of life data at the forefront of their clinical development, but sometimes researchers collect insufficient data on what has happened outside the clinic. The ability to measure outcomes in multiple dimensions remotely is key, and this solution aims to find a better way to collect data through Smartphones, wearables, and home sensors. The platform is being piloted in a clinical trial at the University of Chicago. «

Life Science and Biotech Industry

» The Life Science and Biotech industry entails specialised manufacturing processes. Industrial automation is applicable here, with m2m-based process monitoring during different stages in the manufacture. Automation and robotics would also be utilised.

The laboratory of the future will look very different from today. Legacy in-house or paper based systems have been unable to effectively track materials used for research. The use chemical inventory management from acquisition to disposal is replacing paper based systems. A centralised inventory system starts by bar-coding all chemicals on receipt. This ensures that all people needing a particular chemical substance knows where it is and how much is available. The system also holds information about the properties of the substance, its toxicity, as well as who has charge of it. This improves safety and also makes reporting for compliance purposes easier.

Xeronics for example offers solutions for operational data collection, performance monitoring and business intelligence for automation of the life science laboratory. A traceability feature allows any failure in the process to be traced back to individual devices.

Cold chain logistics ensures the correct temperature is maintained during the delivery of drugs by road. Specialised drugs could require delivery over long distances. Trucks are equipped with location-aware sensors to monitor temperatures inside the cab, as well as distances travelled. A rise in temperature to unacceptable levels, or an unforeseen delay could trigger a message sent to the supplier. Vodafone, AT&T and Digi provide chilled cabinet services and cold chain logistics.

All too often, research projects carried out in academic environments result in the publication of papers which, whilst enriching the CVs of the researchers, more often than not do not result in the commercialisation of their ideas. The EU is supporting a number of projects designed to develop technology that can be commercialised for ultimate utilisation in the health industry. These typically involve several participants drawn from universities and commercial companies.

One example of this is VINDOBONA, involving the development of bone replacement alternatives. The properties of bone are complex and hard to duplicate, but the researchers here have developed special materials meeting all needs as well as being non toxic to living tissue, making them good candidates for biomedical applications. Furthermore, the material can be shaped by a 3D printer, paving the way for improved bone replacements at lower cost. «

Mobile Applications

» The EU is currently reviewing how and where it should regulate health apps. It launched a Green Paper on mHealth in April 2014 and has been in public and wider stakeholder consultation since. Early results of the consultation are summarised as follows:

- Strong privacy and security principles are needed to build users' trust
- Interoperability and the need for standards are a necessary precondition to fully realise the potential of mHealth generated "Big Data"
- Safety and performance requirements of lifestyle and wellbeing apps are not adequately covered by the current EU legal framework
- Certification of mHealth applications is needed as a measure to ensure patient safety.

According to the Green Paper, some 100,000 apps are on sale across mobile platforms. It estimates that by 2017 more than 1.5 billion people around the world will be using these apps, generating total revenues of £14.5bn ($23bn). Moreover, in the EU alone, these apps and gadgets could reduce health costs by €99 billion.

That said, according to the organisation PatientView, it is very difficult to assess exactly how many so-called 'health apps' are on the market as many are misclassified as 'health' on app stores; it estimates there are over 125,000 'health' apps on the market of variable quality and utility.

The correct classification of such apps would therefore be helpful: the FDA revised its guidance on regulating health apps and apps that can function as medical devices in February 2015. The FDA is taking a tailored, risk-based approach that focuses on the small subset of mobile apps that meet the regulatory definition of "device" and that are intended to be used as an accessory to a regulated medical device, or transform a mobile platform into a regulated medical device.

Various app certification programmes are emerging, including the UK's National Health Service online Health Apps library, where all apps have passed a review to prove their safety and compliance with data protection rules. However the EU stresses that apps are not meant to replace doctors.

