



IDIH

INTERNATIONAL COLLABORATION
DIGITAL TRANSFORMATION
HEALTHY AGEING

D1.3

Recommended areas to consider for international cooperation in digital health research and innovation

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(REVISED VERSION 17/12/2020)



Abstract

The report “Recommended areas to consider for international cooperation in digital health research and innovation” in the targeted countries (i.e. the European Union, United States of America, South Korea, Japan, China, Canada) proposes initial recommendations for areas for international collaboration on the basis of matrix of priorities for challenges, strengths and weaknesses and research and innovation priorities. The report will serve as an input for further consultations with experts from research, innovation and policy and gives a short synthesis of common priorities regarding the current state and future trends of digital health research and innovation.

Keywords

Digital health, eHealth, healthcare, information technology, health technology, active and healthy aging, European Union, USA, South Korea, Japan, China, Canada

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Abbreviations and Acronyms

Abbreviation, Acronym	Description
AARP	American Association of Retired Persons
AAL	The Active and Assisted Living Joint Programme
ACCRA	Agile Co-Creation of Robots for Ageing
AHA	Active and Healthy Ageing
AI	Artificial Intelligence
AMED	Agency for Medical Research and Development (Japan)
API	Application programming interfaces
AR	Augmented Reality
CEF	Connecting Europe Facility
CIHR	Canadian Institutes of Health Research (project partner)
CITRIS	University of California Center for Information Technology Research in the Interested of Society
CMS	Center for Medicaid and Medicare Services (USA)
CSA	Coordination and Support Action
DEP	Digital Europe Programme
Dx.x	Deliverable x.x
DTx	Digital Therapeutics
EC	European Commission
eHealth	Electronic Health
EHR	Electronic Health Records
EMR	Electronic Medical Records
EIP AHA	European Innovation Partnership on Active and Healthy Ageing
EIT	European Institute of Innovation and Technology
ERDF	European Regional Development Fund
ESF+	European Social Fund Plus
EU	European Union
FHIR	Fast Health Interoperability
HSCIC	Health and Social Care Information Centre (USA)
HHS	Department of Health and Human Services (USA)
IDIH	International Digital Health Cooperation for Preventive, Integrated, Independent and Inclusive Living

Abbreviation, Acronym	Description
IoT	Internet of Things
METI	Ministry of Economy, Trade & Industry (Japan)
MHLW	Ministry of Health, Labor & Welfare (Japan)
MOHW	Ministry of Health and Welfare (Korea)
MoST	Ministry of Science and Technology (China)
MoU	Memorandum of Understand
NHIS	National Health Insurance Service (Korea)
NIA	National Institute of Aging (USA)
NSFC	National Natural Science Foundation of China
NRC	National Research Council (Canada)
PMDA	Pharmaceuticals and Medical Devices Agency (Japan)
Qbit	Quantum Computing
R&I	Research and Innovation
R&D	Research and Development
RTI	Research, Technology and Innovation
S&I	Science and Innovation
S2i	Steinbeis 2i GmbH
VR	Virtual Reality

Executive Summary

This report is part of the International Digital Health Cooperation for Preventive, Integrated, Independent and Inclusive Living (IDIH) project funded under the European Union's (EU) Horizon 2020 Research and Innovation Programme. It drafts a priority matrix of the digital health research and innovation (R&I) landscape in the EU compared to those of the Strategic Partner Countries: USA, Canada, China, Japan and South Korea.

The present report "Recommended areas to consider for international cooperation in digital health research and innovation" has been elaborated as deliverable 1.3 (D1.3) in the framework of work package 1 "Preparatory Work: Analysis of the international cooperation landscape in active and healthy ageing (AHA)". The report mainly feeds into objective 1 of the project which is to "support the definition of common priorities to enhance strategic international cooperation in digital health for AHA in line with policy orientations". Hence, it identifies AHA digital health challenges and strength and weaknesses in the EU and strategic partner countries in the form of **priority matrixes**.

Common international challenges of an aging society as well as national concerns drive the Strategic Partner Countries to determine **national priorities in digital health**. Certain priorities are common between most of the targeted regions while others are rather of national matter.

A number of bi- and multilateral science and innovation (S&I) agreements have already been established between several of the Strategic Partner Countries and the EU, while there is still potential for further international cooperation. This report highlights convergences and diversities between the priorities and concludes with a set of **initial recommendation areas** for future cooperation as an input for further consultations.

The terms and provisions of the EU Grant Agreement (and its annexes) and the IDIH Consortium Agreement will prevail in the event of any inconsistencies with recommendations and guidelines defined in this deliverable D1.3.

1 Introduction

The International Digital Health Cooperation for Preventive, Integrated, Independent and Inclusive Living (IDIH) is a 36-month Coordination and Support Action (CSA) (01/05/2019 – 30/04/2022), cofounded by the European Commission (EC) under the EU's Horizon 2020 research and innovation programme, aiming to promote and increase international cooperation to advance digital health in the EU and five Strategic Partner Countries (i.e. USA, Canada, China, Japan and South Korea) to support AHA through innovation. To this purpose, **IDIH aims to identify shared priorities in all regions and to set up a Digital Health Transformation Forum as a long-lasting and expert-driven catalyst to foster collaboration between the EU and the Strategic Partner Countries.**

In more detail, IDIH has set the following high-level objectives:

- Objective 1: Support the definition of common priorities to enhance strategic international cooperation in digital health for AHA in line with policy orientations.
- Objective 2: Provide specific contributions to the international dialogue in digital health for AHA.
- Objective 3: Facilitate the exchange between research, technology and innovation (RTI) stakeholders from the EU and Strategic Partner Countries in digital health.
- Objective 4: Foster international collaboration for digital solutions for healthcare benefitting the society and industry.

The present report “Recommended areas to consider for international cooperation in digital health research and innovation” has been elaborated as deliverable 1.3 in the framework of work package 1 “Preparatory Work: Analysis of the international collaboration landscape in AHA”. The report mainly feeds into objective 1 and identifies **digital health priorities** in the targeted countries and proposes an initial matrix of priorities as an input for further consultations with key IDIH stakeholders be it funding agencies, patient and user associations and digital health professionals at industry and academia forming part of the IDIH expert groups.

The report provides an overview on the suggestive **current and future market and research trends** that could shape a future next healthcare generation by also taking into consideration the key enablers and drivers for a digital transformation. Towards this journey, the EU and strategic partner countries have to overcome several challenges that they share in common. Correlated with the strengths and weaknesses of the respective countries, we highlight convergences and diversities between the research and innovation priorities.

To round up the preparatory work we provide a set of national and international priorities worth a closer observation in form of **initial recommendation areas for future international cooperation in digital AHA related R&I**. These initial recommendations aim at delivering a basis for future discussion in the continuous dialogue esp. with policy makers and users in all international target countries and in Europe in subsequent project activities (work package 2).

