World Health Organization

Classification of **digital interventions**, **services** and **applications** in health

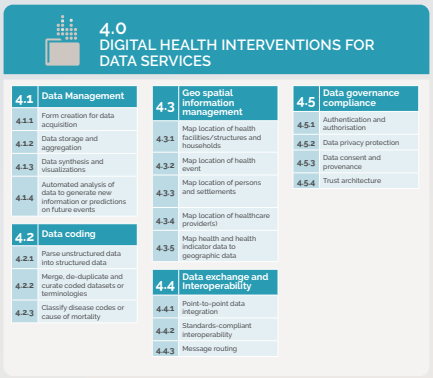
A shared language to describe the uses of digital technology for health, second edition

HEALTH SYSTEM CHALLENGES
1. Information
1.1 Lack of population denominator
1.2 Delayed reporting of events
1.3 Lack of quality/reliable data
1.4 Communication roadblocks
1.5 Lack of access to information or data (including disaggregated data)
1.6 Insufficient utilization of data and information
1.7 Lack of unique identifier
2. Availability
2.1 Insufficient supply of commodities
2.2 Insufficient supply of services
2.3 Insufficient supply of equipment
2.4 Insufficient supply of qualified and skilled health workers
3. Quality
3.1 Poor experience of persons
3.2 Insufficient health worker competence
3.3 Low quality health commodities
3.4 Low health worker motivation and support
3.5 Insufficient continuity and integration of care
3.6 Inadequate supportive supervision
3.7 Poor adherence to evidence-based standards, guidelines and protocols
3.8 Inadequate identification and management of risks
4. Acceptability
4.1 Lack of alignment with local norms
4.2 Programs which do not address individual beliefs and practices
5. Utilization
5.1 Low demand for services
5.2 Geographic inaccessibility
5.3 Low adherence to treatments
5.4 Loss to follow up
6. Efficiency
6.1 Inadequate workflow management
6.2 Lack of or inappropriate referrals
6.3 Poor planning and coordination
6.4 Delayed provision of care
6.5 Inadequate access to transportation and other health services
6.6 Burden of manual processes
7. Cost
7.1 Lack of effective and equitable resource allocation
7.2 Catastrophic health expenditure
7.3 Lack of coordinated payer mechanism
7.4 Lack of financial protection for persons
8. Accountability
8.1 Insufficient person(s) and community engagement
8.2 Unaware of service entitlement
8.3 Absence of community feedback mechanisms
8.4 Lack of transparency in commodity transactions
8.5 Poor accountability between the levels of the health sector
8.6 Inadequate understanding of beneficiary populations
9. Equity
9.1 Inadequate literacy
9.2 Inadequate representation

1.0 DIGITAL HEALTH INTERVENTIONS FOR PERSONS
1.1 Targeted communication to Persons
1.1.1 Transmit health event alerts to specific population group(s)
1.1.2 Transmit targeted health information to person(s) based on health status or demographics
1.1.3 Transmit targeted alerts and reminders to person(s)
1.1.4 Transmit diagnostics result, or availability of result, to person(s)
1.2 Untargeted communication to Persons
1.2.1 Transmit untargeted health information to an undefined population
1.2.2 Transmit untargeted health event alerts to undefined group.
1.3 Person to Person communication
1.3.1 Peer group for individuals
1.4 Personal health tracking
1.4.1 Access by the individual to own medical or summary health records
1.4.2 Self monitoring of health or diagnostic data by the individual
1.4.3 Active data capture/ documentation by an individual
1.4.4 Access by the individual to verifiable documentation of a health event or health status
1.5 Person based reporting
1.5.1 Reporting of health system feedback by persons
1.5.2 Reporting of public health events by persons
1.6 On demand communication with persons
1.6.1 Look-up of information on health and health services by individuals
1.6.2 Simulated human-like conversations with individual(s)
1.7 Person-centred financial transactions
1.7.1 Transmit or manage out-of-pocket payments by individuals
1.7.2 Transmit or manage vouchers to individuals for health services
1.7.3 Transmit or manage incentives to individuals for health services
1.8 Person-centred consent management
1.8.1 Manage provision and withdrawal of consent by individuals

2.0 DIGITAL HEALTH INTERVENTIONS FOR HEALTHCARE PROVIDERS
2.1 Identification and registration of persons
2.1.1 Verify a person's unique identity
2.1.2 Enrol person(s) for health services/clinical care plan
2.2 Person-centred health records
2.2.1 Longitudinal tracking of person's health status and services
2.2.2 Manage person-centred structured clinical records
2.2.3 Manage person-centred unstructured clinical records (e.g. notes, images, documents)
2.2.4 Routine health indicator data collection and management
2.3 Healthcare provider decision support
2.3.1 Provide prompts and alerts based according to protocol
2.3.2 Provide checklist according to protocol
2.3.3 Screen persons by risk or other health status
2.4 Telemedicine
2.4.1 Consultations between remote person and healthcare provider
2.4.2 Remote monitoring of person's health or diagnostic data by provider
2.4.3 Transmission of medical data (e.g. images, notes, and videos) to healthcare provider
2.4.4 Consultations for case management between healthcare providers
2.5 Healthcare provider communication
2.5.1 Communication from healthcare provider to supervisor(s)
2.5.2 Communication and performance feedback to healthcare provider(s)
2.5.3 Transmit routine news and workflow notifications to healthcare provider(s)
2.5.4 Transmit non-routine health event alerts to healthcare provider(s)
2.5.5 Peer group for healthcare providers
2.5.6 Generative AI for tailored content creation
2.6 Referral coordination
2.6.1 Coordinate emergency response and transport
2.6.2 Manage referrals between points of service within health sector
2.6.3 Manage referrals between health and other sectors (social services, police, justice, economic support schemes)
2.7 Scheduling and activity planning for healthcare providers
2.7.1 Identify persons in need of services
2.7.2 Schedule healthcare provider's activities
2.8 Healthcare provider training
2.8.1 Provide training content to healthcare provider(s)
2.8.2 Assess capacity of healthcare provider(s)
2.9 Prescription and medication management
2.9.1 Transmit or track prescription orders
2.9.2 Track individual's medication consumption
2.9.3 Report adverse drug effects
2.10 Laboratory and diagnostics imaging management
2.10.1 Transmit person's diagnostic result to healthcare provider
2.10.2 Transmit and track diagnostic orders
2.10.3 Capture diagnostic results from digital devices
2.10.4 Track biological specimens
2.11 Healthcare provider financial transactions
2.11.1 Verify individual's health coverage and financing scheme membership
2.11.2 Receive payments from individuals

3.0 DIGITAL HEALTH INTERVENTIONS FOR HEALTH MANAGEMENT AND SUPPORT PERSONNEL
3.1 Human resource management
3.1.1 List health workforce cadres and related identification information
3.1.2 Monitor performance of healthcare provider(s)
3.1.3 Manage registration/ certification of healthcare provider(s)
3.1.4 Record training credentials of healthcare provider(s)
3.1.5 Manage health workforce activities
3.2 Supply chain management
3.2.1 Manage inventory and distribution of health commodities
3.2.2 Notify stock levels of health commodities
3.2.3 Monitor cold-chain sensitive commodities
3.2.4 Register licensed drugs and health commodities
3.2.5 Manage procurement of commodities
3.2.6 Report counterfeit or substandard drugs by persons
3.3 Public health event notification
3.3.1 Notification of public health events from point of diagnosis
3.4 Civil Registration and Vital Statistics (CRVS)
3.4.1 Notify, register and certify birth event
3.4.2 Notify, register and certify death event
3.5 Health system financial management
3.5.1 Register and verify health coverage scheme membership of persons
3.5.2 Track and manage insurance billing and claims processes
3.5.3 Transmit and manage payments to health facilities
3.5.4 Transmit and manage routine payroll payment to healthcare provider(s)
3.5.5 Transmit or manage financial incentives to healthcare provider(s)
3.5.6 Manage and plan budget allocations, revenue and expenditures
3.5.7 Determine level of subsidies for health coverage schemes
3.5.8 Collect health insurance contributions
3.6 Equipment and asset management
3.6.1 Monitor status and maintenance of health equipment
3.6.2 Track regulation and licensing of medical equipment
3.7 Facility management
3.7.1 List health facilities and related information
3.7.2 Assess health facilities
3.8 Person-centred health certificate management
3.8.1 Register and store current health certificate information
3.8.2 Retrieve and validate current health certificate information
3.8.3 Revoke and update health certificate


4.0 DIGITAL HEALTH INTERVENTIONS FOR DATA SERVICES
4.1 Data Management
4.1.1 Form creation for data acquisition
4.1.2 Data storage and aggregation
4.1.3 Data synthesis and visualizations
4.1.4 Automated analysis of data to generate new information or predictions on future events
4.2 Data coding
4.2.1 Parse unstructured data into structured data
4.2.2 Merge, de-duplicate and curate coded datasets or terminologies
4.2.3 Classify disease codes or cause of mortality
4.3 Geo spatial information management
4.3.1 Map location of health facilities/structures and households
4.3.2 Map location of health event
4.3.3 Map location of persons and settlements
4.3.4 Map location of healthcare provider(s)
4.3.5 Map health and health indicator data to geographic data
4.4 Data exchange and interoperability
4.4.1 Point-to-point data integration
4.4.2 Standards-compliant interoperability
4.4.3 Message routing
4.5 Data governance compliance
4.5.1 Authentication and authorisation
4.5.2 Data privacy protection
4.5.3 Data consent and provenance
4.5.4 Trust architecture

SERVICES AND APPLICATION TYPES
A. Point of service
A1 Communication systems
A2 Community-based information systems
A3 Decision support systems
A4 Diagnostics information systems
A5 Electronic medical record systems
A6 Laboratory information systems
A7 Personal health records
A8 Pharmacy information systems
A9 Telehealth systems
B. Health system/ Provider administration
B1 Blood bank information management systems
B2 Health finance-related information systems
B3 Health program monitoring systems
B4 Human resource information systems
B5 Learning and training systems
B6 Logistics management information systems (LMIS)
B7 Patient Administration systems
B8 Research information systems
C. Registries & Directories
C1 Census and population information systems
C2 Civil registration and vital statistics (CRVS) systems
C3 Facility management information systems
C4 (Health) Facility registries
C5 Health worker registry
C6 Identification registries and directories
C7 Immunization information systems
C8 Master patient index
C9 Product catalogues
C10 Public Key directories
C11 Terminology and classification systems
D. Data Management services
D1 Analytics Systems
D2 Data interchange and interoperability
D3 Data warehouses
D4 Environmental monitoring systems
D5 Geographic information systems (GIS)
D6 Health Management Information systems (HMIS)
D7 Knowledge management systems
D8 Shared Health Record and Health Information Repository
E. Surveillance and Response
E1 Emergency preparedness and response systems
E2 Public health and disease surveillance systems

World Health Organization

Classification of **digital interventions**, **services** and **applications** in health

A shared language to describe the uses of digital technology for health, second edition

Classification of digital interventions, services and applications in health: a shared language to describe the uses of digital technology for health, second edition

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Executive Summary

Digital health is the systematic application of information and communications technologies, computer science, and data to support informed decision-making by individuals, the health workforce, and health systems, to strengthen resilience to disease and improve health and wellness.(1)

The pace of innovation in digital health is rapid and constant, with new interventions being developed, implemented, tested and refined against a diversity of contexts, constraints, and challenges to address a variety of health and health system needs. These evolving capabilities in technology are routinely being leveraged as interventions within digital applications and services, to aid individuals, the health workforce and health system users, to address challenges and improve access to quality information and health interventions. As stakeholders consider how precisely to leverage digital health, how to inventory existing investments, ways to plan and establish digital architectural blueprints, or ways to compare capabilities around which to develop digital applications and services, there is value in a comprehensive digital health ontology comprising terminology, relationships, and definitions.

