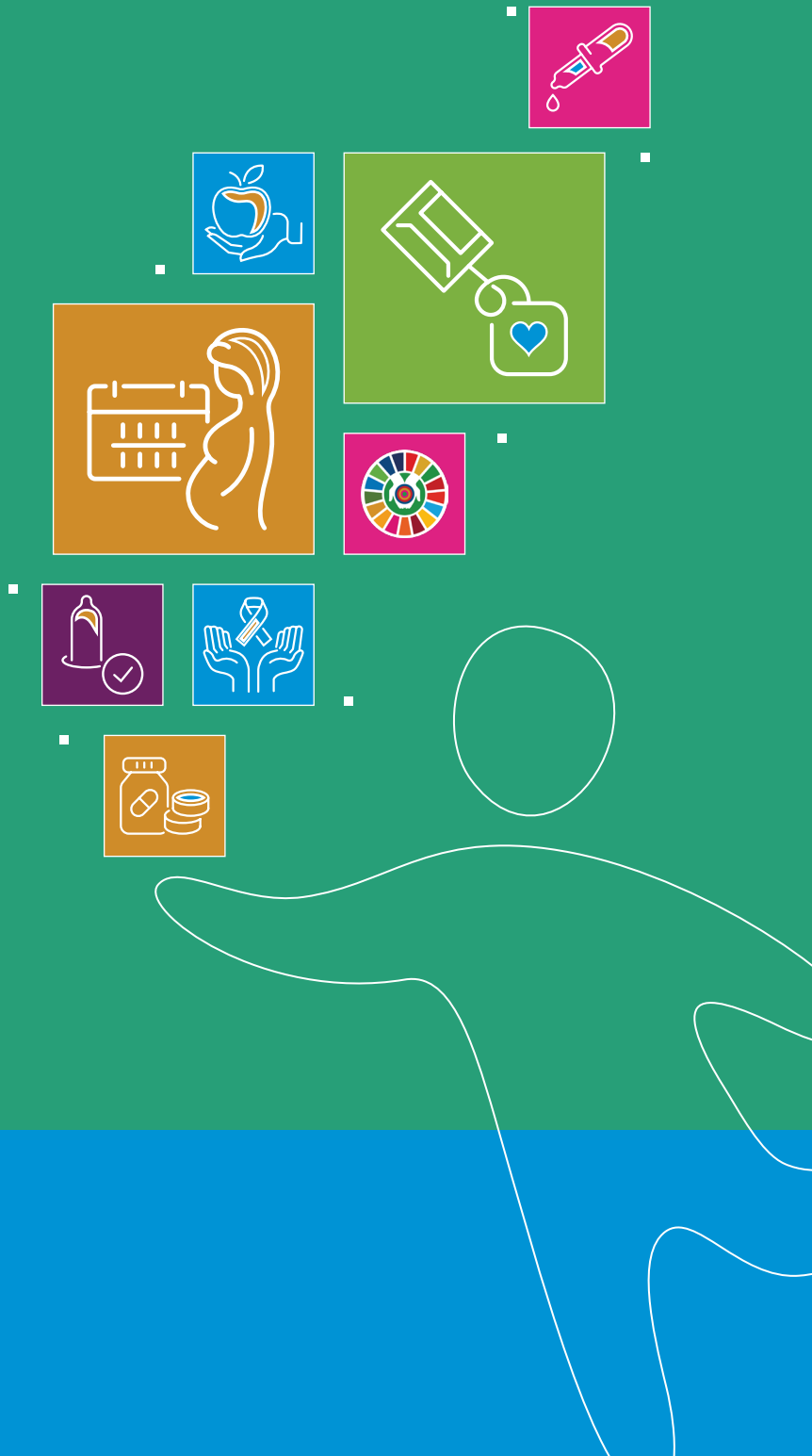
SMART GUIDELINES COLLECTION

Digital adaptation kit for self-monitoring of blood pressure during pregnancy

Operational requirements for implementing WHO recommendations in digital systems



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Digital adaptation kit for self-monitoring of blood pressure during pregnancy: operational requirements for implementing WHO recommendations in digital systems (SMART Guidelines collection)

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Contents

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Abbreviations

ANC	antenatal care
ANM	auxiliary nurse midwife
BP	blood pressure
BPMN	business process model and notation
CHW	community health worker
DAK	digital adaptation kit
DHI	digital health intervention
DT	decision-support table
eHealth	electronic health
HB/PHR	home-based or personal health record
ICD	International Classification of Diseases
ICF	International Classification of Functioning, Disability and Health
ICHI	International Classification of Health Interventions
ICT	information and communications technology
ID	identification
ISCO	International Standard Classification of Occupations
LOINC	Logical Observation Identifiers Names and Codes
PCPOSS	person-centred point-of-service systems
SMART	standards-based, machine-readable, adaptive, requirements-based and testable
SMBP	self-monitoring of blood pressure
SNOMED	Systematized Nomenclature of Medicine
UHC	universal health coverage
WHO	World Health Organization

Glossary

Note: Terms in definitions also defined in this glossary shown in *italics*.

Business process	A set of related activities or *tasks* performed together to achieve the objectives of the health programme area, such as registration, counselling, referral *(1,2)*.
Data dictionary	A centralized repository of information about the *data elements* that contains their definition, relationships, origin, usage and type of data. For this digital adaptation kit, the data dictionary is provided as a spreadsheet.
Data element	A unit of data that has specific and precise meaning.
Decision-support logic	A set of decision rules for standard and exceptional cases that is separate from the *business process*. This helps reduce the complexity of the *business process* depiction without losing the detail necessary for coding the rules required for system functionality.
Decision support (for health workers)	Digitized job aids that combine an individual's health information with the health worker's knowledge and clinical protocols to assist health workers in making diagnosis and treatment decisions *(3,4)*.
Decision-support table	Semi-structured way to depict each discrete decision that will need to be embedded in the system. Depending on the complexity of the clinical guidelines, there will likely be multiple decision-support tables.
Digital health	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 *(1,5)*.
Functional requirement	A capability the system must have in order to meet the end users' needs and achieve *tasks* within the *business process*.
Health information system	A system that integrates data collection, processing, reporting and use of the information necessary for improving health service effectiveness and efficiency through better management at all levels of health services *(6)*.
Health management information system (HMIS)	An information system specifically designed to assist in the management and planning of health programmes, as opposed to delivery of care *(6)*.
Interoperability	The ability of different applications to access, exchange, integrate and use data in a coordinated manner through the use of shared application interfaces and standards, within and across organizational, regional and national boundaries, to provide timely and seamless portability of information and optimize health outcomes.
Non-functional requirement	General attribute or feature of the digital system to ensure usability and overcome technical and physical constraints. Examples of non-functional requirements include ability to work offline, multiple language settings and password protection.
Persona	A generic aggregate description of a person involved in or benefitting from a health programme.
Self-care	The ability of individuals, families and communities to promote health, prevent disease, maintain health and to cope with illness and disability with or without the support of a health worker *(7)*.
Self-management	Management of or by oneself; the taking of responsibility for one's own behaviour, health and well-being *(7)*.
Standard	In software, a standard is a specification used in digital application development that has been established, approved and published by an authoritative organization. These rules allow information to be shared and processed in a uniform, consistent manner independent of a particular application.
Task	A specific action in a *business process*.
Terminologies	For clinical care, terminologies are structured vocabularies covering health-related concepts – such as diseases, diagnoses, laboratory tests and treatments – to enable the storage, analysis and exchange of data in a consistent and standard way *(8)*.
Workflow	A visual representation of the progression of activities (*tasks*, events, decision points) in a logical flow illustrating the interactions within the *business process (2)*.

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1

Part 1. Overview of digital adaptation kits

Background

As digital technologies are increasingly being leveraged to enable and support health-service delivery and accountability, health ministries and partners have recognized the value of digital health as articulated within the World Health Assembly resolution *(1)* and the WHO *Global strategy on digital health 2020–2025 (2)*. Similarly, funding agencies have advocated for the rational use of digital tools as part of efforts to expand coverage and quality of services, as well as promote data use and monitoring efforts *(3–5)*.

However, guidelines are often only available in a narrative format that requires a resource-intensive process to be elaborated into the specifications that are needed for operationalizing into digital systems. This translation of guidelines for digital systems often results in subjective interpretation for implementers and software vendors, which can lead to inconsistencies or inability to verify the content within these systems, potentially leading to adverse health outcomes and other unintended effects *(6–9)*. Despite the abundance of digital tools developed and deployed for health care, there is often limited transparency in the data model, logic model, and the evidence-based clinical or public health recommendations contained in these digital tools, as system documentation may be unavailable or proprietary, requiring governments to start from scratch and expend additional resources each time they intend to update and deploy such a system. This lack of documentation undermines the credibility of such systems, leading to dependency on one vendor and haphazard deployments that are unscalable, impeding the opportunity for interoperability that would otherwise enable continuity of care *(9–11)*.