Thus, the **validation of this initial analysis** will take place in 2021 by funding agencies working on digital health of the target countries as well as the European Commission. They will be sought to provide insights and feedback to the work (Task 2.3). Accordingly, this document, as well as the previous

deliverables D1.1 and D1.2 will be the basis for consultations with the aforementioned stakeholders at the EU and strategic partners' targeted regions.

2 Methodology

For this report, based on desk research and materials from the previous deliverables “Report on Trends, Drivers and Enablers” (D1.1) and “Panorama of the digital health landscape in the EU and in the Strategic Partner Countries” (D1.2), a synthesis of common priorities has been prepared in form of a 4 layered matrix. It is composed and schematised around the following elements:

- I. Description of the current and future market and research trends
- II. Priority matrix of the main challenges facing the EU and strategic partner countries
- III. Delineation and priority matrix presentation of the respective national and international priorities
- IV. Demonstration of strengths and weaknesses of the respective countries

Consequently, and as a 1st step, the current and future market and research trends in the respective countries have been analysed in D1.1 and are recurred to in this report in terms of their prevalence, pace of adoption and the underlying enabling and driving factors conducive to future collaboration specifically for active and healthy ageing. Chapter 3.1 summarises these trends as overarching determinants and lays down the first layer for the later initial proposal for recommended cooperation areas.

The 2nd step is dedicated to elaborating on the main challenges that the countries in consideration are commonly facing. This layer of the matrix is visualised in Table 1, Table 2 in Chapter 3.2.1 through **priority matrixes**.

As a 3rd step the respective digital health R&I priorities will undergo a comparative analysis in terms of intensity, prevalence and propensity for global joint efforts beyond the national characterisation. Table 3 in section 3.3. depicts these priorities

Subject matter of the 4th step will be to analyse the strengths and weaknesses of the respective countries, again in the format of a priority matrix that Table 5 and Table 4 delineate in section [3.4](#).

At a final stage, the opportunities will be weighed against the possible risks on which basis a **preliminary set of recommendations** is formulated and prepared for **further validation and elaboration with key stakeholders during the expert group fora and policy dialogues consultations** with funding authorities and user-groups. As such, this document as well as the supporting materials (deliverable reports D1.1. and D1.2) will be the **basis for consultation with funding authorities** to be carried out in a subsequent step (work package 2).

3 Synthesis of Common Priorities

3.1 Global Issues, Trends, Drivers and Enablers of Digital Health¹

The exponentially growing elderly population and the related prevalence of chronic conditions will progressively strain healthcare systems and economies worldwide. Therefore, the demand for novel technologies that support AHA will as a matter of principle increase globally. Their uptake and roll-out depends, admittedly on several factors that will be described in the following sections.

Nowadays, the current state of technology builds on the profuse implementation of all classes of **Electronic Health Records (EHR)**. The latter shall free up healthcare providers through social media, mobile applications, analytics, or cloud computing technologies, including telehealth, remote monitoring and enhanced communications to concentrate on the marrow and along the way increase efficiency, improve processes and foremost improve the quality of service.

Patients are increasingly encouraged to engage in their own health, through enabling technologies and tools such as the **Internet of Things (IoT)**, **wearables and sensors**, **telehealth**, and **digital therapeutics (DTx)**. Those technologies allow the paradigm shift of healthcare delivery away from institutions to home and mobile-based care (social-) environments.

Senior citizens wish to live long, active, healthy, and dignified lives, allowing them to age in place where they feel at home and comfortable. The development of new digital health tools such as **advanced IoT**, **artificial intelligence (AI)**, **augmented and virtual reality**, **blockchain**, **fast health interoperability** devices, and others are some several approaches observed worldwide striving to meet this demand.

Smart homes and environments enable the elderly to age at home. While interface-agnostic devices and sensors will progressively be embedded into everyday objects, **AI** based digital solutions promise to facilitate not only the continuous monitoring of patients but also the prevention of causalities way ahead before they emanate. In view of that, the onset of diseases or a disease's progression can be detected by healthcare providers at an early stage or in real-time. Already now, the combination with face to face care on-demand allows to create **hybrid health models** and is paving the way for new and emerging fields based for instance on **blockchain** or **AI** and **next generation supercomputers** (exascale or QBit).

While the prevalence of such technologies is spreading steadily, the pace of adoption varies widely across the countries under study. The underlying proper policies, regulations, reimbursement models, and incentives can incite a digital transformation in healthcare and especially AHA. They can create favourable framework condition especially in consideration of the ardent consumer demand be it patients or practitioner alike. Still, there is a considerable **need for more evidence beyond pilots** and use-cases. The **cost-benefit and efficiency** of enabling digital technologies and most importantly clearance on their **safety and security** aspects is still not certain. A prerequisite thereof is indisputably **informed-knowledge and digital skills**, which are basis for trust and acceptance.

¹ D1.1 Trends, Drivers, and Enablers of Digital Health. International Digital Health Cooperation for Preventive, Integrated, Independent and Inclusive Living (IDIH), January 14th 2020 https://idih-global.eu/wp-content/uploads/2020/01/D1.1-Report-on-Trends-Drivers-and-Enablers_v1.1.pdf

3.2 Main challenges facing the EU and strategic partner countries

3.2.1 Challenges related to digital health and ageing

The analysis of key enablers, expert consultations and interviews yield a clear picture depicting similar overarching challenges facing the EU and the strategic partners alike. Nevertheless, the respective countries under study experience these same challenges in country-specific form and with different degrees of urgency and speed. Most prominent among them is the non-revocable increase of the portion of the elderly in the global populace and the respective corollaries related to age, for instance physical and mental frailty under partly severe comorbidity conditions, loneliness and (digital) exclusion.

The following tables Table 1, Table 2 and Table 3 reflect the surveyed statements of key opinion leaders and the literature review with the recurring theme of interest i.e., understanding and later on tackling the ageing challenge. Challenges are stratified according to a number of categories to illustrate under which **health, economic and social framework conditions** policy shall intervene and convene at international level considering that federated and multilevel states be it in EU, Canada, and USA underlie logically also multilevel policy design and implementation mechanisms as compared to China, South Korea, and Japan.

Indeed, and at first glance, the **demographic challenge** seems to hit all partner countries alike and could be considered as a constant variable. However, taking into count the socio-economic and cultural embedding, parts of senior adult strata in the US, Japan and South Korea might experience more intense social isolation and loneliness in comparison to other Asian countries e.g., China where forms of extended families might seem at first glance still common and the family bonds are apparently stronger. Social isolation is not a novelty there considering the large migrations. Likewise, observations in the EU could find proof of both phenomena i.e., isolation in high-industrialised regions as well as multi-generational co-existences where families could not afford nucleus forms of living in low-income countries or afford social and care homes.