Following the development and publication by WHO of the first edition of the Classification of Digital Health Interventions (CDHI) in 2018, there have been considerable advances in technology and their applications as novel digital health interventions. These advances, together with calls from expert communities and other stakeholders, prompted the need to update the first edition of the CDHI.

The updated Classification of Digital Interventions, Services and Applications in Health (CDISAH) is a set of categorizations that links how digital health interventions (DHIs) embedded into digital applications and services are used to address personal and health system challenges and needs. Also referred to as a taxonomy, this classification scheme is anchored on the unit of a "digital health intervention," which represents a discrete capability of digital technology to achieve health sector objectives. It is organized around 3 axes.

This classification is one of several resources developed by WHO and partners that support the process of planning and implementing a digital health enterprise.

The classification of Digital Interventions, Services and Applications in Health is organized around three axes:

1. **Health system challenges**
2. **Digital health interventions (DHIs)**
3. **Digital Services and Application types**

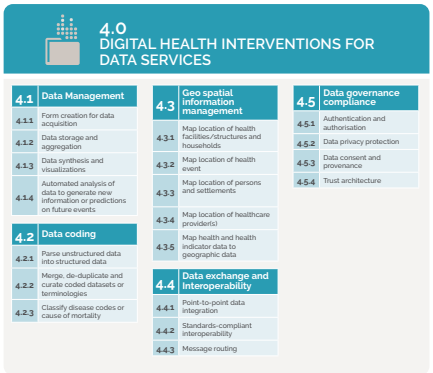
Changes included in the second edition

To address gaps and deficiencies identified in the first edition of the classification, some changes were necessary. The structure within the digital health interventions and health system challenges sections was not changed, but several additions and content updates have been made to these sections. However, substantial changes have been made to what was previously referred to as Systems Categories, which has been renamed to Services and Application types. This section has been re-structured to improve the structure and precision, and address gaps in "services and application" types.

The major content changes to this edition of the Classification include:

- *"Client(s)" are now referred to as* **"Person(s)" or "Individual(s)"** *to maintain a more neutral terminology when referring to individuals who access health interventions from the health system.*
- *Where possible, the language is updated to ensure the DHIs are inclusive of healthcare systems that have a variety of policies and models for healthcare delivery.*
- *Additional descriptors and synonyms have been included for DHIs, to match semantically related terms for specific DHIs.*
- *New DHIs are included to reflect the evolution in the application of technology for health, including capabilities that have emerged in response to the global pandemic.*
- *The Systems Categories section has been renamed to "Services and Application types". This section has also been restructured, and grouped into 5 "Representations" according to their use within digital health enterprise architecture:*
  - Point of service
  - Health System/ Provider administration
  - Registries and Directories
  - Data Management services
  - Surveillance and Response

- *Also included are descriptions for the 5 Representations to provide clarity on the nature of the types of applications and services within each area, with additional types added to address gaps.*
- *Additional descriptors and typical functional areas are added for the services and application types to help users of the Classification to map and categorize digital solutions.*



What is the Classification of digital interventions, services and applications in health?

The classification of Digital Interventions, Services and Applications in Health (DISAH) categorizes the different ways in which digital and mobile technologies are being used to support individuals and health system needs. It acknowledges the diverse ways in which digital capabilities are leveraged in different digital applications and services, to address personal and health system challenges and needs.

Targeted at stakeholders in the digital health sector including government and public health agencies, technologists, healthcare providers, donors, implementers, researchers and academics, this Classification framework aims to promote an accessible and bridging language for health program planners and other healthcare stakeholders to understand and articulate the capabilities in digital health implementations. It is also referred to as a taxonomy and is anchored on the unit of a "digital health intervention," which represents a discrete capability of digital technology to achieve health sector objectives.

Why was the first edition of the Classification of DHIs created?

The diverse communities working in digital health—including government stakeholders, technologists, clinicians, implementers, network operators, researchers, donors— have lacked a mutually understandable language with which to assess and articulate the uses of digital health. A shared and standardized vocabulary was recognized as necessary for the purposes of planning, conducting and evaluating inventories of existing assets, for identifying gaps and duplication, for conducting research in digital health and evaluating effectiveness, and for facilitating alignment across different digital health implementations. In particular, four primary use cases prompted the development of this classification scheme:

- *conducting research and synthesizing evidence;*
- *conducting national inventories and landscape analyses;*
- *developing guidance resources to inform planning;*
- *articulating required digital capabilities against challenges, constraints, needs, and use cases.*

Although frameworks such as the Control Objectives for Information and Related Technologies (COBIT) (2), Health Level Seven (HL7) (3), and International Standards Organization (ISO) (4) exist, these frameworks provide highly technical terms for use by computer scientists and software developers in health. This classification scheme offers a simplified language to help support a dialogue between health practitioners and other digital health stakeholders, and technology-oriented audiences.

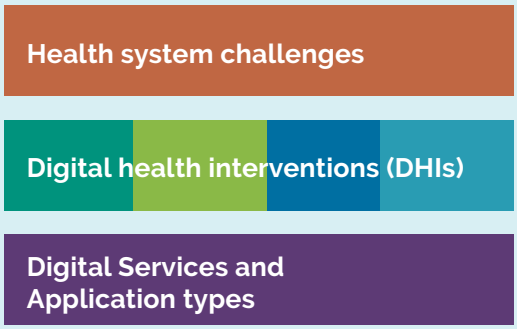
What is the first edition of the Classification of DHIs currently being used for?

In addition to the four primary use cases that prompted the development of the CDHI, it is currently being used globally for:

- *Conducting inventories of digital assets at national and sub-national levels*
- *Developing guidance resources to inform planning and implementation*
- *Investment coordination including portfolio analysis*
- *For planning and governing national digital health investments*
- *Informing legislation and regulation for digital health*
- *Education and training on digital health*
- *Research on the efficacy and effectiveness of digital health interventions*
- *Supporting the development of national digital health policies and implementation strategies*
- *Supporting implementation guidance*
- *Supporting capacity building efforts in digital health*

How is the Classification of DISAH organized?

The overall Classification is organized around three axes:



The **health system challenges** are grouped into 9 overarching categories. Click to view

- *Information*
- *Availability*
- *Quality*
- *Acceptability*
- *Utilization*
- *Efficiency*
- *Cost*
- *Accountability*
- *Equity*

The **digital health interventions** are organized into the following overarching groupings based on the targeted primary user:

1. **Interventions for Persons:** Persons are members of the public who are potential or current users of health services, including health prevention and wellness activities. Other terms that have been used to describe individuals in this group include 'patients', 'clients' and 'health service users'. Caregivers of individuals receiving health services are also included in this group. Click to view

2. **Interventions for healthcare providers:** Health care providers are members of the health workforce who deliver health interventions. This group have also been described as health workers or healthcare workers. Click to view

3. **Interventions for health management and support personnel (health system managers):** Health management and support personnel are involved in the administration and oversight of health systems. Interventions within this category reflect managerial functions related to supply chain management, health system financial management, human resource management. Click to view

4. **Interventions for data services:** This consists of crosscutting functionality to support a wide range of activities related to data management, use, and data governance compliance. Click to view

Synonyms/additional descriptors and Illustrative examples: Each digital health intervention is accompanied by associated synonyms and other commonly used terms. The framework also includes illustrative programmatic examples of these terms based on cited descriptions from project documentation or published literature. These examples aim to facilitate understanding by giving practical examples of documented deployments of digital health intervention(s).

The **services and application types** are grouped into 5 representations within the digital health architecture: Click to view

- *Point of service*
- *Health System/ Provider administration*
- *Registries and Directories*
- *Data Management services*
- *Surveillance and Response*

How can the Classification of DISAH be used?

- ***Read the explanation below to see a description of the 3 axes and how they are linked.***
- ***View the sample use-cases to understand the practical application of the CDISAH in different contexts.*** *Click to view*
- ***Look at the synonyms and additional descriptors to match terminology that are semantically related.***

This classification of **Digital Health Interventions (DHIs)** should be used in tandem with the list of **Health System Challenges (HSC)** in order to articulate how technology is addressing identified health needs, such as lack of service utilisation. The HSC framework provides an overview of needs and challenges faced in health systems, in order

to assist program planners to express what they expect to achieve through implementation of a digital health intervention. For example, one may implement a digital health intervention, such as "targeted communication to persons", in order to address a health system challenge, such as "lack of service utilisation," to achieve an overarching **eHealth outcome** of "improving individuals' access to knowledge resources and support for better management of their health" (6).

The classification of DISAH also highlights functionalities that fit within various **Services and Application types,** such as Logistics Management Information Systems (LMIS) or Electronic Medical Records (EMR). Services and Application types represent the types of digital applications, information systems and services designed to deliver one or more digital health interventions. A digital health intervention such as "notify stock levels of health commodities" would fit into the Application type, LMIS. Linking digital health interventions to services or application types is critical as these serve as the starting point for interoperability considerations.

Figure 1. Linkages across Health System Challenges, Digital Health Interventions, and Service & Application types

Health System Challenge (HSC)	Digital Health Intervention (DHI)	Service and Application types
Need or problem to be addressed	Digital functionality for addressing the Health System Challenge	Digital system or service that delivers one or more of the Digital Health Interventions
2.1 Insufficient supply of commodities	3.2.1 Manage inventory and distribution of health commodities 3.2.2 Notify stock levels of health commodities	B6 Logistics Management Information System
3.7 Healthcare provider's poor adherence to clinical guidelines	2.3.1 Provide prompts and alerts based according to protocol 2.3.2 Provide checklist according to protocol 2.5.2 Communication and performance feedback to healthcare provider 2.7.2 Schedule healthcare provider's activities	A3 Decision support systems A9 Telemedicine systems
1.5 Lack of access to information or data	2.2.4 Routine health indicator data collection and management 4.1.2 Data storage and aggregation 4.1.3 Data synthesis and visualizations	A5 Electronic Medical Record C6 Identification registries and directories D6 Health Management Information System (HMIS)
5.4 Loss to follow-up of person(s)	1.1.3 Transmit targeted alerts and reminders to person(s) 2.2.1 Longitudinal tracking of person's health status and services	A1 Communication system (person-centred communication) A5 Electronic Medical Record

Use-cases

USE-CASE 1

Implementing DHI(s) to address a health system challenge

Government and public health implementers work continuously to improve and strengthen health systems and address health system challenges. For example, in the context of an immunisation programme, there may be an identified challenge relating to the lack of access to information by new mothers resulting in missed immunisations for their new-borns. A major hindrance creating this information gap could be the absence of effective communication between health facilities and new mothers. A more in-depth analysis of this communication deficit could unveil several issues, one of which might be the mother's lack of awareness about the need for her new-born's vaccination, or the time and place for it.

To address this challenge, implementers may consider digital applications or services that can deliver one or more of the following interventions:

- *transmit targeted information to the mother (DHI 1.1.2) and targeted alerts and reminders (1.1.3)*
- *provide the ability for the mother to look up information on health and health services (1.6.1)*

This would help to ensure the delivery of targeted interventions that have impact.