WHO standards-based, machine-readable, adaptive, requirements-based and testable (SMART) guidelines provide essential ingredients to facilitate digital health transformation of health programmes in a way that is consistent with recommended clinical, public health data practices and interoperability standards. To ensure countries can effectively benefit from digital health investments, digital adaptation kits (DAKs), which are the second, operational guidelines layer of the SMART guidelines approach, are designed to facilitate the accurate reflection of WHO clinical, public health and data use guidelines within the digital systems that countries are adopting. DAKs are operational, software-neutral, standardized documentation that distil clinical, public health and data use guidance into a format that can be transparently incorporated into digital systems *(11)*. Although digital implementations comprise multiple factors – including the (i) health domain data and content, (ii) digital intervention or functionality and (iii) digital application or communication channel for delivering the digital intervention – DAKs focus primarily on ensuring the validity of the health content (**Fig. 1**) *(12, 13)*. Accordingly, DAKs provide the generic content requirements that should be housed within digital systems, independent of a specific software application and with the intention that countries can customize them to local needs.

For this DAK, the requirements are based on systems that provide the functionalities of personal health tracking (see **Box 1**) and include components such as personas, workflows, core data elements and decision-support algorithms. Operational outputs, such as spreadsheets of the data dictionary and the detailed decision-support algorithms, are included as part of the DAK as practical resources that implementers can use as starting points when developing digital systems. Furthermore, data components within the DAK are mapped to standards-based classifications and terminologies, such as the International Classification of Diseases (ICD), Logical Observation Identifiers Names and Codes (LOINC), International Classification of Health Interventions (ICHI), International Classification of Functioning, Disability and Health (ICF) and Systematized Nomenclature of Medicine (SNOMED) to facilitate interoperability.

Box 1

Description of personal health tracking

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.

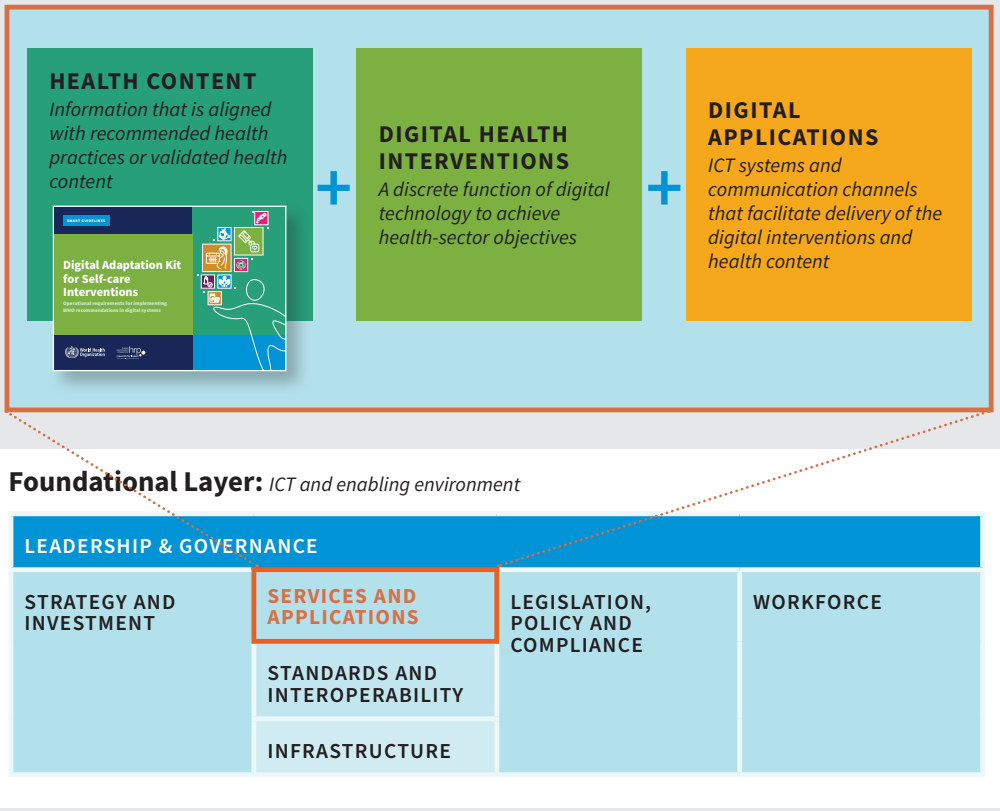
1.4.1 Access by the individual to their own medical or summary health records	*Self-access to health record by an individual; patient's own access to their health record.* - *Ability for persons to track their health history and clinical record.*	**Electronic personal health record**: "makes it possible for patients to augment their medical records with health status data that they have gathered on their own".
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 are 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 the individual	*Personal health monitoring, self-tracking self-care, self-monitoring, journaling (capture of 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."
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 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.

Source: WHO *(14)*.

The DAKs follow a modular approach in detailing the data and content requirements for a specific health programme area – such as antenatal care, family planning, HIV/AIDs, tuberculosis – among the different health areas for which DAKs have been developed. Figure 1 outlines DAKs and their implementation in digital health care. **This DAK focuses on providing the content requirements for self-monitoring of blood pressure (SMBP) in pregnancy through use and tracking of digital personal health records.** Personal health record is defined as 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."

Fig. 1

Digital adaptation kits and their role within digital health implementations



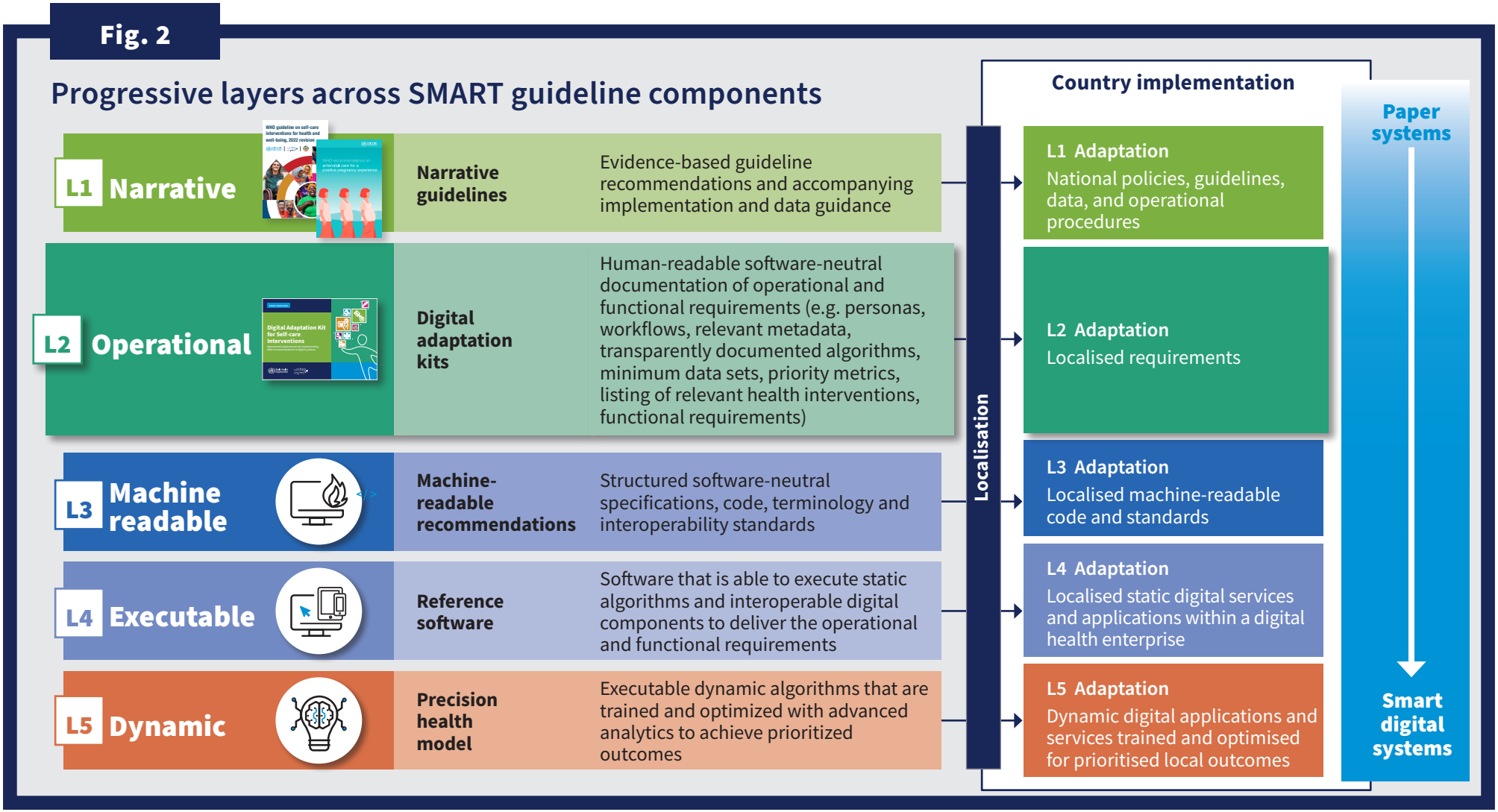
ICT: information and communications technology.