In this context, we can discern disparaging differences of the **health care systems**, not only within the countries themselves e.g., in Canada, US or EU but obviously between them. This is also true with regards of the progression of age in the different countries under study. While some countries are ageing fast, others are experiencing this growth only in recent years. Furthermore, this dichotomy can be extended not only in terms of divergent forms of **digital skills** within the senior adult cohorts but also within their ecosystems be it rural or urban.

Common to the EU and the five international strategic countries might seem to be their difference. But after closer consideration, they are having one major commonality, namely the **healthcare burden through** ageing cannot be contained for long without undertaking the necessary measures and creating the framework conditions if not to revert it then to offset it. Future and emerging technologies some of which we discussed above in Chapter 3.1 can assuage this state of affairs.

Table 1: Main challenges related to digital health in EU and strategic partner countries (Part I)

Challenge	EU	Canada	China	Japan	South Korea	USA
Regulatory framework	<ul style="list-style-type: none"> Appropriate regulatory framework for secure access to datasets across borders are not available. ENISA sees digital health networks as critical information infrastructures and has developed actions focusing on the security challenges and risks 	<ul style="list-style-type: none"> Harmonised regulation to provide coordinated digital patient centred care 	<ul style="list-style-type: none"> Chinese government is promoting a three-tiered senior care system whereby 90 percent of elders are expected to stay at home, seven percent at community centres and three percent at institutional senior care centres 	<ul style="list-style-type: none"> Long review and approval process for new technologies is considered as a high barrier for Japanese and foreign innovators and solution providers Outdated regulations 	<ul style="list-style-type: none"> Korean government has significantly expanded its support for Data, Network and AI 	<ul style="list-style-type: none"> Regulatory clearance for AHA solutions and software pre-certification are undergoing
Digital infrastructure	<ul style="list-style-type: none"> Improvements in computing capacity and performance and emergence of other digital technologies allow large data storage and advanced data analytics 	<ul style="list-style-type: none"> A strong network of academic institutions, improving infrastructure through federal and provincial funding 	<ul style="list-style-type: none"> Rapid development and application of new technologies and products such as cloud computing, big data, Internet of Things, and intelligent hardware 	<ul style="list-style-type: none"> Provision of a data infrastructure for utilization of AI in health, medical care and long-term care fields and establishment of an AI data infrastructure, 	<ul style="list-style-type: none"> Governmental strategy on maximizing national strengths such as the world's best ICT infrastructure, semiconductor and manufacturing tech. 	<ul style="list-style-type: none"> Limitations of data exchange and compatible access modalities
Interoperability of data and standardisation	<ul style="list-style-type: none"> Data is subject to different taxonomies and standards Will to establish an interoperable eco-system for digital health in Europe 	<ul style="list-style-type: none"> Canada as second largest tech sector outside Silicon Valley in the United States and solidified its position as a leader in the field of AI 	<ul style="list-style-type: none"> More than 240 health information standards for basic, data, technical and management populations In the management, processing and application of health data, China's technology is less advanced than that of Western developed countries 	<ul style="list-style-type: none"> High-speed internet almost all over Japan (still more/better WiFi access expected), and sensors 	<ul style="list-style-type: none"> Difficult to industrialise digital healthcare due to complex and redundant certification procedures and inflexible regulations 	<ul style="list-style-type: none"> Technical barriers such as lack of standards Lack of interoperability
Data access	<ul style="list-style-type: none"> Cross border secure access to datasets, shared computing and storage capacity Differentiated ability to access States citizens' personal health data across Member States, (ranging from non-existent, partial in others, to full access) 	<ul style="list-style-type: none"> Ensuring the adaption of digital technologies to an increasingly ageing population 	<ul style="list-style-type: none"> Large part of China's national population lives in rural areas, which poses enormous challenges for the collection and management of health data It is difficult for doctors to obtain long-term, stable data to manage the health of residents esp. in rural areas 	<ul style="list-style-type: none"> Smooth and fair use of anonymously processed medical information, accumulation of various data Creation of a system for collecting data (living laboratories) 	<ul style="list-style-type: none"> Lack of fundamental R&D and knowledge exchange between actors in basic research and technology development 	<ul style="list-style-type: none"> Health information is not always accessible across different systems or accessible by all users (i.e. health care providers often lack access to patient data at point of care and patients lack access to health info.

Table 2: Main challenges related to digital health in EU and strategic partner countries (*Part II*)

Challenge	EU	Canada	China	Japan	South Korea	USA
<i>Market situation</i>	<ul style="list-style-type: none"> • EU is not a fully functioning single market for digital health and care solutions • A lot of companies active in the field of digital health, but their commercial structure is very weak (thereof many start-ups). Access in the public market is challenging 	<ul style="list-style-type: none"> • Digital health technology sector in Canada is expected to continue to grow rapidly • Increasing demand from patients and health care systems • Small marketplace with 13 individual healthcare systems in place • The increased number of research institutes and incubators has spawned many AI start-ups 	<ul style="list-style-type: none"> • China ranks second globally in digital health • China's digital health industry started late but is developing at a high speed. • Digital health enterprises have become a force to be reckoned with in the world's digital health management industry 	<ul style="list-style-type: none"> • Slower digital health and limited start-up culture • Lack in Inter-sectorial collaboration for R&D: Researchers and engineers do not understand needs and workflows of care-providers who in return do not understand availability/usage of technologies 	<ul style="list-style-type: none"> • It is believed that South Korea's digital healthcare industry is continuously growing • Digital healthcare products are not yet fully integrated in healthcare services • Small market size • Innovative SMEs strive for overseas markets 	<ul style="list-style-type: none"> • Global leader in digital health investments • Health care market is still very difficult to penetrate due to regulatory principles, complexity of medicine, data interoperability • Lack of user-focused design, objective metrics to prove the tool's efficacy, and failure to test at-scale
<i>Procurement system</i>	<ul style="list-style-type: none"> • Criticalities may arise from procurement rules while addressing the issue of digital solutions' distribution and liabilities 	<ul style="list-style-type: none"> • Risk-averse procurement culture prioritizes short-term focus on cost • A procurement system that is highly regulated and impedes commercialisation 	<ul style="list-style-type: none"> • Lack of adequate resources and increasing of health and social security burdens the procurement system affecting populations in rural areas most 	<ul style="list-style-type: none"> • Lack of inter-sectorial collaboration impedes innovation entry to market 	<ul style="list-style-type: none"> • Rigid procurement system due to complex certification procedures 	<ul style="list-style-type: none"> • Access to healthcare on the based on selective ability to pay by private providers
<i>Digital literacy</i>	<ul style="list-style-type: none"> • User interfaces are a major barrier to enabling digital technologies for patients, families, and clinicians to empower ageing gracefully at home based on support services • Data protection and acceptance by end-users 	<ul style="list-style-type: none"> • Nearly omnipresent access to the internet, the widespread adoption of mobile devices 	<ul style="list-style-type: none"> • Government needs to invest more funds and primary healthcare service stations to increase the publicity and education of health management, so that more people can realise the importance and reliability of medical data collection, and thus enhance the popularity of digital health in China 	<ul style="list-style-type: none"> • Today, products are not attractive to the consumers due to the lack of communication between makers and consumers. Both healthcare and long-term care are tech-behind industries, when end-users 'IT literacy is low 	<ul style="list-style-type: none"> • Korean governmental focused on high acceptance of new technology (1st in the world of smartphone penetration rate) • Number of elderly people who are highly educated is on the rise and use smartphones are increasing • Widening social gap between urban and rural, high and low-income 	<ul style="list-style-type: none"> • Justified concern that digital literacy will impede older adults' use and reception of innovative technologies. • Operational chasm and acceptance by end-user • Trust barriers such as a reluctance to share data.