USE-CASE 2

Articulating the DHI(s) delivered by services or applications

Digital health services and applications deliver one or more digital health interventions. For example, digital therapeutic products designed to deliver medical interventions directly to patients utilise various modalities to deliver those interventions. A digital therapeutic product that utilises education via text, audio and/or video to deliver the intervention to the patient would be delivering various digital health interventions including:

- *transmitting targeted health information to the person based on their health status (DHI 1.1.2)*
- *enabling look-up of information on health and health services by a person (DHI 1.6.1)*
- *providing simulated human-like conversations with persons (DHI 1.6.2)*

USE-CASE 3

Landscape analysis of digital health technology investment

The Classifications of Digital Interventions, Services and Applications in Health is used by donors, implementers, and digital health advisors to conduct inventories and perform landscape analysis of digital health technology investments. The classifications offer a shared and standardized vocabulary by which they can map digital health technologies and their capabilities within contexts and countries. Using the services and application types detailed in the classification, makes it possible to map types of digital solutions within their investment portfolio and detail the digital health interventions provided against the health system challenges that are being addressed.

USE-CASE 4

Searching the WHO Digital Health Atlas (DHA) for registered projects

The WHO Digital Health Atlas is an online global repository where implementers register their digital health activities. The platform is designed to support governments, technologists, implementers and donors to better account for, and coordinate their digital health investments. There are various data fields for capturing the details of the digital health investment or project including health focus area, digital health intervention(s) being delivered, service or application type, health system challenge(s) being addressed, use of interoperability standards, and jurisdiction of implementation among others.

One search strategy that can be employed in the DHA is to search for registered projects and filter by health focus area. This produces a list of projects with further details on each project including details on the DHIs being delivered, the service or application type, and the health system challenges being addressed by the digital implementation.

Related documents

WHO guideline: recommendations on digital interventions for health system strengthening

Digital Implementation Investment Guide (DIIG): Integrating digital interventions into health programmes

Digital implementation investment guide (DIIG): quick deployment guide

Key terms

Digital health intervention: A discrete technology functionality – or capability – designed to achieve a specific objective addressing a health system challenge.

Digital health application: The software, information and communications technology (ICT) systems or communication channels that deliver or execute the digital health intervention and health content.(1)

Health system challenge: A generic (not health domain specific) need or gap that reduces the optimal implementation of health services. Health system challenges represent a standardized way of describing bottlenecks. For example, "loss to follow-up" is a health system challenge used to generally describe specific bottlenecks that may be articulated as "the person did not come back for their appointment" or "the person has not received a follow-up vaccination".

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HEALTH SYSTEM CHALLENGES

PERSONS

HEALTHCARE PROVIDERS

HEALTH MANAGEMENT AND SUPPORT PERSONNEL

DATA SERVICES

SERVICES & APPLICATIONS

Digital Interventions, Services and Applications in Health

Health System Challenges

The Health System Challenge framework provides an overview of needs and challenges faced in health systems that reduce optimal performance. They describe overarching problems faced by health systems which can be addressed through implementing digital health interventions. Program planners can use them as a starting point to drill down to the specific bottlenecks (or pain points) that they seek to improve within a health programme process, which then enables the selection of appropriate digital health interventions.

HEALTH SYSTEM CHALLENGES

1. Information

1.1	Lack of population denominator
1.2	Delayed reporting of events
1.3	Lack of quality/reliable data
1.4	Communication roadblocks
1.5	Lack of access to information or data (including disaggregated data)
1.6	Insufficient utilization of data and information
1.7	Lack of unique identifier

2. Availability

2.1	Insufficient supply of commodities
2.2	Insufficient supply of services
2.3	Insufficient supply of equipment
2.4	Insufficient supply of qualified and skilled health workers

3. Quality

3.1	Poor experience of persons
3.2	Insufficient health worker competence
3.3	Low quality health commodities
3.4	Low health worker motivation and support
3.5	Insufficient continuity and integration of care
3.6	Inadequate supportive supervision
3.7	Poor adherence to evidence-based standards, guidelines and protocols
3.8	Inadequate identification and management of risks

4. Acceptability

4.1	Lack of alignment with local norms
4.2	Programs which do not address individual beliefs and practices

5. Utilization

5.1	Low demand for services
5.2	Geographic inaccessibility
5.3	Low adherence to treatments
5.4	Loss to follow up

6. Efficiency

6.1	Inadequate workflow management
6.2	Lack of or inappropriate referrals
6.3	Poor planning and coordination
6.4	Delayed provision of care
6.5	Inadequate access to transportation and other health services
6.6	Burden of manual processes

7. Cost

7.1	Lack of effective and equitable resource allocation
7.2	Catastrophic health expenditure
7.3	Lack of coordinated payer mechanism
7.4	Lack of financial protection for persons

8. Accountability

8.1	Insufficient person(s) and community engagement
8.2	Unaware of service entitlement
8.3	Absence of community feedback mechanisms
8.4	Lack of transparency in commodity transactions
8.5	Poor accountability between the levels of the health sector
8.6	Inadequate understanding of beneficiary populations

9. Equity

9.1	Inadequate literacy
9.2	Inadequate representation

1.0 Digital Health Interventions for Persons

The taxonomy in this group describes the capabilities of digital technology that can be implemented to achieve objectives that are targeted toward persons. Persons include members of the public who are potential or current users of health services and caregivers of individuals receiving health services.

1.0 DIGITAL HEALTH INTERVENTIONS FOR PERSONS

1.1	Targeted communication to Persons
1.1.1	Transmit health event alerts to specific population group(s)
1.1.2	Transmit targeted health information to person(s) based on health status or demographics
1.1.3	Transmit targeted alerts and reminders to person(s)
1.1.4	Transmit diagnostics result, or availability of result, to person(s)

1.2	Untargeted communication to Persons
1.2.1	Transmit untargeted health information to an undefined population
1.2.2	Transmit untargeted health event alerts to undefined group.

1.3	Person to Person communication
1.3.1	Peer group for individuals

1.4	Personal health tracking
1.4.1	Access by the individual to own medical or summary health records
1.4.2	Self monitoring of health or diagnostic data by the individual
1.4.3	Active data capture/ documentation by an individual
1.4.4	Access by the individual to verifiable documentation of a health event or health status

1.5	Person based reporting
1.5.1	Reporting of health system feedback by persons
1.5.2	Reporting of public health events by persons

1.6	On demand communication with persons
1.6.1	Look-up of information on health and health services by individuals
1.6.2	Simulated human-like conversations with individual(s)

1.7	Person-centred financial transactions
1.7.1	Transmit or manage out-of-pocket payments by individuals
1.7.2	Transmit or manage vouchers to individuals for health services
1.7.3	Transmit or manage incentives to individuals for health services

1.8	Person-centred consent management
1.8.1	Manage provision and withdrawal of consent by individuals

1.0 Digital Health Interventions for Persons

The digital health interventions for Persons are described below. Descriptors that are semantically related (=), along with a representative example for each category (💡) are also included.

Further illustrative examples can be viewed at bit.ly/CDISAH.

1.1 Targeted communication to Persons

Communication of targeted health information "in which separate audience segments (often demographic categories) benefit from a shared message." (1) Targeted communication can also be further customized according to an individual's specific needs, resulting in "tailored communication to the person," whereby message content is matched to the needs and preferences of an individual *(1)*. The communication can be unidirectional and bidirectional, but initial contact is from the health system; as opposed to on-demand information service where the person initiates the first contact with the health system.

1.1.1 Transmit health event alerts to specific population group(s)

= *Public health event notification; disease notification to specific or pre-identified populations.*
- *Notification of health events to specific populations based on demographic characteristics*
- *Health promotion including health prevention messaging*

💡 **Social messaging tool used in Uganda**: "The following SMS alerts were carefully drafted and sent to Kibaale, and the surrounding districts Hoima, Kiboga, Mubende, Ntoroko, Bundibugyo, Kabarole Kyenjojo, Kyegegwa, Kyankwanzi, and Ibanda. SMS Alert 1: There is an Ebola outbreak in Kibaale. Today and tomorrow I am going to send u some SMSs to give u more info about how to recognise Ebola & how to prevent it..." (2)

1.1.2 Transmit targeted health information to person(s) based on health status or demographics

= *Health education, behaviour change communication, health promotion communication, person-centred messaging, health program communication;*
- *Health communication based on a known person's health status or clinical history*

💡 **Mobile information for maternal health**: "A mobile interactive voice response system that provides pregnant women with information on the stage of her pregnancy and suggestions to keep her and her baby healthy via twice weekly phone calls." (3)

1.1.3 Transmit targeted alerts and reminders to person(s)

= *Alerts for preventive services and wellness*
- *Notifications and reminders for appointments, medication adherence, or follow-up services*
- *Communication for retention in care, continuity of care"*

💡 **Mobile application for supporting maternal and child health services**: "... sends automated SMS reminders to individuals, reminding them of upcoming appointments, missed appointments, and approaching delivery dates so women can prepare to deliver in a health facility." (4)

1.1.4 Transmit diagnostics result, or availability of result, to person(s)

- *Laboratory results management, tests results management*

Digital application that delivers test results to patients: "... delivers CD4 count results to patients who have been tested for HIV but may not return to the clinic to collect their CD4 counts results..." (5)

1.2 Untargeted communication to Persons

Transmission of untargeted health promotion content "in which relatively large, undifferentiated audiences receive identical messages." [1] This includes message blasts usually conducted to a mobile phone user bank. The communication can be unidirectional and bidirectional.

1.2.1 Transmit untargeted health information to an undefined population

- *Mass messaging campaign or communication to an undefined target group.*
- *Health messaging to undefined target group regardless of demographic characteristics or health status.*
- *Social media communication*

Mass communication mhealth program: "A mass communication campaign will be launched to send text messages (SMS) to the general community to inform them of the availability and benefits of the maternal and neonatal health services at their local health-care facilities." (6)

1.2.2 Transmit untargeted health event alerts to undefined group.

- *Public health event notification; disease notification*
- *Mass messaging campaign*
- *Social media communication*

Ebola awareness through SMS: "As part of a massive public awareness effort, Senegal's Ministry of Health sent 4 million SMS messages to the general public warning of the dangers of Ebola and how to prevent it." (7)

1.3 Person to Person communication

Communication between individuals as peers within an organized network/group.

1.3.1 Peer group for individuals

- *Peer learning*
- *Peer group*
- *Peer-to-peer groups*
- *Peer network*
- *Peer support*

Mobile phone support group: "Peer-led support groups for HIV-infected adolescents to communicate amongst themselves on topics they want to discuss." [8]

1.4 Personal health tracking

The use of mobile applications, phone based sensors, health records, and wearables for individuals to monitor their own health status. This can include examples of wearable sensors, web-tools, and apps that allow individuals to review and track their clinical and general health status.

1.4.1 Access by the individual to own medical or summary health records

- *Self-access to health record by an individual; patient's own access to their health record.*
- *Ability for persons to track their health history and clinical record*

Electronic personal health record: "....makes it possible for patients to augment their medical records with health status data that they have gathered on their own" (9)

1.4.2 Self monitoring of health or diagnostic data by the individual

- *Personal health monitoring, self-tracking self-care, self-monitoring*
- *Sensors and wearables for personal health monitoring*
- *Person's health data is collected based on a device a person uses on their own*

Wearables and fitness trackers: Applications that can track every part of your day—including activity, exercise, food, weight and sleep.