Digital adaptation kits within a strategic vision for SMART guidelines

The operational and standardized documentation reflected within the DAKs represents one of the steps within a broader vision of SMART guidelines. SMART guidelines aim to maximize health impact through improved fidelity and uptake of recommendations within standards-based digital systems via a systematic process of transforming guideline development, delivery and application *(8, 15)*. DAKs serve as a prerequisite for developing computable or machine-readable guidelines, as well as executable reference software and advanced analytics for precision health. Figure 2 provides an overview of the different layers of the SMART guidelines continuum and where DAKs fit within this strategy *(8, 15, 16)*.

Fig. 2

Progressive layers across SMART guideline components



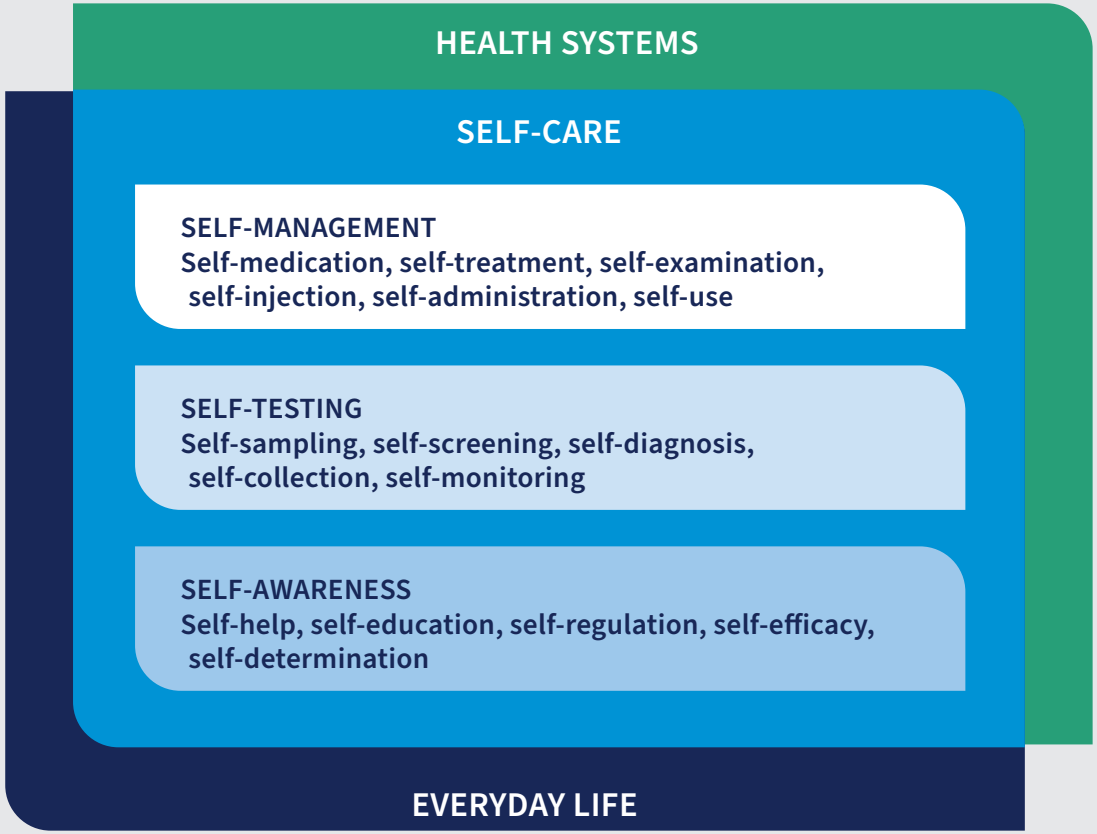
Digital self-care interventions

Self-care interventions enable individuals, families and communities to promote health, prevent disease, maintain health, and cope with illness and disability with or without the support of a health worker *(17)*. Self-care interventions are relevant for all health areas and can be categorized into various modalities such as self-testing or self-management (see **Fig. 3**) *(17, 18)*.

Digital technologies and platforms support clients[1] in achieving tasks essential for access, use and uptake of self-care interventions. This includes accessing health information, learning how to use a health-care product or intervention, managing personal health data, and making informed health decisions on evidence-based drugs and therapeutics, medical devices and diagnostics, information and products *(17)*. Digital health interventions (DHIs) within these tools can make the accomplishment of such tasks easier and more effective. These DHIs are not only for software applications and services at the client level, but also for software used by health and care workers – key players in the digital self-care intervention ecosystem. Whether the user is using a client-facing system or a provider-facing system, a digital tool (delivering one or more DHIs) supports the user's capability in achieving different tasks essential for the successful use of the self-care intervention *(19)*.

Fig. 3

Self-care in the context of interventions linked to health systems



1 Throughout this DAK, "clients" refers to both self-carers and caregivers such as a parent caring for a child. See the definition for client in Part 2: Component 2: Generic personas of this DAK for a more detailed definition.

Objectives of this digital adaptation kit

This DAK focuses on SMBP in pregnancy and aims to provide a common language across various audiences – health programme managers, software developers, and implementers of digital systems – to ensure a common understanding of the appropriate health information content requirements within a defined health programme area, as a mechanism to catalyse the effective use of these digital systems. This DAK also complements the health worker-facing *Digital adaptation kit for antenatal care: operational requirements for implementing WHO recommendations in digital systems* (ANC DAK) *(20)*, in which self-care interventions such as SMBP may be integrated.

The key objectives of this DAK are:

- to foster a common understanding of the particular content needs of the digital self-care intervention ecosystem among health programme leads and digital health teams (including software developers);
- to ensure adherence to WHO clinical, public health and device use guidelines to facilitate consistency of the health content used in the specific aspects of provider-facing and client-facing digital systems that support self-monitoring interventions; and
- to provide a starting point for the specifications for self-care interventions that may be executed through a digital home-based record, describing some of the core data elements and decision-support logic that should be included in this type of tool with the expectation that additional content will be added on in a modular fashion.

Specifically, the DAK details the digital requirements to implement the following recommendations:

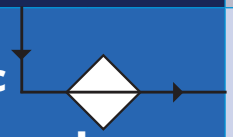
> WHO recommends self-care interventions within a safe, supportive and enabling environment with appropriate links to the health system *(21)*. This first edition of the DAK on self-care interventions focuses on self-monitoring blood pressure in pregnancy in which **WHO suggests making the self-monitoring of blood pressure during pregnancy available as an additional option to clinic blood pressure monitoring by health workers solely during antenatal contacts, for individuals with hypertensive disorders of pregnancy** *(17)*.

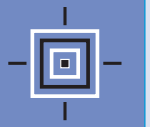
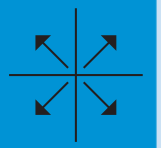
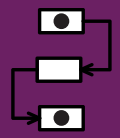
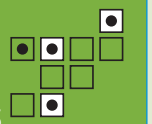
DAKs have also been developed for antenatal care (ANC), family planning, tuberculosis, child health in humanitarian settings, immunizations and HIV. This approach is being expanded to additional health domains, such as postnatal care and community health. All these DAKs work towards a comprehensive approach for standardized software requirements for primary health-care settings.

Components of a digital adaptation kit

The WHO SMART guidelines for the DAK comprises the following interlinked components: (1) health interventions and associated recommendations; (2) generic personas; (3) user scenarios; (4) generic business processes and workflows; (5) core data elements; (6) decision-support logic; (7) scheduling logic; (8) indicators and reporting requirements; and (9) high-level functional and non-functional requirements. Table 1 provides an overview of each of the contributing components of the DAK, which this document elaborates. All information within the digital adaptation kit represents a generic starting point, which can then be adapted according to the specific context.

Table 1. Components of a digital adaptation kit

Component	Description	Purpose	Outputs	Adaptation needed
1. Health interventions and recommendations 	Overview of the health interventions and WHO recommendations included within this digital adaptation kit (DAK). DAKs are meant to be a repackaging and integration of WHO guidelines and guidance documents in a particular health domain. The list of health interventions is drawn from the universal health coverage menu of interventions compiled by WHO *(22, 23)*.	**Setting the stage** to understand how this DAK would be applied to person-centred point-of-service systems (PCPOSS) in the context of specific health programmes and interventions	» **List of related health interventions** based on WHO's Universal health coverage essential interventions *(22)* » **List of related WHO recommendations** based on guidelines and guidance documents	» Contextualization to reflect current or planned national policies
2. Generic personas 	Depiction of the end users and related stakeholders who would be interacting with the digital system or involved in the care pathway.	**Contextualization** to understand the wants, needs and constraints of the end users	» **Description, competencies and essential interventions** performed by targeted personas	» Greater specification and details on the end users based on real people (e.g. health workers) in a given context » High-level information to describe the provider of the health service (e.g. the general background, roles and responsibilities, motivations, challenges and environmental factors)
3. User scenarios 	Narratives that describe how the different personas may interact with the digital system and with each other. The user scenarios are only illustrative and are intended to give an idea of a typical workflow.	**Contextualization** to understand how the system would be used and how it would fit into existing workflows	» Example **narrative** of how the targeted personas may interact with the system and with each other during a workflow	» Greater specification and details on the real needs of end users in a given context
4. Generic business processes and workflows 	A business process is a set of related activities or tasks performed together to achieve the objectives of the health programme area, such as registration, counselling, referrals *(12, 24)*. Workflows are a visual representation of the progression of activities (tasks, decision points, interactions) that are performed within the business process *(12, 24)*.	**Contextualization and system design** to understand how the digital system would fit into existing workflows and how best to design the system for that purpose	» Overview **matrix** presenting the **key processes** in self-monitoring of blood pressure (SMBP) in pregnancy » **Workflows** for identified business processes with annotations	» Customization of the workflows that can include additional forks, alternative pathways or entirely new workflows