A joint analysis by GSMA and PwC estimates that the global mHealth market will reach the equivalent of US$ 23 billion in 2017, with Europe accounting for US$ 6.9 billion. Of this, remote monitoring treatment solutions constitute almost 60% of the total mHealth deployments in Europe. «

Big data analytics

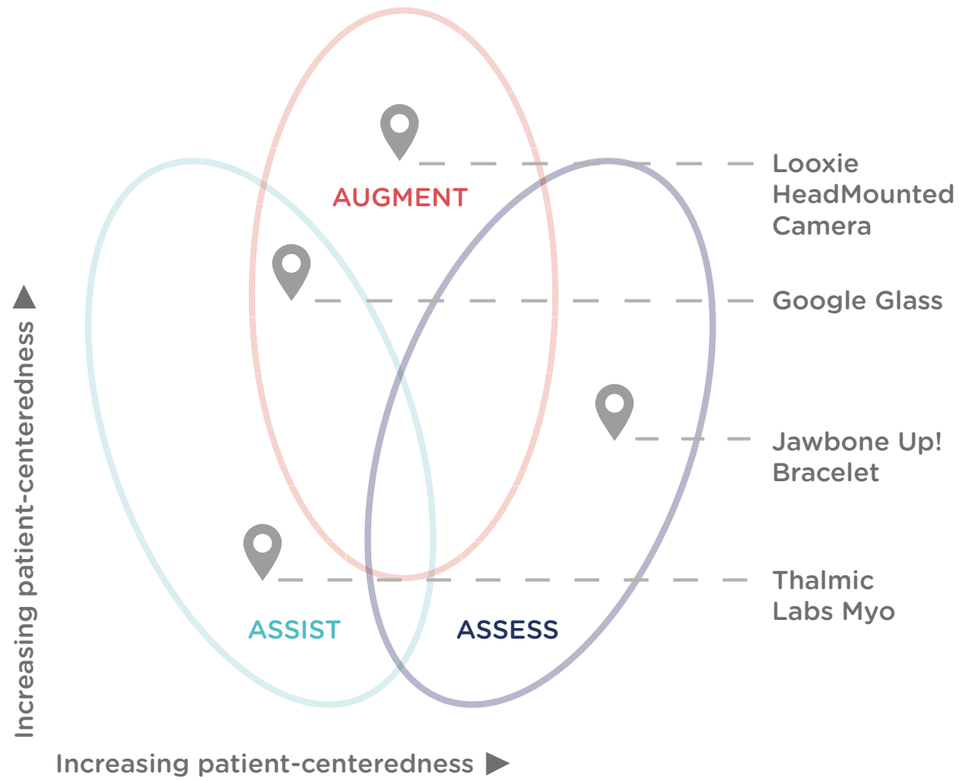
» A typical mHealth application transmits data from a device via Bluetooth or WiFi to a computer based IT system or decision support system for immediate attention and action. For the purposes of clinical and pharmaceutical research, mHealth necessitates the mining of large amounts of patient data. In addition to patient personal data (date of birth, address etc), this would include measurements taken on the patient, medical images, descriptions of symptoms and so on. The great challenge is to derive useful and actionable information from huge and disparate data.

Problems arise however from much data being held in separate silos, and also from the sheer bulk of it. Newer database technologies are continually being developed for speedy processing of large amounts of data, and new ways of gaining understanding (e.g. Hadoop). «

Evolution of Wearables and Emerging Tech (AI and multifunctional biometric sensors)

» The combined use of smartphones and wearable technology has driven the development of the digital personal health sector. There has been criticism about personal health devices on their accuracy and on their real impact on patients. Despite that, technology development is fast and able to improve various features of those devices. The availability of low cost microcontroller development boards, increasing reliable accuracy of biometric sensors, and affordable and reliable connectivity solutions such as Bluetooth Low Energy are driving the adoption of wearable devices in the healthcare space. There is a firm line between clinical wearable devices and non clinical devices, however the technology development is making that line a bit fuzzy and non-clinical devices are used for monitoring health conditions also in a preventive way. The adoption of AI algorithms in wearable devices can also further improve the entire process of observation – analysis – diagnosis – prognosis and treatment. Further development can come from multi-functional medical sensors, which are able to gather several biometric data. And, finally, the development of data analysis will further empower the necessary back-end – clinical data management system – behind those devices. «

Wearable Technology Functions Within Surgical Practice



Key Issues

» mHealth raises many issues of public concern and public health since it involves every citizen. Whilst mHealth is far from being mainstream, the healthcare industry is becoming digitised and information stored electronically. This introduces new threats, not the least being security of data from theft or from interference. When different systems connect through the Internet, the threat increases. As in other areas of technology, innovation rushes ahead faster than regulation. This raises issues of the security and reliability of medical devices, and the protection of patient data, to name just a couple. «

Security

» Lack of adequate security is seriously slowing down the adoption of mHealth. In October 2015, the on-line site BMJ Innovations reported that UK doctors and nurses routinely use their own smartphones in patient care. The researchers highlighted a risk that the current lack of data encryption could result in the inadvertent disclosure of highly sensitive and confidential data.