1.4.3 Active data capture/ documentation by an individual

- *Personal health monitoring, self-tracking self-care, self-monitoring, journaling; capture patient originated data, documentation of health status and activities by individual(s)*

Period-tracking application: The individual"...enters the date of her last period and the service informs her of her fertile days during the cycle. She receives alerts on her "unsafe days" throughout the month." (10)

1.4.4 Access by the individual to verifiable documentation of a health event or health status

- *Confirmation/verification of an individual's status for various public and private transactions including for e.g., insurance status, vaccination record, disability record, social protection.*
- *Access to documentation of health status via a verifiable certificate.*

Applications that provide individuals with access to verifiable credentials that confirm their health status including the occurrence of a health event.

1.5
Person based reporting

Digital platforms, including social media, to enable individuals to report on public health events, as well as experiences, issues, and satisfaction with health services.

1.5.1 Reporting of health system feedback by persons

- *Public reporting on health system issues, such as the availability and quality of services received, interaction with health worker, satisfaction with services, grievances*
  - *Accountability monitoring, accountability reporting*
  - *Crowdsourced feedback, patient/ individual feedback, quality of care feedback*

Text-based youth engagement tool: " youth can send alerts to key stakeholders about the issues being faced in their communities, and feeds back useful information to the U-Reporters." [11]

1.5.2 Reporting of public health events by persons

- *Surveillance notification, disease notification, reporting by individuals, contact reporting*

Short message service (SMS) for social mobilization: "Citizens can report suspected Ebola cases via SMS." (12)

1.6
On demand communication with persons

Health information and health service information accessible to the general public triggered by the individual. This could be available via websites, helplines, USSD/SMS menus, or applications for individuals, among other channels, that may inform decision-making.

1.6.1 Look-up of information on health and health services by individuals

- *Person searches or looks up information on a health topic*
  - *Decision-support for individuals*
  - *Person searches or looks up information about health services including geographic information and facility/infrastructure information*
  - *Appointment booking/scheduling by individuals to access health services*

"An online source of clear, actionable, and thorough health information accessible via computer or mobile device." (13)

1.6.2 Simulated human-like conversations with individual(s)

- *Interactive/ dynamic conversations with individuals and simulated healthcare providers via text or voice.*
  - *Chatbots*
  - *Generative responses from AI chatbots*

"A chatbot generated quality and empathetic responses to patient questions posed in an online forum" (14)

1.7 Person-centred financial transactions

Digital approaches to facilitate financial transactions for persons. These digital financial transactions can be used to facilitate conditional cash transfers and payments related to health service delivery.

1.7.1 Transmit or manage out-of-pocket payments by individuals

Mobile money payments directly made by an individual. This can include payments for any health services such as emergency transportation, health fees, etc.

Medical smartcard: "The maternal health smartcard is a pre-paid card that allows the bearer to obtain antenatal, delivery, and postnatal services at listed prices in participating maternity facilities." (15)

1.7.2 Transmit or manage vouchers to individuals for health services

Health voucher issuance (e.g., for mosquito nets, for transport etc.) and redemption services (i.e., redeem health vouchers)

Mobile finance to reimburse sexual and reproductive vouchers: "Voucher program transmits SMS money transfer to reimburse social franchise service providers for FP services to individuals." (16)

1.7.3 Transmit or manage incentives to individuals for health services

Cash transfers to individuals, conditional on health-related behaviours

"A vaccine registry system that uses SMS reminders to caregivers and conditional cash transfers to caregivers ... The amount of cash the caregiver is eligible to win increases with each subsequent vaccine their child completes." [17]

1.8 Person-centred consent management

Digital approaches to facilitate and manage the provision and withdrawal of consent (permissions) by individuals to enable healthcare providers to access or share the person's health and/or medical records or use their personal information.

1.8.1 Manage provision and withdrawal of consent by individual(s)

- *Digital medical consent*
  - *Digital consent forms*
  - *Electronic informed consent*

Unpublished example: Digital tools that manage the process of providing, reviewing and withdrawing individuals' consent for use of their personal information (including photographs, audio and video recordings), access to their health and medical records or sharing of their medical records with other healthcare providers.

2.0 Digital Health Interventions for Healthcare Providers

The taxonomy in this group describes the capabilities of digital technology that can be implemented to achieve objectives that are targeted toward healthcare providers. Healthcare providers are members of the health workforce who deliver health interventions.

2.0 DIGITAL HEALTH INTERVENTIONS FOR HEALTHCARE PROVIDERS

2.1	Identification and registration of persons
2.1.1	Verify a person's unique identity
2.1.2	Enrol person(s) for health services/clinical care plan

2.2	Person-centred health records
2.2.1	Longitudinal tracking of person's health status and services
2.2.2	Manage person-centred structured clinical records
2.2.3	Manage person-centred unstructured clinical records (e.g. notes, images, documents)
2.2.4	Routine health indicator data collection and management

2.3	Healthcare provider decision support
2.3.1	Provide prompts and alerts based according to protocol
2.3.2	Provide checklist according to protocol
2.3.3	Screen persons by risk or other health status

2.4	Telemedicine
2.4.1	Consultations between remote person and healthcare provider
2.4.2	Remote monitoring of person's health or diagnostic data by provider
2.4.3	Transmission of medical data (e.g. images, notes, and videos) to healthcare provider
2.4.4	Consultations for case management between healthcare providers

2.5	Healthcare provider communication
2.5.1	Communication from healthcare provider to supervisor(s)
2.5.2	Communication and performance feedback to healthcare provider(s)
2.5.3	Transmit routine news and workflow notifications to healthcare provider(s)
2.5.4	Transmit non-routine health event alerts to healthcare provider(s)
2.5.5	Peer group for healthcare providers
2.5.6	Generative AI for tailored content creation

2.6	Referral coordination
2.6.1	Coordinate emergency response and transport
2.6.2	Manage referrals between points of service within health sector
2.6.3	Manage referrals between health and other sectors (social services, police, justice, economic support schemes)

2.7	Scheduling and activity planning for healthcare providers
2.7.1	Identify persons in need of services
2.7.2	Schedule healthcare provider's activities

2.8	Healthcare provider training
2.8.1	Provide training content to healthcare provider(s)
2.8.2	Assess capacity of healthcare provider(s)

2.9	Prescription and medication management
2.9.1	Transmit or track prescription orders
2.9.2	Track individual's medication consumption
2.9.3	Report adverse drug effects

2.10	Laboratory and diagnostics imaging management
2.10.1	Transmit person's diagnostic result to healthcare provider
2.10.2	Transmit and track diagnostic orders
2.10.3	Capture diagnostic results from digital devices
2.10.4	Track biological specimens

2.11	Healthcare provider financial transactions
2.11.1	Verify individual's health coverage and financing scheme membership
2.11.2	Receive payments from individuals

2.0 Digital Health Interventions for Healthcare Providers

The digital health interventions for healthcare providers are described below. Descriptors that are semantically related (=), along with a representative example for each category (💡) are also included.

Further illustrative examples can be viewed at bit.ly/CDISAH.

2.1 Identification and registration of persons

Identity verification and enrolment of persons into health services.

2.1.1 Verify a person's unique identity

= *Biometrics*
- *Person-centred registry*

💡 "A portable biometric identification system operated by CHWs that is capable of identifying patients by their fingerprint and compiling patient adherence data for tuberculosis drug treatment (DOTS)." (18)

2.1.2 Enrol person(s) for health services/ clinical care plan

= *Register an individual for health services.*

💡 **Mobile health application**: "Register each pregnancy at a government health facility..." (19)

2.2 Person-centred health records

Digitized record used to capture, store, access and share health information on a person or grouping of persons. (20)

2.2.1 Longitudinal tracking of person's health status and services

= *Domain-specific registers; eRegister; digital register; digital service record; immunization registry*
- *Digitized registers for longitudinal health program, including tracking of migrant populations' benefits and health status*
- *Case management logs within specific target populations, including migrant populations*
- *Contact tracing*

💡 **Virtual vaccination registry and immunization performance tracking system**: "...allows the health worker to digitally register children, track their immunization records, connect with nonadherent families before vaccination sessions end." (21)

2.2.2 Manage person-centred structured clinical records

- *Clinical record of an individual with information that spans across multiple clinical domains*
  - *Electronic medical record, personal health record*

An open-source medical record system/ software platform used for various use cases and in various care settings, and "...comes with basic electronic health record (EHR) functionality built-in, and has the ability to add new functionality through modules"[22]

2.2.3 Manage person-centred unstructured clinical records (e.g. notes, images, documents)

- *Electronic medical record and personal health records with that are not based on structured data, and instead including notes, images, documents*

Unpublished example: Records are unstructured and designed to be readable by people rather than machine readable, distinct from structured medical records which are coded in question/answer format.

2.2.4 Routine health indicator data collection and management

- *Data collection for Health Management Information System (HMIS)*
  - *Person-centred health data collection*

Health Management Information Systems (HMIS) platform in LMICs: "...used as the national health information system for data management and analysis purposes, for health program monitoring and evaluation." (23)

2.3 Healthcare provider decision support

Digitized job aids that combine an individual's health information with the health-care provider's knowledge and clinical protocols in order to assist health-care providers in making diagnosis and treatment decisions. (20)

2.3.1 Provide prompts and alerts based according to protocol

- *Clinical decision support, job aid–linked to digital health record of individuals*
  - *Provision of alerts for abnormal findings/lab values, "IF THEN statements,"*
  - *Process algorithms to support service delivery according to care plans, guidelines, and protocols*
  - *Case management*
  - *Workflow support*

A tablet-based application for providing alerts to healthcare providers: "The application uses validated clinical algorithms based on WHO guidelines to alert providers when critical observations need to be made and if they are abnormal." (24)

2.3.2 Provide checklist according to protocol

- *Job aid and assessment tools to support service delivery–may or may not be linked to a digital health record*
  - *Decision trees to support service delivery according to care plans, guidelines, and protocols*
  - *Workflow support*

Mobile application for community case management: "HSAs are guided step by step through the process of registering sick children, listening to their complaints, performing an examination, delivering diagnosis, and administering treatment..." (25)

2.3.3 Screen persons by risk or other health status	*Tools for screening, risk assessment, triage and prioritization of individuals;* - *Job aid to support service delivery according to care plans, guidelines, and protocols*	**Mobile phone with decision support application**: "...screen women (and their babies) for complications from pregnancy up to a week after delivery and refer them as needed to the health facility" (26)

2.4 Telemedicine

Provision of health-care services at a distance (20). The delivery of health care services, where patients and providers are separated by distance (27).

2.4.1 Consultations between remote person and healthcare provider	*Remote consultation, tele consultation, person-based telemedicine, hotlines, call centres, helpline* - *Real-time telemedicine, interactive telemedicine, synchronous telemedicine* - *Person calls a health worker or hotline to receive clinical guidance on health issue*	"A toll-free health hotline that is staffed by trained health workers who provide information, advice and referrals over the phone." (28)
2.4.2 Remote monitoring of person's health or diagnostic data by provider	*Telemonitoring, virtual monitoring.* - *Provider is able to monitor individual health through an implanted sensor/ diagnostic equipment.*	**Body sensor networks for mobile health monitoring**: "...patients' biosignals are measured by means of body worn sensors which communicate wirelessly with a handheld device. Alarms and biosignals can be transmitted over wireless communication links to a remote location, and a remote health professional can view the biosignals via a web application." [29]
2.4.3 Transmission of medical data (e.g. images, notes, and videos) to healthcare provider	*Store and forward* - *Asynchronous telemedicine*	**Africa Teledermatology Project**: The Africa Teledermatology Project operates in six African countries, using cameras and laptop PCs to capture and send images of patients to specialists in other African countries, Austria and the United States providing diagnostic and treatment support local physicians, dermatologists, and health care workers in hospitals and clinics in underserved regions. (30)
2.4.4 Consultations for case management between healthcare providers	*Inter-provider communication, closed user-group, health worker to health worker communication.* - *Consulting other health care providers, particularly specialists, for patient case management; seeking second opinion for patient case management*	**Mobile telemedicine**: "Information collected in the mobile phones is uploaded to OpenMRS. A specialist in remote locations sends the recommendation through SMS." (31)

2.5 Healthcare provider communication

Communication and transmission of information among healthcare providers, supervisors, and health system managers, including communication to persons.