Component	Description	Purpose	Outputs	Adaptation needed
5. Core data elements 	Data elements are required throughout the different points of the workflow. These data elements are mapped to standards-based classifications and terminologies to ensure the data dictionary is compatible with other digital systems.	**System design and interoperability** to know which data elements need to be logged and how they map to other standard terminologies (e.g. International Classification of Diseases [ICD] and Logical Observation Identifiers Names and Codes [LOINC]) for interoperability with other standards-based systems	» List of data elements » Link to **data dictionary** with detailed data specifications in spreadsheet format (available here: https://smart.who.int/dak-smbp/dictionary.html)	» Translation of data labels into the local language and additional data elements created depending on the context
6. Decision-support logic 	Decision-support logic and algorithms to support appropriate service delivery in accordance with WHO clinical, public health and data use guidelines.	**System design and adherence to recommended clinical practice** to know what underlying logic needs to be coded into the system	» List of decisions that need to be made throughout the encounter » Link to **decision-support tables** in spreadsheet format with inputs, outputs and triggers for each decision-support logic (available here: https://smart.who.int/dak-smbp/decision-logic.html)	» Change of specific thresholds or triggers in a logic (IF/THEN) statement (e.g. body mass index [BMI] cut-off and age trigger for youth-friendly services) » Additional decision-support logic formulas depending on the context
7. Scheduling logic 	Scheduling logic to support appropriate reminders for follow-up visits and services in accordance with WHO clinical, public health and data use guidelines.	**System design and adherence to recommended clinical practice** to know what service schedules need to be coded into the system so that appropriate reminders are generated.	» List of scheduling logic tables. » **Not included in this DAK**	» Additional scheduling logic depending on the context.
8. Indicators and performance metrics 	Core set of indicators that need to be aggregated for decision-making, performance metrics, and subnational and national reporting. These indicators and metrics are based on data that can feasibly be captured from a routine digital system, rather than survey-based tools.	**System design and adherence to recommended health monitoring practices** to know what calculations and secondary data use are needed for the system, based on the principle of "collect once, use many."	» Indicators table with the numerator and denominator of data elements for calculation, along with appropriate disaggregation » **Not included in this DAK**	» Changing calculation formulas of indicators; » Adding indicators; and » Changing the definition of the primary data elements used to calculate the indicator based on the available data.
9. Functional and non-functional requirements 	List of core functions and capabilities that the system must have in order to meet the end users' needs and achieve tasks within the business process.	**System design** to know what the system should be able to do	» Link to the tables of functional and non-functional requirements with the intended end user of each requirement, and the reason why that end user needs that functionality in the system (available here: https://smart.who.int/dak-smbp/system-requirements.html)	» Adding or reducing functions and system capabilities based on budget and end user needs and preferences

Throughout the DAK, there are identification (ID) numbers to simplify tracking and referencing of each of the components. Note that the DAK represents an overview across the different components, while the comprehensive and complete outputs of each component (e.g. data dictionary and decision-support tables) are linked as implementation tools. Box 2 provides an overview of the notation guidance.

Box 2

ID notation guidance

Component 1: Health interventions and recommendations

No notations used.

Component 2: Generic personas

No notations used.

Component 3: User scenarios

No notations used.

Component 4: Business processes and workflows

» Each workflow should have a "Process name" and a corresponding letter.

» Each workflow should also have a "**process ID**" that should be structured: "**abbreviated health domain**" and "**corresponding letter for the process**" (e.g. if the abbreviated health domain is SMBP and the corresponding letter is B: SMBP.B).

» Each activity in the workflow should be numbered with an "**activity ID**" that should be structured as "**process ID**" and "**activity number**" (e.g. if the activity number is 7: [SMBP].B7)

Component 5: Core data elements (data dictionary)

» Each data element should have a "**data element (DE) ID**" that should be structured as "**activity ID**", "**abbreviated health domain**" (e.g. DE) and "**sequential number of the data element**" (e.g. if the activity ID is B7 and the sequential number of the data element is 1: [SMBP].B7.DE.1; if the sequential number is 2: [SMBP].B7.DE.2)

Component 6: Decision-support logic

» Each decision-support logic table should have a "**decision-support table (DT) ID**" that should be structured as "**activity ID**" and "DT" (e.g. if the decision-support table ID is B3: [SMBP].B3.DT; if the ID is B5: [SMBP].B5.DT)

Component 8: High-level system requirements

» Each functional requirement should have a "**functional requirement (FXNREQ) ID**" that should be structured as "**abbreviated health domain**", "FXNREQ" and "**sequential number of the functional requirement**" (e.g. if the sequential number of the functional requirement is 1: [SMBP].FXNREQ.1; if the sequential number is 2: [SMBP].FXNREQ.2)

» Each non-functional requirement should have a "**non-functional requirement (NFNREQ) ID**" that should be structured as "**abbreviated health domain**", "NFXNREQ" and "**sequential number of non-functional requirement**" (e.g. if the non-functional requirement number is 1: [SMBP].NFXNREQ.1; if the sequential number is 2: [SMBP]. NFXNREQ.2)

How this digital adaptation kit was developed

Existing WHO guidelines, guidance and tools considered relevant for the development of a DAK dedicated to SMBP in pregnancy were mapped. Key resources included the *WHO guideline on self-care interventions for health and well-being, 2022 revision (17)* and additional relevant guidance documents focused on the management of blood pressure and complications in pregnancy (see the WHO guidelines, recommendations and guidance section in this chapter). Relevant recommendations from this guideline were extracted to inform the basis for the DAK. This process also informed the development of the workflows, data dictionary and decision-support logic algorithms. These components were further refined with external reviewers and WHO staff. A specialist in hypertensive disorders of pregnancies reviewed the technical content for further validation. Other published DAKs, including the teams responsible for their development, were consulted as needed to ensure alignment across across the SMART guidelines programme.

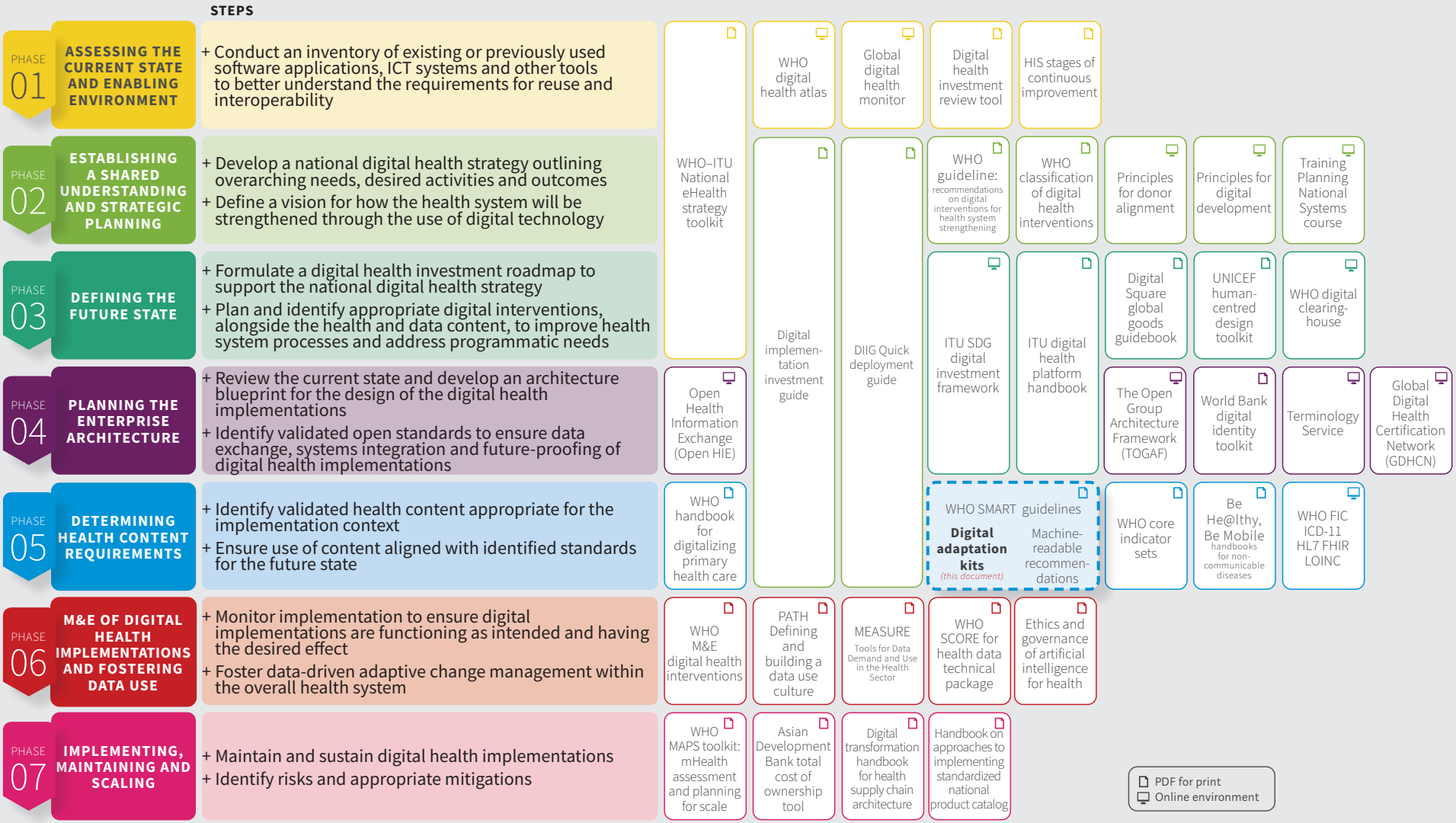
All individual external contributors involved in the development and review of this DAK declared any potential conflicts of interest prior to providing their contributions, including contributions made during their participation in any technical consultations. These declarations were reviewed by WHO, which found none of the contributors to have conflicting interests that would influence the content of this publication.