Table 3: Specific challenges related to ageing in EU and strategic partner countries

Challenge	EU	USA	South Korea	Canada	China	Japan
Demo- graphy	<ul style="list-style-type: none"> • Populations ageing across Europe: economic old age dependency ratio to rise from 43.1% in 2016 to 68.5% in 2070 in the EU • Increasing number of older people reach an age where declining physical and mental health makes them dependent on help from others and many face multiple health conditions 	<ul style="list-style-type: none"> • Americans aged 65 and older projected to nearly double from 52 million today to over 95 million by 2060 • Population is aging while there is an increase of the total population • 80% of older Americans have one chronic condition and 60% at least two chronic conditions • Social isolation and loneliness 	<ul style="list-style-type: none"> • South Korea is expected to become an aged society with more than 20% of people aged 65 or older in 2026 • Average life expectancy is 82.5 years (2015 to 2020), 114.1% higher than the global average of 72.3 years • Increasing number of elderly people suffer from chronic and combined diseases in Korea • Elderly poverty rate is 45.7%, the highest among OECD countries 	<ul style="list-style-type: none"> • Challenges for ageing population: <ul style="list-style-type: none"> (a) ageing in place (b) support to caregivers (c) supporting the ageing workforce (d) healthcare sustainability, (e) ageism and discrimination (f) keeping older people connected and active 	<ul style="list-style-type: none"> • Aging population is a relatively new trend and speed of aging is high • The over 60 population will grow from around 165 million in 2010 to 440 million by 2050, constituting 45% of the country's total population • In 2050: the largest amount of aged population among the emerging countries 	<ul style="list-style-type: none"> • The aging of the population happened more rapidly in Japan than anywhere else, and Japan now has the oldest society in the world with 28% of citizens aged 65 or more • The total population is decreasing • Solitary deaths among elderly • Loneliness and poverty of the Japanese ageing population
Healthcare systems	<ul style="list-style-type: none"> • Exponential growth of healthcare burden • Pensions, healthcare and long-term care systems risk becoming financially unsustainable • Fragmented reimbursement models in EU • Financing institutional care often resides with the older person needing such care 	<ul style="list-style-type: none"> • Combined Social Security and Medicare expenditures account for 8.7% of the GDP and are projected to increase to 11.8% by 2050 • Reimbursements for digital health technologies are not standardised in the US • Medicare expanded reimbursement to include virtual and digital services 	<ul style="list-style-type: none"> • Ministry of Health and Welfare will invest 200 billion KRW for nine years from 2020 to 2028 with a focus on preventing dementia and strengthening care services for mild dementia patients living alone or with their families at home. 	<ul style="list-style-type: none"> • A transformation of the health system is required to truly address the current needs of its citizens 	<ul style="list-style-type: none"> • Rapid increase in the average medical expenses of the elderly • The inability of young people to take care of the large aging population will create a huge demand for the nursing home industry and different senior care providers 	<ul style="list-style-type: none"> • Health-care system provides universal coverage, including both medical care and long-term care • Increases in medical expenditures • Labour shortage of the healthcare and long-term care
Policy	<ul style="list-style-type: none"> • Active ageing is EC's policy to contribute to the economy and society • European innovation partnership on AHA to foster innovation promoting active ageing and raise healthy life expectancy • Chronic diseases can restrict the independence of older people 	<ul style="list-style-type: none"> • Approximately 35% of all older adults report some type of disability • Not enough US federal funding for the elderly 	<ul style="list-style-type: none"> • Korean government adopted a National Strategy for AI under the vision of "Toward AI World Leader beyond IT" 	<ul style="list-style-type: none"> • The refreshed strategic plan (2019-2021) aims to ensuring the adaptation of healthcare and services to an aging population as a key priority • Supporting research focused on advancing digital and eHealth innovations 	<ul style="list-style-type: none"> • Chinese government sees ageing a top priority for provinces facing fast-aging population • China's "National Planning Guideline for the Healthcare Service System" aims at engaging more with technological and internet-based healthcare solutions. 	<ul style="list-style-type: none"> • Administrative sectionalism, so called "vertical administrative wall" of governmental offices is one of the biggest problem in Japan and creating the inter-sectional collaboration as a challenge

3.2.2 Relevance of Digital Health Challenges for AHA and Future Cooperation

As seen in the previous section, notwithstanding the regional peculiarities and the varying level of intensity, digital health solution providers and healthcare customers, patients and practitioners alike have to deal with intrinsic stumbling blocks beyond their geographical boundaries. Indeed, in order to **alleviate the healthcare burden and provide favourable conditions for AHA** through among others, the **introduction, adoption or replication and transfer of novel technologies and solutions**, there is a need to consider these framework conditions. They can be summarised under the following theme complex:

- **Market framework conditions:** Numerous players and stakeholders are building networks on a national and international level with the aim to address the demands of AHA and digital health and to promote collaboration and support at multiple levels. Still, the access of new technologies to the market is difficult due to health policy regulations that only partially or hardly includes novel digital health solutions. The complex procurement and reimbursement procedures should reflect innovations in AHA and be adapted to include these novel technologies. The same is true for the varying standards and certification modalities of software and applications for AHA. In addition, risk impact assessment studies especially on digital solutions in health are still pending which makes future investments in terms of procurement hard to mobilise as the return of investment and the necessary incentives are not obvious, clear and tangible.
- **Regulatory issues, including, secure access, safety and ethics:** It remains challenging for healthcare organisations to optimise their services and for researchers to make the scientific achievements that are needed to support early disease diagnosis, coordinate response to epidemics and accelerate therapy development without cross-border secure access to datasets, shared computing and storage capacity and an appropriate regulatory framework that allows for secure access to datasets across borders. Senior adults are double punished in the sense that e.g. the use of taxonomies and uneven or lacking standards for evidence-based research fails already at the cradle of research before they could reach the market. In addition, new technologies do not move beyond proof-of-concepts or regional boundaries as data is strictly restricted. Consequently, promising concepts of large impacts cannot be verified nor tested in other regions and stay thus regional inventions. Likewise, ownership and ethical handling of patient data play a major role in the uptake of emerging technologies.
- **Public and private mobilisation of funds related to ageing:** Relevant key programmes and funding agencies are supporting collaboration on a national and international level facilitated e.g. by the Multiannual Financial Framework of the EU and other financial frameworks at EU level and internationally through several programmes (described in the D1.2 Panorama of the digital health landscape in the EU and in the Strategic Partner Countries). Nonetheless, through its transversal nature digital health research and innovation is still mainly considered as an economic factor (silver economy) rather than a multifaceted field of further research and development for its own merit. Therefore, breakthrough innovations in AHA are in danger of falling under the monopoly of data tech giants. Furthermore, there are relatively few investments specifically targeting ageing per se. Thus, further international demand for cross-border projects seems to be evident and could close the gap of funding at national and regional and at the international level with long-term strategic investment in priority research of mutual benefit (see next sections 3.3)

3.3 Research and Innovation Priorities in the EU and in the Strategic Partner Countries²

The central importance of digitalisation in the healthcare sector is internationally recognised for its potential to contribute to higher quality therapeutic decision-making and treatments as well as to an increase in the process and operational quality of health services. Additionally, digital solutions can substantially contribute to preventive care and diagnosis.

The following matrix (Table 4) gives an overview on the relevant research and innovation priorities in digital health and AHA in the EU and the Strategic partner countries. There are **3 interrelated factors** upon which such an undertaking depends. They are worth considering as possible fields of collaborative research and innovation beyond national borders as they require a special attention not only from the research and patient end-user side but also the policy and payers/funding agencies:

- **Data management**
- **Interoperability**
- **Infrastructures**

In addition to the technical usability, digital health solutions are of relevance only if data is available and manageable. While data volumes are not a big issue but rather a problem with an ever-growing production, consume and transfer of especially picture and video material, accumulating pertinent data is a twofold ordeal. On the one hand, it is not easy to access information especially patients' sensitive data without consent and legal clearance. On the other hand, the availability of huge amounts of data of heterogenous origins, formats and indications are practically useless if there is no interfacing and interoperability tools in place to mine, analyse and translate these data into meaningful information. Therefore, the next-generation healthcare requires not only solid infrastructures to host tremendous bulks of data but also carry out intricate computation processes for complex health questions.

² D1.2 Panorama of the digital health landscape in the EU and in the Strategic Partner Countries. International Digital Health Cooperation for Preventive, Integrated, Independent and Inclusive Living (IDIH), May 30th 2020, unpublished.

Table 4: R&I priorities in digital health of EU and strategic partner countries

	EU	Canada	China	Japan	South Korea	USA
Health topics	<ul style="list-style-type: none"> Personalised medicine (through shared European data infrastructure) 	<ul style="list-style-type: none"> Healthy ageing Solutions for complex health challenges (Multimorbidity) 	<ul style="list-style-type: none"> Personalised medicine Health promotion, disease prevention, diagnosis, management, rehabilitation and palliative care 	<ul style="list-style-type: none"> Lengthen life expectancy Preventive care Personalised medicine 	<ul style="list-style-type: none"> Quality of life in an ageing society 	<ul style="list-style-type: none"> Interpersonal and societal factors of ageing, (caregiver burden) Age-related diseases, disorders, and disabilities (Alzheimer’s and dementia)
Data management	<ul style="list-style-type: none"> Citizen’s secure online access electronic health records Sharing of health data (EHR), also across borders Protection of personal data, interoperability and R&I funding 	<ul style="list-style-type: none"> Electronic health records (eHealth) 	<ul style="list-style-type: none"> National electronic health records Regional medical information and service platforms 	<ul style="list-style-type: none"> Curated national health dataset for use by third parties and accurate machine learning models (Japan Vision - Healthcare 2035) Protection of personal data, interoperability 	<ul style="list-style-type: none"> National electronic health records Regional medical information and service platforms (intelligent, voice-based) 	<ul style="list-style-type: none"> Electronic health records (eHealth) Citizen’s access to telehealth services particularly seniors in rural areas and increase access to primary care services and telestroke
Inter-operability and Tools	<ul style="list-style-type: none"> Electronic health records Digital tools for citizen empowerment and person-centred care AI for health Big data sharing 	<ul style="list-style-type: none"> Electronic health records (eHealth) Data-intensive research 	<ul style="list-style-type: none"> National electronic health records Big data sharing 	<ul style="list-style-type: none"> Information and Communication Technologies, IoT and AI as tools of social innovation Big data in combination with AI 	<ul style="list-style-type: none"> Digital health care service technologies (robots, bioengineering, AI) Big data sharing AI platform for accelerated drug development 	<ul style="list-style-type: none"> Electronic health records (eHealth) Public health supported by mobile devices (mHealth) Health technologies: IoT, AI, blockchain to improve access to care, reduce costs, improve health outcomes
Infrastructure	<ul style="list-style-type: none"> Shared European data infrastructure High performance computing 	<ul style="list-style-type: none"> Increased infrastructure complexity and infrastructure digitalisation 	<ul style="list-style-type: none"> Large data infrastructures Regional medical information platforms 	<ul style="list-style-type: none"> Large data infrastructure for AI 	<ul style="list-style-type: none"> Large data infrastructures Regional medical information platforms 	<ul style="list-style-type: none"> Electronic Health (eHealth) infrastructures Health information sharing
Health care system	<ul style="list-style-type: none"> Better understanding, improved functioning and efficiency of complex health systems. 	<ul style="list-style-type: none"> Diversification of available healthcare and AHA services Health system financing, funding, and sustainability Creation of Learning Health Systems & next generation of researchers with the skills to partner in health system learning and transformation 	<ul style="list-style-type: none"> Health Information standardisation Internet-based medical diagnosis and treatment Digital health solutions for a more sustainable and accessible and affordable health care system 	<ul style="list-style-type: none"> “Society 5.0” - Creation of Next-generation healthcare system providing solutions to the ageing population Education of medical professionals and healthcare workers using AI in training facilities 	<ul style="list-style-type: none"> Diversification of available healthcare and AHA services Digital government: Public services Increased demand for care services, healthcare services, safety services and lifelong education services 	<ul style="list-style-type: none"> Expanding telehealth services that will benefit seniors in rural areas and increase access to primary care services and telestroke (Chronic Care Act) Reducing hospital readmissions (Independence at Home (IAH) model)

3.4 Strengths and Weaknesses of the respective countries

A common denominator and logic line described in the previous sections is the necessity to address the **specific needs of ageing societies** throughout the globe. Efforts are being made to ensure **equitable access to health services and care**. Still, the propensity of the elderly being discarded and undergoing the risk of drifting in a potential **grey digital gap** is especially higher the more they retract from active life and retreat into the societal peripheries. Therefore, the elderly contribution is negligible to pure consuming units especially in the product design. This weakness can be attenuated through digital health solutions anywhere and anytime empowered by those mostly affected i.e. the senior population. Still, it is a double dilemma as seniors are well years away from active life in their well-deserved retirement but also as skilled personnel that are a much-anticipated guest to fill in an ever-growing schism. Consequently, **co-creation** does hardly ever take place.