2.5.1 Communication from healthcare provider to supervisor(s)

"...a two-way, mobile phone-based communication system that uses basic text messaging, or SMS, to connect ministries of health and health workers." (32)

2.5.2 Communication and performance feedback to healthcare provider(s)

Supportive supervision, coaching/ mentoring, audit and feedback
- *Communication to healthcare provider based on their performance*

Mobile health (mHealth) platform for performance feedback: "To communicate detailed performance feedback, we set up a call center, placing weekly calls to the community nutrition experts and relaying feedback on performance metrics. Phone calls provided a way to discuss and receive feedback from the community nutrition experts regarding any work-related issues, personal needs, or technical difficulties..." (33)

2.5.3 Transmit routine news and workflow notifications to healthcare provider(s)

Alerts and reminders to healthcare provider
- *Motivational communication healthcare provider*
- *Transmission of workflow updates to healthcare provider*

Text message reminders to health workers: "...a one-way communication of text message reminders about paediatric malaria case management sent to health workers' personal mobile phones. All health workers doing outpatient consultations in the intervention group received text messages about malaria case-management for 6 months." (34)

2.5.4 Transmit non-routine health event alerts to healthcare provider(s)

Public health related updates to health workers including research updates
- *Emergency alerts to healthcare providers*
- *Mass messaging to healthcare providers*

Mobile phone-based communication platform: "...a two-way, mobile phone-based communication system that uses basic text messaging, or SMS, to connect ministries of health and health workers to communicate critical messages to health workers during a crisis or emergency response." (32)

2.5.5 Peer group for healthcare providers

Peer support, peer learning, closed user groups
- *Communication mechanisms for healthcare providers to discuss among themselves*

Mobile learning solution: "...includes a group chat feature which allows CHWs to share knowledge and communicate directly with supervisors, and a toll-free help desk enables end-users to access support when they need it." (35)

2.5.6 Generative AI for tailored content creation

creation of tailored communication content specific to patient needs

Using chatbots/ AI assistants to draft responses that healthcare providers can edit. (14)

2.6
Referral coordination

Digital approaches to support communication and coordination mechanisms to facilitate referrals, both within the health sector and to other health-related sectors

2.6.1 Coordinate emergency response and transport

- *Ambulance systems, emergency response management*
- *Care coordination*

Mobile phone with decision support application: "...use text or voice communication to notify a health facility that a woman is in transit to ensure the facility is prepared." (26)

2.6.2 Manage referrals between points of service within health sector

- *Clinical task linking*
- *Referral management*

A tablet-based application that uses validated clinical algorithms: "It also strengthens the referral pathway between peripheral and referral facilities by enabling electronic transmission of data between facilities..." (24)

2.6.3 Manage referrals between health and other sectors (social services, police, justice, economic support schemes)

- *Intersectoral referral management*

Unnamed project: Referrals do not only take place within the health sector, but also between the health sector and other non-health services. For example in cases of gender based violence referrals may be made between social services, police, justice services and health services. In cases of traffic crashes referrals are needed between police, emergency services and health services. In cases of malnutrition referrals may be needed between health and food support services. In cases where health and poverty and closely inter-related, referrals may be needed between economic strengthening, social services and health services. Digital systems may provide features for supporting and tracking these referrals.

2.7
Scheduling and activity planning for healthcare providers

Automated scheduling and planning tools to assist in prioritizing provider follow-up. Digital work planning and scheduling tools can take the form of reminders to healthcare providers on upcoming/overdue services and other mechanisms to flag individuals that need to be prioritized for service delivery (36).

2.7.1 Identify persons in need of services

- *Automated scheduling of person's health appointments*

Digital platform that uses mobile technology, information systems and support materials: "The platform integrates scheduling and service reminder tools..." (37)

2.7.2 Schedule healthcare provider's activities

- *Work planning*
  - *Prioritization of daily activities/tasks*
  - *Task management including management of visits to individuals*
  - *Healthcare provider rostering*

mHealth system: "...integrated mobile phone and server-based software system for CHWs that helps them to digitally manage their daily workflow." (38)

2.8 Healthcare provider training

The management and provision of education and training content in electronic form for health professionals (20). In contrast to decision support, healthcare provider training does not need to be used at the point of care.

2.8.1 Provide training content to healthcare provider(s)

- *mLearning, eLearning, virtual learning, remote learning*
  - *Educational videos, multimedia learning and access to clinical guidance*
  - *Training reinforcement and refreshers*
  - *Training for capacity building*
  - *Employee health training and support*

Mobile platform for accessing educational content: "Providing health workers with mobile-based video instruction and reference materials..." (39)

2.8.2 Assess capacity of healthcare provider(s)

- *Quizzes and interactive exercises to assess knowledge and competence*

Smartphone application: "The App features push messages with quiz questions spurring the health worker to use the application to update their knowledge." (40)

2.9 Prescription and medication management

Digital approaches to facilitate the management of prescriptions, including tracking prescription orders and monitoring physical consumption of medication.

2.9.1 Transmit or track prescription orders

- *Tracking medication orders*
  - *Tools to place prescription orders or track the status of prescriptions and refills*

Unnamed example: Pharmacy management applications that facilitate dispensing, prescription order tracking, stock management and billing and accounting for drugs and services.

2.9.2 Track individual's medication consumption

- *Monitoring adherence to medications and drugs*
  - *Monitoring/observing whether patients have taken their prescribed medications*

Digital medication adherence solution: "When the patient opens his bottle of medication, an automatic SMS message is sent from the bottle's SIM card to the patient's health facility, which records that the medication has been taken." (41)

2.9.3 Report adverse drug effects	*Reporting contraindications, drug interactions, adverse events, drug reactions*	**Texting-based reporting of adverse drug reactions to ensure patient safety**: "Text messages received by any of the three mobile phone companies were directed to a central system. The system was accessible 24 hours a day and 7 days a week and was configured to set an alert if there was a cluster of similar adverse drug reactions (ADRs) from one or more drugs or one drug repeatedly reported for several ADRs entering the system." (42)

2.10 Laboratory and diagnostics imaging management

Digital approaches to manage and exchange laboratory and diagnostic orders and results.

2.10.1 Transmit person's diagnostic result to healthcare provider	*Laboratory results management* - *Tests results communication between healthcare providers*	**SMS for early infant diagnosis of HIV**: "When test results are ready, the central SMS system sends a message alerting the clinic workers." (43)
2.10.2 Transmit and track diagnostic orders	*Laboratory test requisition and management*	**A web-based laboratory information system to improve quality of care of tuberculosis patients**: "....notify health centres of new results or contaminated samples, and track both enrolled patients and the status of pending laboratory tests." (44)
2.10.3 Capture diagnostic results from digital devices	*Point of care diagnostics* - *Diagnostic accessories added to digital devices*	**Mobile phone microscopy for the diagnosis of parasitic worm infections**: "Converts iPhone into a field microscope for point-of-care diagnosis of soil-transmitted helminths in school-aged children." (45)
2.10.4 Track biological specimens	*Tracking of blood donations and other biological specimens*	**Unnamed example**: Biological products such as blood donations and specimens are collected, tested and transported to the point of use. Digital systems can support the identification and tracking of these products from the point of collection, through quality control procedures, to the point of use.

2.11
Healthcare provider financial transactions

Digital approaches used by healthcare providers to facilitate financial transactions relating to individuals that access health services.

2.11.1 Verify individual's health coverage and financing scheme membership

Verify eligibility of persons for waiver schemes

- *Verify eligibility for services or claims within insurance coverage*

Online eligibility check-in: The app allows staff that are registered at a health facility to "search and check eligible beneficiaries when individuals approach health facilities seeking treatment." (46)

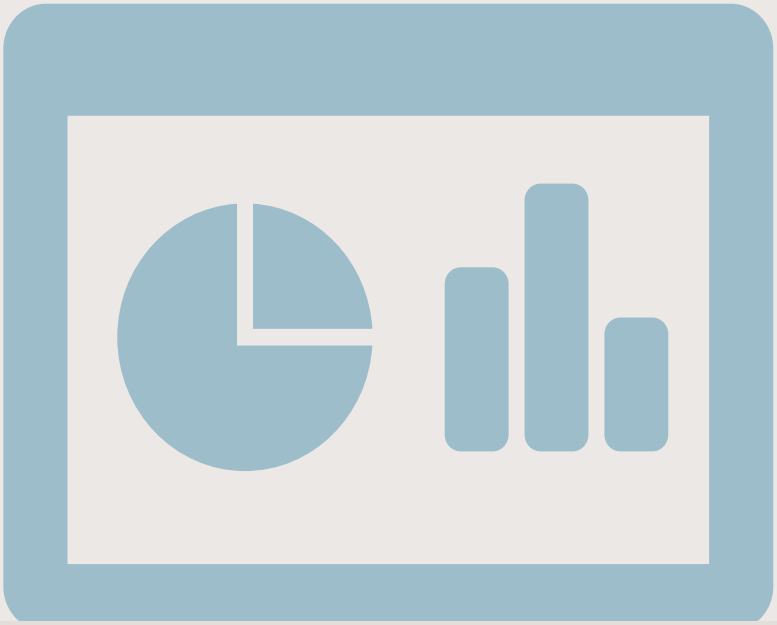
2.11.2 Receive payments from individuals

Payments made by persons directly to healthcare providers for health services.

Unnamed example: Digital tools that enable healthcare providers to receive financial transfers/ payments from individuals for services rendered.

3.0
Digital Health Interventions for Health Management and Support Personnel (Health System Managers)

The taxonomy in this group describes the capabilities of digital technology that can be implemented to achieve objectives that are targeted toward health management and support personnel. Health management and support personnel are involved in the administration and oversight of health systems.



3.0 DIGITAL HEALTH INTERVENTIONS FOR HEALTH MANAGEMENT AND SUPPORT PERSONNEL

3.1	Human resource management
3.1.1	List health workforce cadres and related identification information
3.1.2	Monitor performance of healthcare provider(s)
3.1.3	Manage registration/ certification of healthcare provider(s)
3.1.4	Record training credentials of healthcare provider(s)
3.1.5	Manage health workforce activities

3.2	Supply chain management
3.2.1	Manage inventory and distribution of health commodities
3.2.2	Notify stock levels of health commodities
3.2.3	Monitor cold-chain sensitive commodities
3.2.4	Register licensed drugs and health commodities
3.2.5	Manage procurement of commodities
3.2.6	Report counterfeit or substandard drugs by persons

3.3	Public health event notification
3.3.1	Notification of public health events from point of diagnosis

3.4	Civil Registration and Vital Statistics (CRVS)
3.4.1	Notify, register and certify birth event
3.4.2	Notify, register and certify death event

3.5	Health system financial management
3.5.1	Register and verify health coverage scheme membership of persons
3.5.2	Track and manage insurance billing and claims processes
3.5.3	Transmit and manage payments to health facilities
3.5.4	Transmit and manage routine payroll payment to healthcare provider(s)
3.5.5	Transmit or manage financial incentives to healthcare provider(s)
3.5.6	Manage and plan budget allocations, revenue and expenditures
3.5.7	Determine level of subsidies for health coverage schemes
3.5.8	Collect health insurance contributions

3.6	Equipment and asset management
3.6.1	Monitor status and maintenance of health equipment
3.6.2	Track regulation and licensing of medical equipment

3.7	Facility management
3.7.1	List health facilities and related information
3.7.2	Assess health facilities

3.8	Person-centred health certificate management
3.8.1	Register and store current health certificate information
3.8.2	Retrieve and validate current health certificate information
3.8.3	Revoke and update health certificate

3.0 Digital Health Interventions for Health Management and Support Personnel (Health System Managers)

The digital health interventions for health management and support personnel (Health System Managers) are described below. Descriptors that are semantically related (=), along with a representative example for each category (💡) are also included.