Hence healthcare organisations need to develop policies to support the safe and secure use of digital technologies in the workplace, and that strategies are needed to craft better policies in digital healthcare.

Moreover, patient records contain data which is more detailed than financial data that could be stolen from bank records: this includes personal data such as date of birth, address, state of health. According to Polarion, stolen medical data on the black market is more valuable than debit or credit card numbers as it includes this personal information.

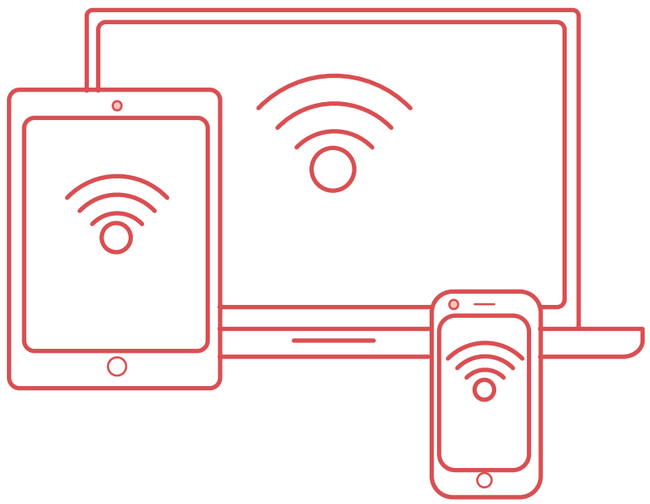
There are also issues in the formatting and trustworthiness of electronic health records. In the UK in 2014, the Epic EHR system was implemented by the National Health Service. Since then some hospitals have had problems implementing the system, which have been highlighted by the UK's Care Quality Commission. EHR usability and functionality have long been issues surrounding adoption, also raising patient safety issues.

In addition, hospitals are also increasingly coming under cyber attacks and malware infections. «

Data privacy

» The issue of whether patient data can be used in broader health studies is hotly debated. In France for example, Withings has published reports revealing the most obese cities in France and the US, as well as another study showing sleep patterns across Europe. Withings maintains that the data it collects belongs to the user only and does not compromise the privacy of the individual user's data because it is aggregated and anonymised for the purpose of identifying trends in populations.

For the public good, accredited organisations should be able to aggregate and anonymise patient data to show regional/national trends for public health purposes. Insurers may also make good use of this data to help them craft appropriate policies, and drug companies for purposes of better understanding the efficacy of their products. «



Legal issues

» According to the EU Green paper, identifying potential liability arising from the use of an mHealth solution may be complex, because of the numerous actors involved. They include:

- The developer of the mHealth solution a defective device
- A healthcare professional, any other care professional involved in the treatment
- The electronic communications provider of the Internet connection
- Inadequate training for the patient in the correct use of the device.
- Some prosecutions are said to be in progress.

The eHealth Action Plan 2012-2020 has noted that the rise of mHealth is blurring the distinction between the traditional provision of clinical care and the self-administration of care and wellbeing; the different actors involved are seeking clarity on their roles and responsibilities in this new value chain of mobile health.

Furthermore, the recently adopted resolution by the European Parliament on the eHealth Action Plan 2012-2020 underlines the need to have a clear legal framework for mHealth, to ensure its development and safe adoption. App developers and mobile platform manufacturers must be aware of the legal issues arising from the use of lifestyle and wellbeing apps, in view of the potential safety risks they may pose to citizens' lives.

Added to this, the medical profession is debating whether data collected remotely is sufficiently accurate for a diagnosis. Hence there is much work to be done in making mHealth 'safe' in every respect.

From the viewpoint of the public who are potential and actual receivers of care, they are more conscious of health issues as well as being tech savvy. They are increasingly involved in their own care; it is not uncommon to look up their symptoms on the Internet and even question the doctor's diagnosis. «

Government initiatives

» In 2015, the US President Obama launched his Precision Medicine Initiative. This will rest on the digitisation of health records, use of mobile technologies and analysis of huge amounts of medical data.