How to use this digital adaptation kit

Once the strategic vision for point-of-service systems has been developed, SMART guidelines can assist in determining the necessary health content requirements based on available guidance. In contexts where an overarching vision may not exist, users should first consult the WHO–International Telecommunication Union *National eHealth strategy toolkit (25)*, *WHO guideline: recommendations on digital interventions for health system strengthening (13)*, and WHO's *Digital implementation investment guide (DIIG) (12)* to establish a better understanding of how to select and apply appropriate DHIs. **Figure 4** situates DAKs within the broader set of resources for planning and implementing digital health systems.

Fig. 4

DAKs within the broader digital health ecosystem



HIS:health information system; ICT: information and communications technology; ITU: International Telecommunication Union; M&E: monitoring and evaluation; MAPS: mHealth Assessment and Planning for Scale; SDG: Sustainable Development Goal.

Source: Adapted from WHO *(12)*.

Target audience

The primary target audience for this DAK are software developers and health programme managers within the health ministries, who will be working with their digital or health information systems counterparts in determining the health content requirements for SMBP in pregnancy. The DAK also equips individuals responsible for translating health-system processes and guidance documents for use within digital systems with the necessary components to kick-start the process of developing personal health tracking systems in a standards-compliant manner. These individuals are also known as business analysts who interface between health content experts and software development teams.

Additionally, using this DAK requires a collaboration between health programme managers responsible for maternal health and counterparts in digital health and health information systems. Although each DAK focuses on a particular health programme area (in this case, SMBP in pregnancy), the DAKs are envisioned to be used in a modular format and link to other health programme areas within primary health-care settings to support integration across services.

Scenarios for using the DAK

The DAK may be used across various scenarios, some of which are listed below.

Scenario 1 **Incorporating WHO guideline content into existing personal health tracking systems**	Implementers that may already have developed personal health tracking systems may use the information in the DAK to cross-check whether the underlying content and data for specific health programme areas are aligned with WHO guidelines. Users of the DAK can identify and extract specific decision algorithms that would need to be incorporated into their existing digital systems. By reviewing this systematic documentation, implementers can more readily identify differences in workflows, data inputs and decision-support logics to examine the rationale for deviations and understanding local adaptions of guideline content.
Scenario 2 **Transitioning from paper to digital**	Some implementers may currently have paper-based approaches for personal health tracking that they would like to digitize. Users in this scenario may review the DAK as a starting point for streamlining the necessary data elements and decision support that should be in the optimized client-level digital system. Users may also then refer to the paper-based tools to determine whether there are missing fields or content that should also be included within the digital system.
Scenario 3 **Leveraging data standards to promote interoperability and integrated systems**	This DAK includes data elements mapped to ICD 11th Revision (ICD-11) codes, ICD 10th Revision (ICD-10) codes, LOINC, ICHI, ICF and SNOMED codes to support the design of interoperable systems. The data dictionary provides the necessary codes for different data elements, thus reducing the time for implementers to incorporate these global standards into the design of their digital systems. Box 3 provides guidance on developing the third layer of the SMART guidelines and its role in designing interoperable systems, such as linking to point-of-service systems (e.g. an electronic health record) managed by a health worker.

Scenario 4 **Establishing benchmark requirements to facilitate governance of digital health systems**	The DAK allows for countries to clearly outline software-agnostic baseline expectations and requirements for a digital service and application for a particular use case. The templated format allows for countries to establish their own standards for any digital service and application that is to be implemented within the country. The DAK provides a shared language to allow for alignment across all the relevant stakeholders, regardless of which software system is used.

Box 3

Third knowledge layer (L3) of SMART guidelines

The next step in the digitalization journey of normative content involves the development and/or implementation of the computable and machine-readable content of standards-based, machine-readable, adaptive, requirements-based and testable (SMART) guidelines, also known as the third knowledge layer (L3). This layer builds on L2 and is represented as a Fast Healthcare Interoperability Resources (FHIR) implementation guide. It focuses on producing machine-readable recommendations that can be tested for conformance to interoperability standards. This step ensures that the semi-structured normative content, in the form of the digital adaptation kit (DAK), is converted to a machine-readable format that promotes interoperability and can be easily adapted to meet the requirements of different contexts. Developing an L3 provides benefits to multiple stakeholders. Some, but not all, are listed below:

» **Ministry of health**: the localized implementation guide will promote a local ecosystem of standards that many software vendors can tap into, thereby avoiding software lock-in;

» **Technology partners**: with standards-based machine-readable code available within the implementation guide, partners have a quicker development cycle and easier adoption of standards-based code into solutions;

» **Health workers**: greater support for day-to-day workload by having access to decision-support logic within digital systems.

Stakeholders looking to understand the importance of interoperability and its key components, and to plan investments in integrating these components in the national digital health systems, should consult the *Stepwise toolkit for planning & budgeting interoperability of digital health solutions (12, 26)*.

Key considerations for developing L3

Before developing or implementing the L3, it is important to:

» **Scope the needs**: identify the requirements of the digital tool, such as translation needs and test data generation needs;

» **Budget and resources**: determine the necessary budget and required resources;

» **Team competence**: assemble a team with the required software development skills and experience to develop and/or implement a FHIR implementation guide;

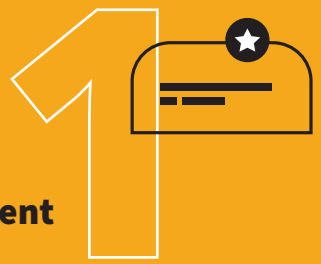
» **Review the L3 SOP**: the L3 SOP is intended to guide developers and implementers through the process of creating an HL7 FHIR implementation guide following the WHO SMART guidelines approach. The SMART guidelines community is actively working on defining the SOP for authoring L3 implementation guides and the latest version is available *here (https://smart.who.int/ig-starter-kit/)*.

The status of all L3 implementation guides developed by WHO and implementation partners can be consulted at the WHO *Smart Guidelines Publications site*.

DAK: digital adaptation kit; FHIR: Fast Healthcare Interoperability Resources; SMART: standards-based, machine-readable, adaptive, requirements-based and testable; SOP: standard operating procedure.

2

Part 2. Digital adaptation kit content for self-monitoring of blood pressure during pregnancy



Component 1

Health interventions and recommendations

Digital systems should be deployed in the context of an overall health intervention, or multiple interventions. The World Health Organization (WHO) guidelines and guidance documents that support these interventions form the basis of the digital adaptation kit (DAK) content, reformatted for use in software development.

Interventions based on WHO's *UHC Compendium*

This DAK module focuses on self-care interventions in the antenatal period that may benefit from the pregnant client's use of the digital home-based or personal health record (HB/PHR) or similar software. Specifically, this DAK module details the software requirements for the following, as listed in the WHO *UHC Compendium* on health interventions for universal health coverage (UHC) *(22)*:

» blood pressure (BP) monitoring for the management of antenatal care (ANC) complications
» electronic or telephonic transfer of home blood pressure readings using validated devices[2] (where possible)

Self-monitoring of blood pressure during pregnancy

To monitor and help manage the hypertensive disorders of pregnancy, including early detection of pre-eclampsia, WHO suggests that a pregnant client can choose to measure their own BP in addition to BP measurement in a clinic setting *(17)*. Following diagnosis of a hypertensive disorder and having been deemed eligible by a health worker, the client uses a BP device approved for home-based use to take BP measurements, sometimes multiple times a day, depending on the treatment plan. Each time the pregnant client takes a BP reading, they enter this information into the BP measurement device. In response, the personal health tracking application generates various actions based on the system's comparison of the self-monitoring of blood pressure (SMBP) measurement results with standard BP thresholds for specific hypertensive conditions. One of these actions could be to collect contextual data on the client's current condition, behaviour and environment around the time of the SMBP measurement. Another action may instruct the client to contact a health worker or go to a health facility right away for a consultation, in addition to continuing with regular ANC contacts. SMBP continues until birth (or after birth if needed), or when the health worker changes the management plan.