Further illustrative examples can be viewed at bit.ly/CDISAH.

3.1 Human resource management

Digital approaches to manage the health workforce, including the use of databases to record training levels, certifications, and identification of health workers.

3.1.1 List health workforce cadres and related identification information

= *Health worker registry; provider registry*
- *Documentation of healthcare providers' demographics, identification, health facility assignment, and other identifier information*

💡 **A human resource information management system**: "The iHRIS Manage component of the software suite facilitates health workforce tracking, management, deployment and mapping " (47)

3.1.2 Monitor performance of healthcare provider(s)

= *Remote monitoring of healthcare providers*
- *Workforce management*
- *Audit and feedback*
- *Supervision, supportive supervision*
- *Clinical task tracking*

💡 **Mobile learning solution**: "Community Health Extension Workers (CHEWs)receive weekly reports on worker performance and are able to target those in need of additional support..." (35)

3.1.3 Manage registration/ certification of healthcare provider(s)

= *Management of health worker registration*
- *Certification or licensure with regulatory authority such as a professional council*

💡 **Electronic human resources information system**: "Electronic records are easier to find and update, enabling Council staff to more efficiently verify a prospective employee's training qualifications. In addition, the system provides a way to ensure that nurses and midwives have completed the continuous professional development courses required to maintain licensure." (48)

3.1.4 Record training credentials of healthcare provider(s)

= *Track or manage preservice and/or in-service training received by a health worker*

💡 "The electronic human resources information system added significant value.... Electronic records are easier to find and update, enabling Council staff to more efficiently verify a prospective employee's training qualifications." (48)

3.1.5 Manage health workforce activities

- *Assignment of activities to healthcare providers*
  - *Assignment of specific populations of persons to healthcare providers or teams of healthcare providers*

Unnamed example: Digital solutions that are used by health resource managers to manage healthcare worker assignment and activities.

3.2 Supply chain management

Digital approaches for monitoring and reporting stock levels, consumption and distribution of medical commodities. This can include the use of communication systems (e.g. SMS) and data dashboards to manage and report on supply levels of medical commodities.

3.2.1 Manage inventory and distribution of health commodities

- *Stock monitoring of health commodities*
  - *Logistics management*
  - *Stock management*
  - *Commodity security*

"...electronic Logistics Management Information System collects data on consumption and availability of family planning commodities, which is consolidated and entered for [viewing on] an interactive dashboard." (49)

3.2.2 Notify stock levels of health commodities

- *Stockout prevention and monitoring*
  - *Alerts and notifications of stock levels*
  - *Restocking coordination*

A text message (SMS)-based, web accessible logistics management information system for community-level health products:
"... automatically calculates resupply quantities and notifies staff at health centers, who check their stock levels and advise HSAs on whether stock is available for pick up or alerts health facilities and district managers if there is insufficient stock" (50)

3.2.3 Monitor cold-chain sensitive commodities

- *Sensors to monitor temperature and stability of vaccines*
  - *Supply safety*

"....an SMSbased system that monitors and logs temperature conditions in peripheral cold chain equipment." "....health centers storing vaccines were equipped with remote temperature monitoring devices that included sensors, monitors and SMS gateways. When an alarm is activated due to exceeded temperature limits, an SMS text message is immediately sent to a central server that logs the issue and sends a notification to health workers and supervisors....." (51)

3.2.4 Register licensed drugs and health commodities

- *Drug regulation and registration*

Web-based database with an SMS-based reporting module: The app also includes "an SMS-based information exchange module, which allows ADDO and pharmacy personnel to send and receive information, for example, on accreditation requirements or drug recalls." (52)

3.2.5 Manage procurement of commodities

- *Logistics management*
- *Procurement management*

Pharmaceutical Information Management System: ".....utilized it for managing and ordering medical supplies." (53)

3.2.6 Report counterfeit or substandard drugs by persons

- *Counterfeit drug notification*
- *Monitoring drug authenticity and quality*
- *Pharmacovigilance*

Mobile product authentication solution: "Consumers send an SMS to the ...server of a one-time-use scratch card code listed on the pharmaceutical products and receive reply SMS determining drug authenticity." (54)

3.3 Public health event notification

Digital approaches for alerting and compiling information on non-routine public health events.

3.3.1 Notification of public health events from point of diagnosis

- *Public health surveillance*
- *Event based surveillance*
- *Surveillance from laboratory systems*
- *Disease surveillance*

"Automatically send SMS text or email alerts to MOH officials when a new MDR positive or Rif positive case is detected." (55)

3.4 Civil Registration and Vital Statistics (CRVS)

Digital approaches to support the registration of births and deaths, issue birth and death certificates, and compile and disseminate vital statistics, including cause of death information (56).

3.4.1 Notify, register and certify birth event

- *Birth event alert*
- *Birth registration, can include registration for health system purposes, as well as registration to civil registrar.*
- *Civil Registration and Vital Statistics (CRVS)*
- *Issuance of birth certificate*

Monitoring of vital events using information technology:: "...mobile phone data collection and a web-based reporting platform for the notification and registration of births and deaths occurring outside of the health facilities." "The system can also inform family members when the certificates are ready..." (57)

3.4.2 Notify, register and certify death event

- *Death surveillance*
- *Death event alert*
- *Mortality surveillance*
- *Issuance of death certificate*

Monitoring of vital events using information technology: Health workers can use SMS on mobile phones to notify a death event. (57)

3.5 Health system financial management

Digital approaches to manage and monitor funding flows within the healthcare system. These digital financial transactions can be used for payments to health workforce, insurance/payers, as well as administrative management of budget and expenditures.

3.5.1 Register and verify health coverage scheme membership of persons

- *Eligibility verification for insurance, social services or other financing schemes*
  - *Determination of insurance coverage*
  - *Recording and verifying that a person is a member of a scheme or entitled to benefits*
  - *Social protection*
  - *Identification of eligible individuals for subsidized contributions/payments for health coverage schemes*

Mobile enrolment app: Used for the "secure digital administration of large-scale health schemes via mobile phones." It uses "contactless systems to verify patients seeking treatments at hospitals." (46)

3.5.2 Track and manage insurance billing and claims processes

- *Social protection; administrative transaction processing; claims management; claims submission; fraud detection*
  - *Claims and encounter reports for reimbursement*
  - *Insurance financial transactions*
  - *Verification of claims eligibility*
  - *Claims adjudication*

E-claims system: "At the service provider side, 29 health facilities were initially selected to submit claims through two options: (1) an XML (Extensible Markup Language) interface that transmits claim information from the provider's HMIS and electronic health record system, and (2) web-based tool for entering and submitting claim information." (58)

3.5.3 Transmit and manage payments to health facilities

- *Performance-based payments to health facilities*

MSM mobile money system: "Health facilities register to receive and send payments with the mobile phone operator of their choice. They can then receive cash payments through their phones..." (59)

3.5.4 Transmit and manage routine payroll payment to healthcare provider(s)

- *Health worker routine payments*
  - *Payroll management*

"...developed mobile applications that link to the database and included a mobile payment component for premises and personnel fees..." (52)

3.5.5 Transmit or manage financial incentives to healthcare provider(s)

- *Financial incentives for health worker motivation*
  - *Conditional payments; performance-based financing for health workers; results-based financing*
  - *Provider reimbursement*

Mobile application for community-based family planning services: "...pay-for-performance system with monthly performance targets with real-time performance tracking on the CHW phone and program dashboard." (60)

3.5.6 Manage and plan budget allocations, revenue and expenditures

- *Financial management*
  - *Resource planning including forecasting*
  - *Facility operation financial management*

Web-Based planning, budgeting, and reporting system: A web-based platform that "assists in planning, budgeting, projecting revenue, and tracking funds received." (61)

3.5.7 Determine level of subsidies for health coverage schemes

- *Determine the contribution rate for subsidized households*

Digital technologies to support the identification of poor and vulnerable population groups for health coverage schemes: "....to determine which contribution rate a household should pay, the 3MS system can retrieve the information from the Ubudehe system." (62)

3.5.8 Collect health insurance contributions

- *Electronic or mobile payment of insurance contributions*
  - *Digital systems to register and manage payment information*
  - *Verification of payment status*

Money transfer platform: "...to facilitate timely remittance of member contributions and maintenance of up-to-date payment information for individual accounts, NHIF has partnered with (...) a leading telecommunications company in Kenya, to provide a flexible and convenient platform for remittance of monthly insurance premium contributions from informal sector populations." (59)

3.6 Equipment and asset management

Digital approaches to track and manage the maintenance of health equipment. This can include the use of databases, as well as sensors and feedback mechanisms for monitoring health equipment.

3.6.1 Monitor status and maintenance of health equipment

- *Listing of available equipment and physical assets, e.g. hospital beds*
  - *Tracking maintenance of equipment*

Unpublished example: Mechanisms to regularly update a list of available physical assets within health facilities and track their maintenance needs.

3.6.2 Track regulation and licensing of medical equipment

- *Physical asset management*
  - *Regulation of physical assets*

Unpublished example: Countries have regulatory and licensing procedures for equipment used in the health sector. Digital systems can help track equipment through the regulatory process and manage information about the regulatory status of different types and brands of equipment.

3.7 Facility management

Digital approaches that enable administrative functions related to the management of facilities

3.7.1 List health facilities and related information

- *Register health facilities*
  - *List unique IDs and locations of health facilities*
  - *Health facility registry*
  - *Catchment area management*

Master Health Facility list: "...mapped facilities were placed on an online portal for verification by state-level and district-level officers on 21 attributes covering the signature domain and facility functionality information. A random numbering system was used to allocate the 10-digit unique identification number (national identification number) for all verified facilities." "The portal holds records of more than 200 000 verified public health facilities covering all states and union territories." (63)

3.7.2 Assess health facilities

- *Assess performance and capacity of services provided at health facilities*
  - *Regulate and monitor services provided at health facilities*
  - *Supervision of health facilities*

Smartphones for supportive supervision for TB: "...a standard, integrated TB supervision checklist to assess and monitor diagnostic laboratories and DOTS services in the public and private sectors." (64)

3.8 Person-centred health certificate management

Digital approaches to register, store, update, retrieve, validate and revoke individuals' health certificate information. A health certificate being a verifiable credential attesting to the occurrence of a health (or health-related) event pertaining to a person.