A further common denominator and at the same time a common weakness is that the **majority of the solutions are provided by SMEs and start-ups** in an over-proportional relation to the large corporates. But the former has gigantic difficulties accessing an **overregulated healthcare market** and gaining insights into the **fragmented procurement** and **reimbursement** official spelling rules, let alone the still **unclear regulatory requirements** concerning novel digital health solutions.

The other side of the coin is the still ambiguous evidence of **cost-benefit equation for patients in hospitals**, elderly at home or social residencies, or healthcare providers and payers. The former is used to digital health applications for almost free of charge and the latter are expected to invest upfront in refurbishing their facilities with new infrastructures and tools.

In contrast to the above, the EU and the strategic international partners demonstrate both complementarities e.g. the different strengths be it favourable **regulatory framework conditions** for entrepreneurship for instance in Canada, China or US or **advanced progress** in future and emerging technologies e.g. AI, IoT or robotics, or **reimbursement standards** in Japan. These converging areas open the door to future opportunities for potential venues of collaboration, synergies to explore beyond the geographical interfaces and good practices for peer-to-peer learning.

Table 5 and Table 6 in the following pages summarise the weaknesses and strengths in digital health of the EU and the strategic partner countries.

Table 5: Weaknesses in digital health of EU and strategic partner countries

Weaknesses	EU	Canada	China	Japan	South Korea	USA
<i>Political and regulatory framework</i>	<ul style="list-style-type: none"> • Fragmented policies • Fragment reimbursement models and research investments • Solution distribution difficulties arise from procurement rules 	<ul style="list-style-type: none"> • Regulatory challenges to consistently integrate digital health solutions across Canada 	<ul style="list-style-type: none"> • Low confidence in elderly care system • Increasing health insurance costs • One-Child policy 	<ul style="list-style-type: none"> • Complex standardisation procedures 	<ul style="list-style-type: none"> • Lack of concrete measures and strategies to keep policies and welfare projects for the elderly financially stable • The social security system is vulnerable 	<ul style="list-style-type: none"> • Misaligned incentives that can drive stakeholders away from patient-centred care
<i>Infrastructure & Technology</i>	<ul style="list-style-type: none"> • Many eHealth companies are start-ups and access to the public market is challenging. • Very few investors, low willingness to risk capital to support innovations and disruptive business models • The grey digital gap - low internet usage by elderly • Uneven internet access and usage and lower digital skills (senior adults and practitioner alike) 	<ul style="list-style-type: none"> • Weak entrepreneurial culture among academics in this area • Access to health data can be challenging 	<ul style="list-style-type: none"> • Growing spending capacity in large infrastructures • Growing propensity of cybersecurity attacks and proper use of data • Access to data in remote areas 	<ul style="list-style-type: none"> • Lack of inter-sectoral collaboration prevents investments and mobilisation of funds 	<ul style="list-style-type: none"> • Commercialisation of technology, sector-specific linkage and personalised management is difficult • Small market size • Complex certification procedures 	<ul style="list-style-type: none"> • Digital health innovation focused on the young and healthy
<i>Health care system</i>	<ul style="list-style-type: none"> • Fragmented procurement and reimbursement system • Lack of qualified digital workforce 	<ul style="list-style-type: none"> • Challenge of integrating digital health solutions into the health and social system due to lack of cost-benefit analyses 	<ul style="list-style-type: none"> • Inefficiencies (over-utilisation of large hospitals and the underutilisation of smaller facilities) • Compared with Western countries, quality of healthcare in China is still lagging behind • Unbalance service quality between urban and rural areas 	<ul style="list-style-type: none"> • Healthcare labour shortage • Administrative sectionalism and conservative attitude of professionals 	<ul style="list-style-type: none"> • Exploding medical expenses for the elderly population • Social gap between rural and urban, low and high income 	<ul style="list-style-type: none"> • Non-standardised and incomplete reimbursement models for digital health

Table 6: Strengths in digital health of EU and strategic partner countries

Strengths	EU	Canada	China	Japan	South Korea	USA
<i>Political and regulatory framework</i>	<ul style="list-style-type: none"> • Clear mandate to ensure equitable access to high-quality health services for everyone living in their countries. 	<ul style="list-style-type: none"> • Demonstrated ability to work collaboratively across institutions, sectors and countries 	<ul style="list-style-type: none"> • Existence of important networks in the field of digital health, which work coherently as the mainstay of digital healthcare in China. • Increasingly favourable regulatory environment (reforms of health system) 	<ul style="list-style-type: none"> • Strong investment in digital health research and development 	<ul style="list-style-type: none"> • Growing R&D investments for digital health projects • Eagerness for leadership in the digital healthcare market 	<ul style="list-style-type: none"> • Commitment to advancing health technologies • Provision of unparalleled opportunities and incentives for entrepreneurship • Creation of favourable entrepreneurial environment
<i>Infrastructure & Technology</i>	<ul style="list-style-type: none"> • Strong individual research and innovation infrastructures • Considerable industrial and public data sets 	<ul style="list-style-type: none"> • Excellent capacity in all aspects of digital health, including AI 	<ul style="list-style-type: none"> • World's highest rates of highspeed internet & mobile phone-use • Widespread adoption of new technologies (mobile devices, cloud computing, big-data analytics) • Mature market on digital solutions • Large amount of data that can be used for disease prediction and diagnosis 	<ul style="list-style-type: none"> • Leader in micro-electronics, robotics and AI • Advanced digital technology market 	<ul style="list-style-type: none"> • Familiarity with digital technologies 	<ul style="list-style-type: none"> • Largest digital health hubs and research centres established in US
<i>Health care system</i>	<ul style="list-style-type: none"> • Strong individual health systems and support services 	<ul style="list-style-type: none"> • Public health and social systems are open to include digital health approaches 	<ul style="list-style-type: none"> • Development of Electronic Medical Records (EMRs) and improvement of the hospital information systems 	<ul style="list-style-type: none"> • Well standardised reimbursement system • The Integrated Community Care System (ICCS) allowing elderly to receive intensive nursing care at home 	<ul style="list-style-type: none"> • The nation's interest in lifecycle healthcare through digital health increases. • More SMEs offering holistic care services with innovative technologies & cooperation 	<ul style="list-style-type: none"> • Although fragmented with inconsistent funding streams for healthcare services, Center for Medicaid and Medicare Services provides nearly universal coverage for American seniors