2 This intervention requires the proper connectivity and digital infrastructure, so its implementation timeline may differ from country to country, depending upon the maturity of the country's digital ecosystem.

Digital health interventions covered in this DAK

Table 2 contains the digital health interventions (DHI) incorporated into this DAK, extracted from WHO's *Classification of digital interventions (14)*:

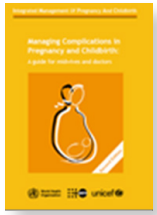
Table 2. Digital health interventions

DHI category		DHIs	
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 specific 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)
2.1	**Identification and registration of persons**	2.1.2	Enrol person(s) for health services/clinical care plan
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
2.10	**Laboratory and diagnostics imaging management**	2.10.3	Capture diagnostic results from digital devices

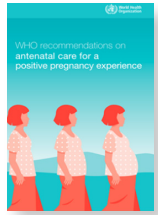
WHO guidelines, recommendations and guidance

The DAKs are intended to reflect health recommendations and content that has already been published in WHO guidelines and guidance documents. The health content and interventions for this DAK module are based on the following WHO documents.

WHO guideline on self-care interventions for health and well-being, 2022 revision (2022) *(17)*

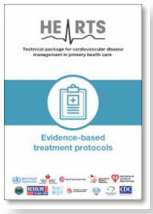


Managing complications in pregnancy and childbirth: a guide for midwives and doctors, second edition (2017) *(27)*



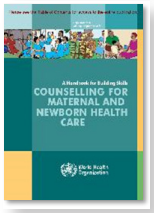
WHO recommendations on antenatal care for a positive pregnancy experience (2016) *(28)*

WHO technical specifications for automated non-invasive blood pressure measuring devices with cuff (2020) *(29)*

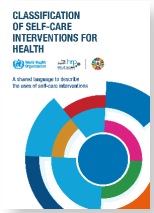


HEARTS: technical package for cardiovascular disease management in primary health care: evidence-based treatment protocols (2018) *(30)*

WHO recommendations on home-based records for maternal, newborn and child health (2018) *(31)*



Counselling for maternal and newborn health care: a handbook for building skills (2013) *(32)*

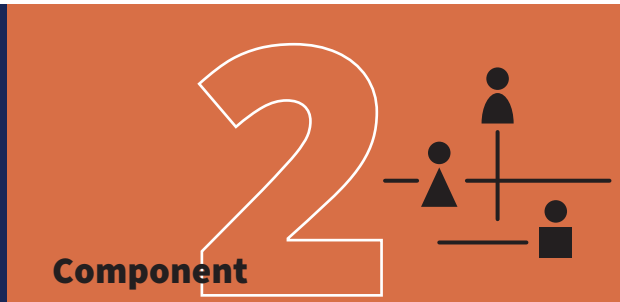


Classification of self-care interventions for health: a shared language to describe the uses of self-care interventions (2021) *(18)*

Pregnancy, childbirth, postpartum and newborn care: a guide for essential practice, third edition (2015) *(33)*

Other WHO documents represented in the DAK include:

» *HEARTS: technical package for cardiovascular disease management in primary health care: healthy-lifestyle counselling* (2018) *(34)*;
» *Implementation tools: package of essential noncommunicable (PEN) disease interventions for primary health care in low-resource settings* (2013) *(35)*;
» *WHO recommendations for prevention and treatment of pre-eclampsia and eclampsia* (2011) *(36)*;
» *Noncommunicable disease education manual for primary health care professionals and patients* (2017) *(37)*;
» *Practical guide for the design, use and promotion of home-based records in immunization programmes* (2015) *(38).*



Component 2

Generic personas

A persona is a depiction of a relevant stakeholder, or end user of the digital system. The specific roles and demographic profile of the personas will vary depending on the local setting. Where available, generic personas for the various health worker roles are based on descriptions in the International Standard Classification of Occupations (ISCO) *(39)*, and on competencies and qualifications denoted in other WHO health workforce documentation. Generic personas for other roles in the self-care intervention ecosystem, including clients, are based on the characteristics of people who use self-care interventions *(21)*, as well as in the published literature. It should be noted that all of the personas reflect a synthesis of profiles across multiple contexts. Further contextualization will be required at the local level according to the needs, motivations and challenges of the personas in each setting.

Targeted generic personas

A persona is a generic depiction of a relevant stakeholder, or end user of the system. The key user personas for self-care interventions will vary depending on the business process, as well as the self-care intervention being used. While the focus of any self-care intervention is on the client – who is a key persona in all business processes – health workers also play essential roles. Descriptions of key personas are given in Table 3.

Table 3. Descriptions of key generic personas for self-care interventions

Occupational title	Description	Different names	ISCO code *(39)*
Client	The person acting to "promote health, prevent disease, maintain health, and cope with illness and disability with or without the support of a health worker" *(21)* by using a self-care intervention on themselves, a family member or friend to whom they voluntarily give care without compensation. Clients are a diverse population group, representing different demographics, backgrounds and social situations, with varying motivations for choosing self-care interventions. Clients may use a self-care intervention for one condition but choose a facility-based intervention for another. They may also choose self-care interventions because they are in a vulnerable population, avoiding facility-based care because of access issues or from a fear of stigma, discrimination or other repercussions. Clients do not typically have extensive health-care knowledge or training.	Self-carer, individual, family member, pregnant woman	None

ISCO: International Standard Classification of Occupations.

Related personas

In addition to the targeted persona detailed above, there may be value in exploring health worker occupational groups and personas within the context of SMBP. However, these were not identified as the central personas for the data and decision-support content detailed in this DAK. Additional related personas are listed in Table 4.

Table 4. Descriptions of additional related personas

Occupational title	Description	Different names	ISCO code *(39)*
Midwife	A person who has been assessed and registered by a state midwifery regulatory authority or similar regulatory authority. They offer care to childbearing women during pregnancy, labour and birth, and during the postpartum period. They also care for the newborn and assist the mother with breastfeeding. Their education lasts three, four or more years in nursing school, and leads to a university or postgraduate university degree, or the equivalent. A registered midwife has the full range of midwifery skills *(39)*.	Registered midwife, professional midwife, community midwife	2222 (Midwifery professionals)
Nurse	A graduate who has been legally authorized (registered) to practise after examination by a state board of nurse examiners or similar regulatory authority. Education includes three, four or more years in nursing school, and leads to a university or postgraduate university degree, or the equivalent. A registered nurse has the full range of nursing skills *(39)*.	Registered nurse, nurse practitioner, clinical nurse specialist, advance practice nurse, practice nurse, licensed nurse, diploma nurse, nurse clinician	2221 (Nursing professionals)
Auxiliary nurse midwife	Auxiliary nurse midwives (ANMs) assist midwives and physicians in the provision of maternal and newborn health care, particularly during childbirth, but also in the antenatal and postpartum periods. ANMs also advise and educate expectant mothers on symptom management, behaviour, hygiene and diet during pregnancy, as well as baby care postpartum. They possess some of the competencies needed in midwifery but are not fully qualified midwives *(39, 40)*.	Auxiliary midwife (e.g. *bidan* in Indonesia), assistant midwife	3231 (Nursing associate professionals) 3222 (Midwifery associate professionals)
Community health worker	Community health workers (CHWs) provide health education and referrals for a wide range of services, and provide support and assistance to communities, families and individuals with preventive health measures and gaining access to appropriate curative health and social services. They create a bridge between providers of health, social and community services and communities that may have difficulty in accessing these services *(41)*.	Lay health worker, community health volunteer, village health worker, treatment supporter, promoter	3253 (Community health workers); would vary by context

ISCO: International Standard Classification of Occupations.

Additional considerations for contextualizing personas

Although this section provides an overview of the generic roles of the targeted personas, it will be important to contextualize these personas to your setting. The personas described in Tables 3 and 4 can be supplemented by reflecting on these additional considerations.

» **Background and demographics**: For example, what is their age or familiarity with digital devices? Do they own a mobile phone or a smartphone?

» **Context**: What is the level of internet connectivity? How are the personas compensated? How far away is the nearest referral facility? What other personas or health workers do they interact with?

» **Challenges**: What are the day-to-day challenges the end user might face?

Component 3 User scenarios

User scenarios are a narrative description of how the end user would interact with the digital system. The user scenario is provided to help the reader better understand how the system will be used and how it would fit into existing workflows. It is to provide context in a story format. Furthermore, within the user scenario, it should be possible to derive the key components that are further elaborated in the rest of the DAK. This includes the core data elements, decision-support logic and core functionality of a needed digital system. A user scenario should:

» include personas involved based on the generic personas component;
» have narrative descriptions of who and how a digital system would be used;
» provide details on what kinds of data are collected and decisions are made; and
» reflect the workflows that will be further elaborated on in **Component 4: Business processes and workflows**.