3.8.1 Register and store current health certificate information

- *Create/ Generate health certificate information*

Digital immunisation certificates: Digital tools that provide the digital documentation of immunisation certificates and support the "...issuance, verification, and acceptance of interoperable certificates of vaccinations, tests, and recovery." (65)

3.8.2 Retrieve and validate current health certificate information

- *Confirm person's status by accessing a subset of their health record*
  - *Verify the validity and authenticity of health certificate*

See example 3.8.1

3.8.3 Revoke and update health certificate

See example 3.8.1

4.0 Digital Health Interventions for Data Services

The taxonomy in this group describes the capabilities of digital technology that can be implemented to support objectives that are targeted toward optimal data management, use and governance.

4.0 DIGITAL HEALTH INTERVENTIONS FOR DATA SERVICES

4.1	Data Management
4.1.1	Form creation for data acquisition
4.1.2	Data storage and aggregation
4.1.3	Data synthesis and visualizations
4.1.4	Automated analysis of data to generate new information or predictions on future events

4.2	Data coding
4.2.1	Parse unstructured data into structured data
4.2.2	Merge, de-duplicate and curate coded datasets or terminologies
4.2.3	Classify disease codes or cause of mortality

4.3	Geo spatial information management
4.3.1	Map location of health facilities/structures and households
4.3.2	Map location of health event
4.3.3	Map location of persons and settlements
4.3.4	Map location of healthcare provider(s)
4.3.5	Map health and health indicator data to geographic data

4.4	Data exchange and Interoperability
4.4.1	Point-to-point data integration
4.4.2	Standards-compliant interoperability
4.4.3	Message routing

4.5	Data governance compliance
4.5.1	Authentication and authorisation
4.5.2	Data privacy protection
4.5.3	Data consent and provenance
4.5.4	Trust architecture

4.0 Digital Health Interventions for Data Services

The digital health interventions for Data Services are described below. Descriptors that are semantically related (=), along with a representative example for each category (💡) are also included.

Further illustrative examples can be viewed at bit.ly/CDISAH.

4.1 Data Management

Digital approaches to data management including collection, aggregation/organisation and storage for analysis. This can include standalone interventions focusing exclusively on data collection and aggregation, as well as data services to support other interventions, such as data visualization.

4.1.1 Form creation for data acquisition

= *Electronic data collection, digital data collection*
- *Mobile based surveys, using applications such as OpenDataKit (ODK), Enketo, FormHub, etc.*

💡 **Unnamed example**: Digital applications for survey administration and creation of questionnaires.

4.1.2 Data storage and aggregation

= *Data warehouse, repository*

💡 **The Global Health Observatory Data Repository**: "publicly available interface for the World Health Organization's health-related statistics for.... Member States. It includes statistics for over 1,000 indicators including mortality, child nutrition, maternal health, HIV/AIDS, environmental health, equity, and more." (66)

4.1.3 Data synthesis and visualizations

= *Reporting dashboards, report generation*
- *Presentations of data*
- *Business intelligence*

💡 **Health Management Information Systems (HMIS) platform in LMICs**: "Get the complete overview through the pivot table feature, spot trends in your data with charting and visualize your geographical data aspects using the GIS functionality."(23)

4.1.4 Automated analysis of data to generate new information or predictions on future events

= *Predictive analytics*
- *Artificial intelligence including Machine learning*
- *Calculations*

💡 **Simplified, effective, labour monitoring-to-action tool**: "Prediction models will be developed to identify women at risk of intrapartum-related perinatal death or morbidity (primary outcomes) throughout the course of labour." (67)

4.2 Data coding

Digital approaches to code data and manage the use of standardized datasets.

4.2.1 Parse unstructured data into structured data

- *Dirty data management*
  - *Automated data cleaning*

Unpublished example: This tool will develop a set of automated algorithms for cleaning and linking unstructured information (e.g. medical notes) to structured datasets.

4.2.2 Merge, de-duplicate and curate coded datasets or terminologies

- *Maintenance and versioning of health informatics terminology standards*
  - *Terminology services*
  - *Semantic interoperability*

Unpublished example: Terminology management applications for standardizing data and mapping similar definitions across systems.

4.2.3 Classify disease codes or cause of mortality

- *Recording cause of death*
  - *ICD coding, clinical coding for reporting and insurance*
  - *Mapping local terminology, codes, and formats*

Electronic diagnostic terminology software: "It is an encyclopaedia of medical terms that has an automated codebook format type of encoder, incorporating all ICD-10 codes and all ICPC2 codes. It is developed for use offline and well suited for paper-based medical records. It enables the coder to type the diagnosis/health problem into a search bar and review code selections, look-up tables and various other automated notations that facilitate the choice of the most accurate code."(68)

4.3 Geo spatial information management

The use of geolocation coordinates to map objects and events.

4.3.1 Map location of health facilities/ structures and households

- *Global Positioning System (GPS) mapping*
  - *Mapping distances between locations including listing travel times between and within settlements and health facilities/structures*

GIS mapping of health facilities: "The portal displayed the location of each facility location on Google Maps. It allows a user to conduct searches for facilities by district, public or private sector ownership, and services."(69)

4.3.2 Map location of health event

- *Geospatial visualization*
  - *GPS mapping*

Mobile SMS-based disease outbreak alert system web portal: " Web portal displays a dashboard with patient-level information, bar graphs with cumulative incidents, and hot spot maps indicating the health facilities that reported the cases." (70)

4.3.3 Map location of persons and settlements

- *Demarcation of catchment areas*
- *Mapping coverage areas*
- *Geospatial visualization*
- *GPS mapping*
- *Population density mapping*

Web-based indoor residual spraying (IRS) tool: "Team leaders enter data on their tablets while standing at each house, which is sent to the cloud server as soon as a data connection is established. The spatially-integrated spray data is then visualized on the tablet by the team leaders showing the location and type of spray point." (71)

4.3.4 Map location of healthcare provider(s)

- *Mapping of health worker route to track the services provided*

Geographic information system to track vaccination teams movement and performance. (72)

4.3.5 Map health and health indicator data to geographic data

- *Geocoding*
- *Data triangulation*
- *Distributed mapping*

Digital tools that allow association of non-spatial attributes to spatial objects to enable health analysis. For example, used to associate health data to pertinent geographic boundaries for display and visualization of health programs and outcomes.

4.4 Data exchange and Interoperability

The capability of two or more systems to communicate and exchange data through specified data formats and communication protocols. (73)

4.4.1 Point-to-point data integration

- *Data mediation*
- *Information exchange*
- *Integration between health systems and between health and non-health systems*
- *Interface*

"National health information exchange platform to facilitate the communication between different health information systems (HISs) and eHealth services." "It allows exchange of health care data between different HISs, care organisations, governmental agencies, patient communities and patients according to nationally defined service contracts." "Rather than having direct integration between HISs, all integration is with the national HIE platform which then redirects requests for information and transactions to the appropriate system."(74)

4.4.2 Standards-compliant interoperability

- *Interoperability layer*
- *Semantic interoperability*
- *Technical interoperability*
- *Information exchange*

See example 4.4.1

4.4.3 Message routing

- *Routing of messages to appropriate architecture component or external Point-of-Service system.*
- *Enterprise service bus*
- *Data orchestration*

See example 4.4.1

4.5 Data governance compliance

Digital approaches that support the process of maintaining the integrity and security of data to enable the secondary use of health data.

4.5.1 Authentication and authorisation

- *Identity verification*
  - *Permissions*
  - *Identity and Access Management (IAM)*
  - *Role-based access control*

Unnamed example: Digital tools that provide "authentication of health record entries i.e., process used to verify that an entry is complete, accurate and final."(75)

4.5.2 Data privacy protection

- *Secure sensitive data*
  - *Classify and protect sensitive data*
  - *Redact sensitive data*
  - *Data minimization*

Unnamed example: Digital applications that automate data privacy processes.

4.5.3 Data consent and provenance

- *Selective disclosure*
  - *Consent management*

Consent management system "allows users to control their personal data collection and consent to its usage throughout the data lifecycle." "Users can delegate their consent rights and audit them by tracking the event logs..... Users are notified about any consent violation and can withdraw consent at any time." (76)

4.5.4 Trust architecture

- *Trust network*
  - *Certification network*

Unnamed example: Digital applications that provide management of public and/or private trust within an organisation and enable the authentication of digital identities.

SERVICES AND APPLICATION TYPES

The digital services and application types represent the types of software, information and communications technology (ICT) systems and services or communication channels that deliver or execute the digital health intervention(s) and health content. The classification categorizes them into 5 representations within the Digital Health Architecture. Definitions and additional descriptors are included to support the appropriate mapping and categorizing of digital solutions.

A. Point of service

A1	Communication systems
A2	Community-based information systems
A3	Decision support systems
A4	Diagnostics information systems
A5	Electronic medical record systems
A6	Laboratory information systems
A7	Personal health records
A8	Pharmacy information systems
A9	Telehealth systems

B. Health system/ Provider administration

B1	Blood bank information management systems
B2	Health finance-related information systems
B3	Health program monitoring systems
B4	Human resource information systems
B5	Learning and training systems
B6	Logistics management information systems (LMIS)
B7	Patient Administration systems
B8	Research information systems

C. Registries & Directories

C1	Census and population information systems
C2	Civil registration and vital statistics (CRVS) systems
C3	Facility management information systems
C4	(Health) Facility registries
C5	Health worker registry
C6	Identification registries and directories
C7	Immunization information systems
C8	Master patient index
C9	Product catalogues
C10	Public Key directories
C11	Terminology and classification systems

D. Data Management services

D1	Analytics Systems
D2	Data interchange and interoperability
D3	Data warehouses
D4	Environmental monitoring systems
D5	Geographic information systems (GIS)
D6	Health Management Information systems (HMIS)
D7	Knowledge management systems
D8	Shared Health Record and Health Information Repository

E. Surveillance and Response

E1	Emergency preparedness and response systems
E2	Public health and disease surveillance systems

A. Point of service

Systems that facilitate the provision and delivery of healthcare services to persons at the point of care. They include software capabilities that enable healthcare providers to access, record and update individuals' health information as well as interactively communicate with them. (1)

A1 Communication systems

Systems that are used to transfer electronic information. (2) Messages can be exchanged between healthcare providers or between healthcare providers and persons.

Other descriptors:
- Person-centred (Client) communication
- Hospital communication system
- Clinical/ Medical communication
- Care communications

Functional areas include:
- Referrals
- Emergency alert and notifications
- Provider-to-person communication
- Provider-to-provider communication/ Healthcare worker collaboration

A2 Community-based information systems

Applications that facilitate data collection and use at the community level. These applications are utilised by community-based workers who provide health promotion and disease prevention activities.

Functional areas include:
- Patient management
- Tasking
- Decision support
- Community communication

A3 Decision support systems

"Computer based tools which combine medical information databases and algorithms with patient specific data. They are intended to provide healthcare professionals and/or users with recommendations for diagnosis, prognosis, monitoring and treatment of individual patients."(2)

Other descriptors:
- AI for clinical decision support
- Clinical decision support

A4 Diagnostics information systems

Other descriptors:
- Diagnostic applications found in devices (Software in a medical device)
- Wearables that collect health data generated by the user
- Software as a medical device
- Radiology information systems
- Medical imaging systems
- Picture archiving and communication system (PACS)

A5
Electronic medical record systems

A secure, online system that holds information about people's health and clinical care and is managed by healthcare providers.

Other descriptors:
- Electronic health record

Functional areas include:
- Clinical decision support
- Record management
- Person(s) registration

A6
Laboratory information systems

"Systems that support the process from patient sample to patient result."(2)

Other descriptors:
- Laboratory information management system (LIMS)

Functional areas include:
- Lab requests/ test ordering
- Sample tracking
- Sample processing
- Results reporting

A7
Personal health records

Digital personal health record is a record of an individual's health information in a structured digital format for a set of defined use cases over which the person has agency.