Hereafter, though the regulatory framework conditions are complex or fragmented, there is a strong commitment in all countries to **promote a digital transformation in health** and address the ageing challenge. Pre-commercial procurement procedures involving public and private stakeholders can help convert this weakness into a strength. By involving these divergent stakeholders with the adult senior at the centre, novel models and use cases can be explored and de-risked that also have the propensity to be deployed and absorbed by both procurer and user alike. The smart mobilisation of funds in these models have been proven for instance at EU level in the framework of Horizon 2020 and in the new Horizon Europe programme through instruments e.g. Public procurement of innovative solutions actions, Pre-commercial procurement or innovation and market deployment actions. These and similar instruments in and open for the strategic countries, notably SMEs and start-ups can accelerate the testing, validation and uptake of novel solutions that are standardised, regulatory conform and utilised.

Even though, certain bi- and multilateral S&I agreements have already been established between some of the strategic partner countries and the EU, there is still great potential for specific arrangements tackling digital health research and innovation specifically dedicated to ageing. Increasing international cooperation in the field of digital health will help to further **harmonise common priorities and standards**, enhance **peer-to-peer learning** and allow to better understand local discrepancies and thus explore synergies and complementarities.

Needless to state that beside common targets that concern all or most countries, several strengths are rather related to regional and national matters due to regulations, capacities and national health funding programmes. Still and as depicted in Table 6, Japan as leader in medical care and welfare technologies by utilising robotics for home care, big data together with the excellence of AI in Canada can profit from the largest digital hubs in the US and the general receptiveness of the ageing population in Asia in adapting novel digital health solutions with e.g. China boasting with the highest rate of highspeed internet and digital testbeds alongside the supercomputing capabilities in US and the research infrastructures in the EU.

These converging areas constitute a **preliminary set of recommended** topics summarised in the next section that will be subject matter that should be explored into detail by the expert groups and stakeholders of IDIH.

4 Recommended Areas for International Cooperation in Digital Health Research and Innovation for Active and Healthy Ageing

Even though relevant key programmes and funding agencies are supporting collaboration in digital health R&I on a national and international level facilitated e.g. by the Multiannual Financial Framework and other financial frameworks, there are relatively few international S&I agreements between the EU and the Strategic Partner Countries, especially with Asia. Thus, further international demand for cross-border projects seems to be evident, particularly in order to address the challenges of active and healthy ageing with digital health solutions in a globally coordinated manner leveraging on each partners' expertise.

While the EU and the Strategic Partner Countries are jointly facing a **common challenge**, namely that of an aging population, they are also confronted with similar issues related to:

- **Insufficiency of essential regulatory frameworks** regarding ethical and security issues on eHealth data access
- **Highly regulative and impeding procurement systems**
- **Complex certification procedures** that hinder the industrialisation of digital healthcare, the development of related start-up cultures, and hence the growth of the digital health market
- **Lack of necessary funding for research and development** which is either not available in sufficient quantity or scattered across different funds and objectives.

There are **several analogies** across the EU and its Strategic Partner Countries as to their **major priorities** regarding digital health for AHA that are listed below with supportive trends and drivers (as symbolized by ) that are listed below:

Health topics

The countries under study have recognised that a combination of R&I measures need to be taken into consideration to alleviate the healthcare burden through ageing and support AHA for all. This includes:

- **Understanding the complex health challenges arising from multimorbidity** of the elderly related to ageing is key for providing an effective treatment, improving life quality and averting critical conditions. This requires holistic approaches to tackling these challenges combining multidisciplinary efforts ranging from omics research to nutrition and the impact of the environment through socio-economic as well as cultural and gender specific aspects on health that might widely differ.
- **Personalised medicine** for more effective, adult-centred solutions for the senior population. Personalised Medicine takes up the unique genetic and molecular profiles for faster diagnosis and personalised treatment with lesser side effects with the deployment of data-oriented health management. The use of big data fit-for-purpose requires common standards and

foremost transparent and ethically right user access that need concerted action on a global level.



AI often serves as a transversal technology tier behind digital health products and logically AHA solutions. Combined with IoT, AI translates large quantity of device-generated data based upon self-learning algorithms into actionable information and enables to identify patterns and to make suggestions or acts upon them.

- **Measures for health promotion, disease prevention and care at home**

Health promotion and the prevention of disease are priorities that prevail in prominent position at the preambles of health system programmes. Providing inclusive, integrated and independent care starts with the promotion of healthy habits and preventive actions. Countries have developed strategies and programmes to tackle the challenge of their ageing society differently. Still, there is a clear potential for mutual learning on the deployment of digital solutions to foster healthy and active ageing e.g. Apps promoting healthy dietary habits, physical movement and monitoring tools for activity or observance of medication intake.



Augmented Reality (AR) / Virtual Reality (VR) can be an expedient tool to provide guided physical and mental rehabilitation services and help reduce social isolation and loneliness among the adult senior population. The deployment of such tools needs further understanding of the complex (socio-mental) mechanisms of ageing and can contribute to both rehabilitation and wellbeing in AHA.

- **Social challenges regarding health care and inclusion of elderly people**

Due to insufficient health coverage and increasing social isolation of the elderly, social inclusion measures go beyond technological systems and solutions that facilitate inclusive living of the elderly at home or outside. The major challenge is about the adaption of enabling technologies in daily life to enhance quality of living. Digital literacy programs for the seniors and technical assistance to elders is a key element for the adaptation of such services into daily activities of the elderly. Covid-19 pandemic underlines the severity digital divide could cause and underlined its importance of this aspect

Infrastructures

In the field of digital health, **data infrastructure improvement** and **enhanced data exchange** is one of the main priorities for the EU and most Strategic Partner Countries. Corresponding topics like an **empowerment of citizen's** through access to their health data and the **standardisation** of health information to facilitate relevant research are intended. Large research infrastructures are not only costly crucial investments but also facilities that shall not necessarily be available in every next centre but decentralised and interconnected in possible excellence centres or single flagships e.g., CERN or similar. These could allow science excellence gathering large interdisciplinary groups from several domains and at the same time creating value for AHA in e.g., personalised medicine and research in complex health systems related to ageing for instance.

- **Data infrastructure improvement and enhanced data exchange**

secure and interoperable ICT infrastructures and data networks are urgently needed. While it is apparent that the exchange of data can contribute to raising the quality of care, this exchange of data is still limited. The existing digital infrastructure in the healthcare system is lagging behind in comparison to other sectors. Those already in place are only to a limited extend, suitable for data exchange outside of a specific organisation and less the case outside a region or continent.