How to interpret user scenarios

User scenarios are helpful tools that not only improve understanding of the context in which a digital tool would operate but also generate insights into the key data elements that would need to be recorded and accounted for in the database. Additionally, the context in which the tool would operate, illuminated by the user scenarios, provides insight into some functional and non-functional requirements that the system would also need. For example, in the user scenario below, some key data elements that need to be recorded and/or calculated are highlighted in yellow. Highlighted in blue is the decision-support logic that can be automated in the system. Highlighted in green are some key functional and non-functional requirements that should be included in the system. **Table 5** provides an interpretation of the example user scenario.

Table 5. Interpretation of scenario for identification and preparation for SMBP

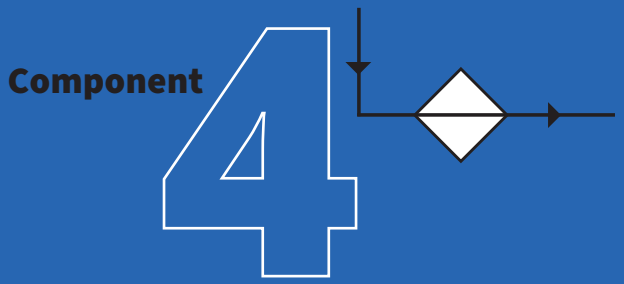
Data elements to be collected	Decision logic to be embedded	Functional and non-functional requirements
Unique identifier Gestational age/expected date of delivery Systolic blood pressure (BP) Diastolic BP Current health conditions Type of hypertensive disorder of pregnancy	Determine contextual data for self-monitoring of blood pressure (SMBP) SMBP health actions Danger signs	Ability to generate list of health actions in response to SMBP results Provide links to training materials to review how to use the SMBP device

User scenario for identification and preparation for SMBP

Key Personas	Client: Grace Community health worker: Irene Nurse/midwife: Aisha

Grace is pregnant and lives far away from her nearest health clinic. Irene, a community health worker (CHW), visits Grace regularly to check in and provide ANC support, in between her clinic contacts. When Grace is in her fifth month of pregnancy, Irene finds that Grace's BP is elevated, at 148/94 mmHg. She arranges for Grace to visit the clinic right away, where Aisha, the nurse/midwife, performs a clinical examination (including a proteinuria test) and does not find Grace to be in any immediate danger. However, she does diagnose Grace with gestational hypertension. To prevent any further complications, Aisha wants to monitor Grace's BP daily, and have Irene check on her more frequently.

As it is challenging for Grace to travel to the clinic, and because Aisha believes Grace is a good candidate for SMBP, Aisha discusses SMBP intervention with Grace. Aisha teaches Grace how to use a BP measurement device properly, giving her a pamphlet and a link to a training video. She also shows Grace the help options in the personal health tracking application. She asks Grace to demonstrate what she has learned by taking her own BP measurement in the examination room.



Business processes and workflows

A business process is a set of related activities or tasks performed together to achieve the objectives of the health programme area, such as registration, counselling, referrals *(12, 24)*. Workflows are a visual representation of the progression of activities (tasks, events, interactions) that are performed within the business process *(24)*. The workflow provides a story for the business process being diagrammed and is used to enhance communication and collaboration among users, stakeholders and engineers.

This DAK focuses on key business processes conducted by the personas (described in **Component 2**) as part of SMBP in pregnancy. These business processes are described in **Table 6**. For each of these business processes, the corresponding business processes, data elements and decision-support needs are detailed within the following sections of this document.

Table 6 provides an overview of the key business processes conducted by the various personas for the self-care intervention ecosystem. For each business process, the table summarizes the objective, task set and triggers that motivate the persona to do these tasks.

Taken together, all of these business processes provide a comprehensive picture of a self-care client's health journey when using an intervention that may benefit from a personal health tracking application. However, to keep the scope manageable and within the realm of WHO's mission, not all business processes are fully operationalized. Therefore, although this DAK module describes all the business processes through workflows, annotations, and functional and non-functional requirements, only half of them have decision logic and data elements ready for DAK readers to adapt and deploy in their digital systems. Future iterations of this DAK will operationalize the business processes further.

Table 6. Overview of business processes for SMBP in pregnancy

Process name	Process ID	Personas	Objective	Task set
Title	ID used to reference this process throughout the digital adaptation kit (DAK)	Individuals interacting to complete the process	A concrete statement describing what the process seeks to achieve	The general set of activities performed within the process
A. Identification and preparation for SMBP	SMBP.A	» Nurse » Auxiliary nurse midwife (ANM) » Community Health Worker (CHW) » Physician » Midwife » Client	To identify if a client is eligible for self-monitoring of blood pressure (SMBP), counsel clients on SMBP, guide clients on taking their blood pressure (BP) measurements and set up the personal health tracking intervention. The components of this workflow are meant to be integrated into an antenatal care (ANC) contact for clients with diagnosed hypertensive disorders in pregnancy.	Starting point: SMBP can be an option for management of the client's condition. » Identify the need for self-monitoring intervention during consultation (identification by a health worker) » Obtain self-monitoring device/health-care product access » Set up the personal health tracking application » Learn how to use the self-monitoring device and run a test scenario of what client will perform at home
B. Conduct SMBP	SMBP.B	» Client	To conduct SMBP and understand the health actions in response to the BP measurement/ data output	Starting point: the client needs to take a measurement using a self-monitoring device. » Prepare for the measurements » Conduct the measurements and register them into the system » Check for actions and level of support » Seek professional support or care services, if needed » Confirm the schedule for the next measurement event
C. ANC contact[a]	SMBP.C/ ANC.B	» Client » ANM or nurse midwife	To counsel and provide ANC services to pregnant woman	Starting point: woman has been registered and is ready to begin ANC contact. » Record health history » Assess danger signs » Assess current pregnancy conditions, including symptoms, and perform physical exam and lab tests » Conduct case management or make referral » Schedule follow-up contact » Provide counselling on all health topics necessary (e.g. nutrition, HIV testing, family planning, psychosocial and support services)

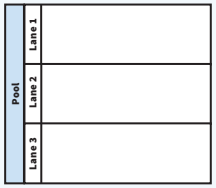
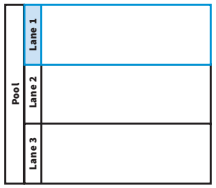
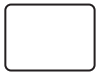
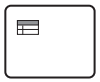
ANC: antenatal care; ANM: auxiliary nurse midwife; BP: blood pressure; CHW: community health worker; DAK: digital adaptation kit; ID: identification; SMBP: self-monitoring of blood pressure.

a See WHO's *Digital adaptation kit for antenatal care: operational requirements for implementing WHO recommendations in digital systems* (ANC DAK) *(20)*.

Overview of key processes

This section illustrates the workflows of the identified processes using standardized notations for business process mapping, based on the business process model and notation (BPMN) standard *(42)*. Table 7 provides an overview of this notation, while Figure 5 shows an overview of key processes for SMBP.

Table 7. Business process symbols used in workflows

Symbol	Symbol name	Description
	Pool	The pool assumes process control – in other words, it assigns the tasks. A **pool** consists of one or more so-called swim lanes that depict all the individuals or types of users that are involved in carrying out the business process or workflow. Diagrams should be clear, neat and easy for all viewers to understand the relationships across the different swim lanes. For example, a pool would depict the business process of conducting an outreach activity, which involves multiple stakeholders represented by different lanes in that pool. A business process diagram can contain two or more pools that connect through message flows (messages received from outside of the pool). This indicates different process owners collaborating and exchanging information. For example, in the case of a referral, health facility A (the referring facility) represents the process owner that assigns internally the tasks for the actors represented as swim lanes in the pool. Health facility B (the receiving facility) has allocated its own pool and is considered a different process owner, with the same role. These two facilities exchange information relevant for a referral (client history, referral details, etc.), represented as message flows, but each facility has control only over its internal activities, without directly impacting the activities of the other facility.
	Swim lane	Each individual or type of user is assigned to a **swim lane**, a designated area for noting the activities performed or expected by that specific actor. For example, a health worker may have one swim lane; the supervisor would be in another swim lane; and the clients or patients would be classified in another swim lane.
	Start event or trigger event	The workflow diagram should contain both a **start** and an **end event**, defining the beginning and completion of the task, respectively.
	Start event message	This is a type of a start event. In some instances, the workflow can start with a **message**. A message in the business process model and notation does not indicate only letters, emails or calls, but also includes information exchanged between two different systems, such as data exchange, notifications. Any action that refers to a specific addressee and represents or contains information for the addressee is a message.
	End event	There can be multiple **end events** depicted across multiple swim lanes in a business process diagram. However, for diagram clarity, there should only be one end event per swim lane.
	Activity, process, step or task	Each **activity** should start with a verb, for example, “register client”, “calculate risk”. Between the start and end of a workflow, there should be a series of activities noting the successive actions performed by the actor for that swim lane. There can also be subprocesses of each activity.
	Activity with subprocess	This denotes an activity that **has a much longer subprocess** to be detailed in another diagram. If the diagram starts to become too complex and unhelpful, the subprocess symbol should be used to reference another process depicted on another page.
	Activity with business rule	This denotes a decision-making activity that requires the **business rule**, or **decision-support logic**, to be detailed in a decision-support table. This means that the logic described in the decision-support table will come into play during this activity, as outlined in the business process. This is usually reserved for complex decisions.