Other descriptors:
- Patient portals

Functional areas include:
- Appointment booking and cancellations
- Appointment reminders and summaries
- Prescription list
- Secure messaging to providers
- Test results

A8
Pharmacy information systems

Other descriptors:
- Medication information

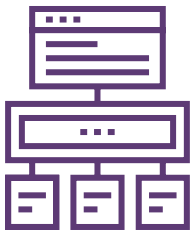
Functional areas include:
- Dispensing
- Drug interaction monitoring
- Decision support
- Medicines inventory management
- Medicines administration
- Electronic prescribing

A9
Telehealth systems

"Electronic information and telecommunication technologies that support long-distance clinical health care, patient and professional health-related education, public health and health administration."(3) "They are intended to allow monitoring and/or delivery of healthcare to patients at locations remote from where the healthcare professional is located."(2)

Other descriptors:
- Telemedicine systems
- Virtual health and care
- Tele-expertise
- Tele-triage

Functional areas include:
- Store and forward
- Interactive services
- Remote patient (or person) monitoring
- Teleconsultation
- Guided self help



B. Health System/ Provider administration

Systems that provide capabilities that facilitate the administrative and clinical management aspects of health systems. They provide software capabilities or services to healthcare that may be leveraged by other applications across the digital health enterprise.(1)

B1 Blood bank information management systems

Other descriptors:
- Blood bank software

Functional areas include:
- Lab test management
- Patient management
- Blood components management
- Donor test results management
- Adverse reaction data management

B2 Health finance-related information systems

"Stores, categorizes and facilitates the administration of centralised claims and finance related data to care provision to patients within the health information exchange (HIE). The service receives claims/ financial data from Point of Service (PoS) applications (including financing applications acting as a point of service interface outside of other PoS systems) and curates the management of them."(4)

Other descriptors:
- Integrated financial management information system
- Public financial management information systems
- Health coverage schemes information management systems
- Health insurance information system
- Social protection scheme management
- Claims management system
- Budget systems

Functional areas include:
- Health accounts
- Facility financial management
- Revenue and expenditure management
- Claims management

B3 Health program monitoring systems

Other descriptors:
- Delivery monitoring
- Health program forecasting

B4 Human resource information systems

Systems that supply health system/ resource leaders with information to track, manage and plan the health workforce.

B5
Learning and training systems

Other descriptors:
- e-learning platform
- Medical simulation software
- Case log systems

Functional areas include:
- continuing professional development (CPD) / continuing medical education (CME) tracking

B6
Logistics management information systems (LMIS)

Systems that store and aggregate routine supply chain data and facilitates its analysis for improving supply chain management.(1) They play a central role in enabling commodity visibility and operational management of a wide-area supply chain operation.(4)

Other descriptors:
- Supply chain management system

Functional areas include:
- Stock forecasting
- Cold chain monitoring
- Order management
- Warehouse management
- Inventory management

B7
Patient Administration systems

Functional areas include:
- Admissions-Discharge-Transfer (ADT)
- Patient care tracking
- Bed occupancy status
- Admissions management
- Appointments management

B8
Research information systems

Other descriptors:
- Clinical trial management software (CTMS)
- Electronic lab notebook

C. Registries & Directories

Systems that serve as a central authority for maintaining specific sets of data. They provide software capabilities or services that are canonical/master lists, which are enforced by specific governance mechanisms.(1)

C1 Census and population information systems

Digital systems that systematically record information about members of a population.(1)

Other descriptors:
- National ID systems
- Population register

C2 Civil registration and vital statistics (CRVS) systems

"Registers all births and deaths, issues birth and death certificates, and compiles and disseminates vital statistics, including cause of death information. It may also record marriages and divorces."(5)

Functional areas include:
- Birth registration and certificates
- Death registration and certificates
- Cause of death assignment/selection tool
- Verbal autopsy tool

C3 Facility management information systems

Functional areas include:
- Facility based performance management
- Asset management
- Facility registration
- Accounts receivable

C4 (Health) Facility registries

A central authority to uniquely identify all places where health services are administered within a country.(1)

Other descriptors:
- Facility directory

C5 Health worker registry

Central authority for maintaining the unique identities of healthcare providers within a country.(1,4)

Other descriptors:
- Human resource information systems

C6
Identification registries and directories

Systems that serve as a central authority for maintaining unique identifiable data of citizens in a population. They provide proof of legal identity and "enable a person to prove who they are, using credentials recognised by law."(6)

C7
Immunisation information systems

"Confidential, population-based, computerized databases that record all immunization doses administered by participating providers to persons residing within a given geopolitical area."(7)

Other descriptors:
- Electronic immunisation registry
- Immunisation records
- Vaccination records

Functional areas include:
- Immunisation status monitoring
- Reminder/ recall notification
- Immunisation record generation

C8
Master patient index

Manages the unique identity of individuals receiving health services within a country.(1,4)

Other descriptors:
- Client (Person-centred) registry
- Patient registry

C9
Product catalogues

The central authority for defining products, such as health and medical commodities, and their categorization.(1)

Other descriptors:
- Product registry

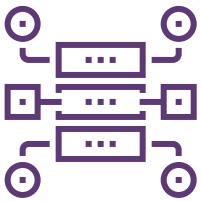
C10
Public Key directories

Central repository for exchanging the information required to authenticate electronic machine-readable documents including health certificates.

C11
Terminology and classification systems

A central authority to uniquely identify the clinical activities that occur within the care delivery process by maintaining a terminology set mapped to international standards such as ICD10, ICD11, LOINC, SNOMED and others.(1,4)

Other descriptors:
- Clinical terminology
- Terminology service
- Terminology management service
- Terminology coding/ mapping tool



D. Data Management services

Systems that serve as a repository containing data that has been validated. They provide capabilities to store, process, retrieve and analyse data held within such systems.

D1 Analytics systems

"Systems that examine and process the information outputs produced by middleware."(8) They are data tools that are used to facilitate decision making.(1)

Other descriptors(9):
- Predictive analytics
- Prescriptive data analytics
- Diagnostic data analytics
- Descriptive data analytics

Functional areas include:
- Data visualization
- Dashboards
- Business intelligence
- Clinical data dashboards

D2 Data interchange and interoperability

Provides software capabilities to support managed data exchange and interoperability between applications and services across the digital health enterprise.(1)

Other descriptors:
- Interoperability layer
- Health information exchange

Functional areas include:
- Authentication
- Entity matching service

D3 Data warehouses

"An enterprise system used for the analysis and reporting of structured and semi-structured data from multiple sources."(10)

Other descriptors:
- Repositories
- Data storage
- National Data Repository

Functional areas include:
- Data processing (extract, transform, load - ETL)
- Data consolidation
- Data cleaning
- Reporting

D4 Environmental monitoring systems

"Environmental management information systems (EMIS) are organizational-technical systems for systematically obtaining, processing, and making available relevant environmental information."(11)

Other descriptors:
- Environmental management information systems (EMIS)

D5
Geographic information systems (GIS)

"Computer system that analyses and displays geographically referenced information."(12)

Functional areas include:
- Display of spatial relationships

D6
Health Management Information systems (HMIS)

Stores routinely collected aggregate healthcare data and facilitates their analysis, with the goal of improving the quality of health services.(1,4)

Other descriptors:
- Hospital information systems
- Clinic information systems

Functional areas include:
- Analytics
- Performance management

D7
Knowledge management systems

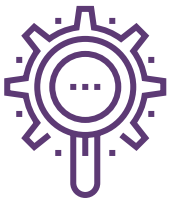
Systems that facilitate the creation and utilisation of knowledge.(13) "They are databases containing inference rules and information relating to expert knowledge in a special field."(14)

Other descriptors:
- eLearning system
- Knowledge base software
- Content management software

D8
Shared Health Record and Health Information Repository

A repository containing the normalized version of content created within the community, after being validated against other registries (i.e., health worker registries, facility registries, client/person-centred registries). It is a collection of person-centric records for patients with information in the exchange.(4)

Other descriptors:
- Longitudinal health records
- National health domain-specific registries
- Clinical data repository
- Clinical data warehouse



E. Surveillance and Response

Systems that support the continuous, systematic collection, analysis and interpretation of data for use in health contexts. They provide software capabilities that utilise protocols to generate information.

E1 Emergency preparedness and response systems

"Systems that support the management of knowledge and capacities to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters."(15)

Other descriptors:
- Early warning system

Functional areas include:
- Contact tracing
- Track and trace
- Case reporting
- Case investigation

E2 Public health and disease surveillance systems

Other descriptors:
- Disease registries
- Infection surveillance
- Community based surveillance
- One-health surveillance
- Public health indicator reporting

Functional areas include:
- Case reporting
- Vaccine-related adverse events monitoring
- Social media monitoring

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Annex

How was the CDISAH developed?

This Classification scheme reflects emerging uses of digital technologies for health.

First edition (published in 2018)

The taxonomy leveraged mobile health (mHealth) categorizations from the mHealth Technical Evidence Review Group (mTERG) and Labrique et al.(5), and expanded on these terms to be inclusive of eHealth and broader capabilities that have relevance in the health sector. WHO convened a series of technical consultations to further refine these terminologies and definitions. Public feedback was solicited through the Health Data Collaborative Digital Health and Interoperability Working Group. Additionally, a desk review was conducted to align with reference frameworks [2-4], and to establish examples of DHI in current use.

Second edition

WHO employed a collaborative, systematic and public process of review and refinement of the classifications guided by various stakeholders and subject matter experts across the digital health and healthcare communities including digital health experts from WHO regional offices and other WHO technical departments. The WHO collaborating centre at the University of Geneva with the Geneva Health Forum (GHF) Working Group contributed a review and gap assessment of the first edition of the CDHI, which was used to inform updates to the Classification. In addition, participants from the Classifications Small Working Group (SWG) of the Digital Health and Interoperability (DH&I) working group provided input and feedback to these recommendations. Comments and feedback were also sought through public consultation, to inform revisions. Via public forms on the WHO website, feedback was received globally from a wide range of stakeholders across various sectors including healthcare, research, UN/International Organizations, government, donors, implementation, trade associations, standards development organizations, and the technology sector.

As part of the update process, an advisory committee was convened by WHO to review the input received via public process and via technical working groups, to inform the content and structure of the updated edition of the Classification.

The update was led by WHO's Department of Digital Health and Innovation (DHI), using the following guiding principles:

- *Update interventions to include novel digital capabilities only when there is evidence in the literature of their use.*
- *Consider advances in technology and the additional interventions that have arisen including in response to the global COVID-19 pandemic.*
- *Retain the fundamental structure across the document, including four primary user types of digital health interventions*
- *Consider adding new health system challenges if they were not included in the first edition*
- *Improve clarity and usability of the section on Systems Categories*

How will the CDISAH evolve?

This reference Classification will continue to evolve as new digital functionalities, health systems challenges, and digital applications and services emerge and the evidence-base increases. The WHO Secretariat will seek input, and periodically update this Classification based on technical consultations and public feedback and highlight new editions.

Individuals that would like to provide feedback on any aspect of the classification, including suggestions for additional illustrative examples, should please do so via this form. Subsequent editions of this Classification will be available via the DHI department webpage.

Feedback form can be accessed at bit.ly/cdisah_feedback.

A full list of illustrative examples of digital health interventions can be accessed at bit.ly/CDISAH

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