In Europe, a study published in 2015 found that Denmark is the top performer of 25 EU member states in mHealth adoption by doctors and patients. This was the largest mHealth study conducted by Research2Guidance and HIMSS, which aims to ascertain the readiness of the mHealth market in EU member states.

Five mHealth projects have received funding from the Danish government, and they will run from 2015 to 2018. They are:

- Rehabilitation at home to free up resources
- An app to help young diabetics master their condition
- Home monitoring of heart patients
- Virtual clinic to improve quality of life with fewer resources
- Home monitoring to prevent acute hospitalisations of senior medical patients. «

Conclusions »

» Traditional medicine may be where a clinician might see a patient and then prescribe a set treatment approach for a set time; now it looks as though the future may enable clinicians to tailor treatments to individuals and their lifestyle.

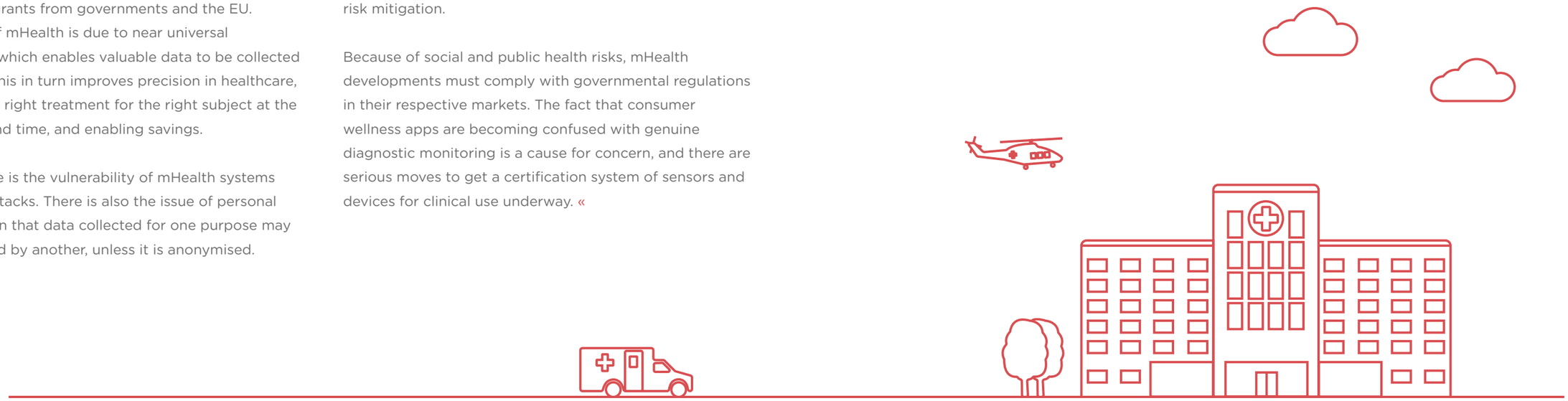
We have seen how IoT technology can be applied within hospitals, surgeries and even patient's homes, thanks to sensor based apps that allow clinicians to understand what is happening to the patient in real time. We also saw a recent example of how machine learning will be applied in conjunction with predictive technology to caring for patients in hospital.

As of the time of writing, many remote monitoring and other applications are largely experimental; however there are some solutions available commercially and new ones are constantly under development, sometimes supported by research grants from governments and the EU.
The upside of mHealth is due to near universal connectivity which enables valuable data to be collected and shared; this in turn improves precision in healthcare, providing the right treatment for the right subject at the right place and time, and enabling savings.

The downside is the vulnerability of mHealth systems to security attacks. There is also the issue of personal ownership – in that data collected for one purpose may not be utilised by another, unless it is anonymised.

That said, the sharing of cross border data would be beneficial in the case an outbreak of disease or toxic exposure. A process for linking these records would allow a more robust approach to risk assessment and risk mitigation.

Because of social and public health risks, mHealth developments must comply with governmental regulations in their respective markets. The fact that consumer wellness apps are becoming confused with genuine diagnostic monitoring is a cause for concern, and there are serious moves to get a certification system of sensors and devices for clinical use underway. «



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All research and data has been undertaken by **Beecham Research** for and on behalf of Internet of Business.

Beecham Research is a leading market research, analysis and consulting firm, specialising in the worldwide M2M / Internet of Things market. We are internationally recognised as thought leaders in this area, where we have deep knowledge of the market dynamics at every level in the value chain.

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