Blockchain has been suggested as a secure solution for the health care domain to accessing, storing and managing medical or clinical trial records. Blockchain can help capture medical device data, access to patient history, medical records, or insurance network information. It can help make informed medical decisions sensitive to the patient's insurance coverage or distributed patient consent and clinical trial data records to avert false medication and enhance recovery or even enable patients to allow access to part of their health data for researcher. Similar to AI as a "backend" technology and trend, it can unleash its potential for AHA when considered in a larger concept of solutions and framework conditions

- **mHealth for monitoring for prevention and close control of chronic patients**

mHealth solutions contribute not only to a connected living in communities of interest but are deployed for close monitoring of health and as assistance aids to manage daily life. In addition to digital and health literacy, solutions shall be adapted when designed and created to adult seniors in terms of user experience, usability, reliability and technical security



DTx are not just mere health monitoring tools informing patients or senior adults about healthy behaviours but can treat conditions including coaching, and clinical support either in conjunction with or as a replacement for a medicine or other traditional therapy or diagnostic tool. DTx can contribute to AHA

Data Management and ethics

Scientific achievements need access to not only infrastructures but also to data and knowledge. Without cross-border secure access to datasets, concepts with potentially substantial impacts to humanity can be neither proofed nor tested and are doomed to never emanate. Therefore, while data is the new gold, an ethical frame shall be put into place to allow the protection of data and at the same time the responsible usage of such data as the propensity of new technologies and digital solutions to enter the market will depend on how what data is owned by whom. A further converging theme is that digital health solutions can alleviate a possible state of affairs where frailties and comorbidities through age could be predicted, prevented, and observed. Key enabling technologies can play a pivotal role through novel “thera-gnostic” tools.

- **Citizen’s empowerment through access to health data (EHR)**

Electronic medical records are at the same time the cornerstone of major health related services and a curse considering that large data are not digitalised or accessible. EHRs enriched digital health solutions be it social media, mobile applications, analytics, and cloud computing in short SMAC - technologies, including telehealth, remote monitoring and enhanced communications is one of the most powerful tools still to be fully exploited. EHRs can empower health care stakeholders through the deployment of the above-mentioned enabling technologies. Users are equipped with tools that allow them to access their health data, comprehend and manage their own health and relationships in this value chain.



EHRs can contribute to an efficacious data and enable improved care delivery workflow and thus a coordinated and integrated care. It should become the foundation for digitally connected care of senior adults and an ageing population. However, they are still not fully integrated in the healthcare workflow thus still siloed. So, while available, their benefits are only partly reaped due to other factors e.g. interoperability and reluctance of healthcare providers to access data, among others.

- **Sharing and analytics of big data for disease prediction and diagnosis**

The transfer and sharing of data beyond the geographical and research borders is strictly regulated and is under ethical constraint rather hardly possible. On the one hand, this is an important prerequisite for gaining trust and guaranteeing security and private privacy of the citizens. However, the circulation of data, samples and knowledge impedes breakthrough innovations in emerging fields e.g. precision medicine but also intensifies redundancy of research and learning from failures or early decision making e.g. in translational medicine or new drug developments.



Digital Biomarkers could also revolutionise both the diagnostic and therapy market and pave the way for thera-gnostics. Digitally conducted analyses can identify through EMRs and from remote locations using sensors and wearables data symptoms or indications of frailty. Combined with other data analytic techniques and simulation technologies, reduce physical intervention and favour remote diagnosis and

Interoperability

Despite a few island solutions for specific applications and programmes or services, that overcome compatibility hurdles, **interoperability standards** through fast healthcare interoperability resources (FHIR), application programming interfaces (APIs) or other adequate alternative technologies should be a high priority issue at transnational level. Standardised data transfer and enhanced data exchange (as described in the previous section: *Infrastructures*) will not only allow collect data but also process it into meaningful knowledge (e.g. need for clinical trials to run in many countries to come up with very large cohorts). **IoT** or **5G** technologies could be also exploited and explored to the full potential when technologies could be able seamlessly to communicate. This important bottleneck requires concerted action from all relevant stakeholders be it large tech, health authorities, policy and regulatory instances as well as advocacy groups. AHA can profit from this breakthrough agreement immensely e.g., through access to novel integrated and inclusive care in smart homes anywhere anytime

- **Standardisation of health records and data to facilitate relevant research**

The major bottleneck for interoperable systems is less a technological issue but rather a challenge with a resolvable solution in the realms of standardisation and the cost of investment and consensual agreements framing them.



FHIR is a framework built around the concept of standardised data transfer from one system to another. The increase use of FHIR and API can allow the fast retrieval of data from EMRs. Applying similar standards internationally is therefore a trend to follow closely.



5G is a relatively new field for many sectors. Its potential to revolutionise health care and AHA is still difficult to predict. However, combined with AI and IoT, 5G can enable real-time wireless data transfer at unpredicted speed and volumes and as such attractive for several stakeholders beyond the healthcare system potential for AHA when considered in a larger concept of solutions and framework conditions

Health care system

- **Preventive care and solutions supporting care at home as key to relieve the health care system**
Preventive care technologies for the elderly populations that are more personalised and that promote senior engagement and inclusion shall also focus on the legitimate need of senior adults to rely on remote support in the physical absence of their family and caregivers. Generally, most of the solutions and services developed for the elderly aim to support the care givers of the elderlies and not to support especially those in frail conditions but still yearn to live independently.



Robotics multifunctional roles as a care companion, reference directory to process information into easily digestible information, can serve both patients who have limited mobility and/or adult seniors alike experiencing loneliness or social isolation. In combination with artificial intelligence, robots have the potential to counteract the shortage of (digitally) skilled healthcare labour in AHA domain.

- **eHealth to serve remote areas, reduce hospitalisation rate or specialist doctor's appointments**
eHealth has the potential to facilitate access to healthcare including improved access to electronic health resources and meet diverse needs both of the provider as well as the recipient of services. eHealth can contribute to improving digital health literacy and empower patients with disabilities or specific needs to (learn to) access to healthcare and actively request telecare and support.



Thanks to the progress in the **IoT**, new business models around the concept of "Smart Homes" or "Smart Places" provide connected environments where seniors can age in place. Sensors embedded into daily articles offer a constant monitoring mechanism able to detect changes in a person's health and potentially predict, spot or alert the onset of poor health ahead of time

- **Lifelong education of health care takers**
Successful uptake and usage of digital solutions relies considerably not on the severity of the clinical or health situation but markedly on improved digital health literacy of the recipients of care but also the healthcare providers alike. In consideration of the shortage of skilled workforce in healthcare and the general unattractiveness of the sector to younger generations, investments in infrastructures and learning health systems shall put into place incentives and measures that take into account those who will use these technologies in the future.