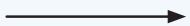
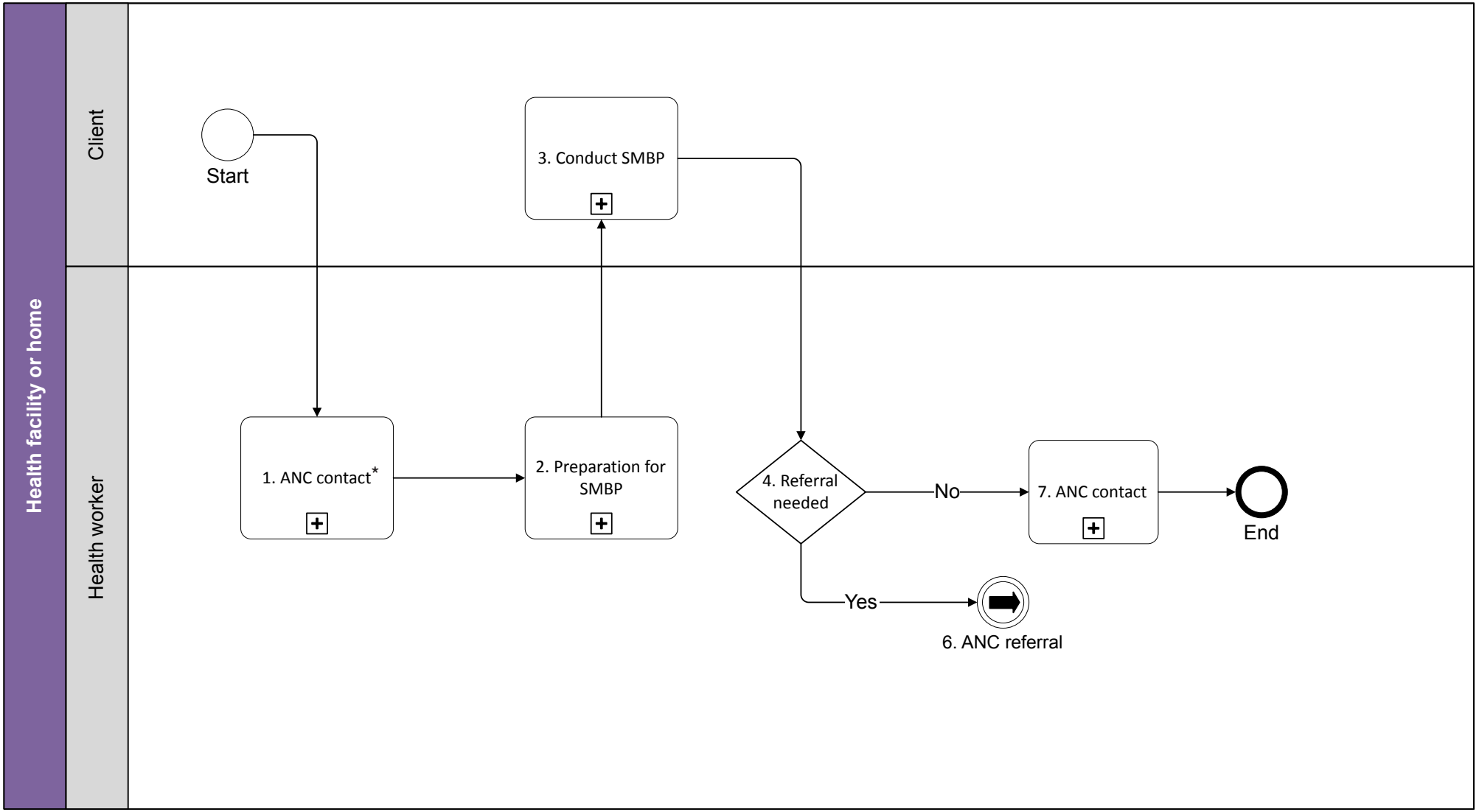
Symbol	Symbol name	Description
	Sequence flow	This denotes the **flow direction** from one process to the next. The end event should not have any output arrows. All symbols (except for start event) may have an unlimited number of input arrows. All symbols (except for end event and gateway) should have one and only one output arrow, leading to a new symbol, looping back to a previously used symbol or to the end event symbol. Connecting arrows should not intersect (cross) each other.
	Message flow	This denotes the **flow of data or information** from one process to another. This is usually used for when data are shared across swim lanes or stakeholder groups.
	Exclusive gateway	This symbol is used to depict a **fork**, or **decision point**, in the workflow, which may be a simple binary (e.g. yes/no) filter with two corresponding output arrows, or a different set of outputs. There should only be two different outputs that originate from the decision point. If you find yourself needing more than two output or sequence flow arrows, you most likely are trying to depict decision-support logic or a business rule. This should be depicted as an **activity with business rule** (above) instead.
	Parallel gateway	The parallel gateway can be used to **model concurrency** in a process. This type of gateway allows forking into multiple paths of execution or joining multiple incoming paths of execution. An important difference with other gateway types is that the parallel gateway does not evaluate conditions.
	Throw – link event	The **throw – link event** serves as the start of an off-page connector. It is the end of the process when there is no more room on your page for that workflow. It is the end of a process on your current page or the end of a subprocess that is part of a larger process. A **catch – link** will need to follow the **throw – link**.
	Catch – link event	The **catch – link serves** as the end of an off-page connector. It is the start of the new process on a different page from the **throw – link** or the start of a subprocess that is part of a larger process. A **throw – link** must be aligned to the **catch – link**.
	Ad hoc marker	An ad hoc subprocess can contain multiple activities (tasks or subprocesses), which can be executed in any order, executed several times or skipped. However, not all these activities need to be finished before moving on to the next activity.
	Loop activity	A **loop activity** indicates that the activity repeats until a defined condition either applies or ceases to apply. The condition on which a loop executes is included as an annotation.

Fig. 5. Overview of key processes for SMBP in the antenatal period



* See the WHO *Digital adaptation kit for antenatal care: operational requirements for implementing WHO recommendations in digital systems* (ANC DAK) for more information *(20)*.

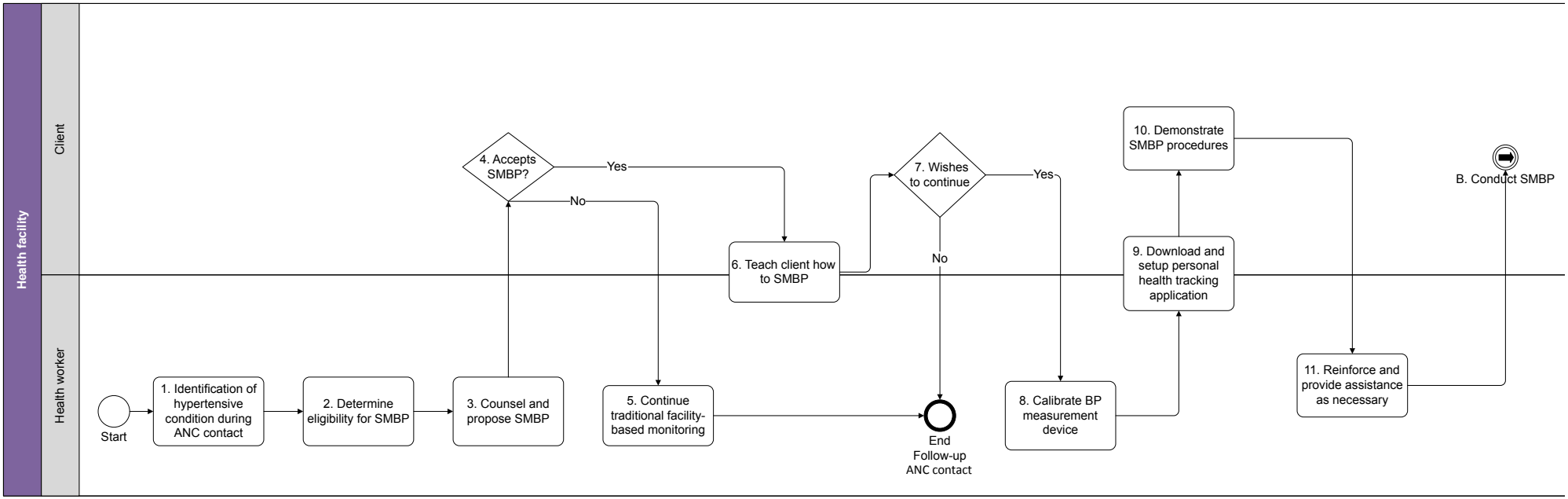
Workflows

Workflows represent the progression of activities performed within the business process. They help users and stakeholders understand the relationship between activities, data elements and decision-support needs. The workflows shown depict processes that have been generalized and may not reflect variation and nuances across different settings. Also, the simplicity of the workflow may not adequately illustrate non-linear steps that may occur.

Business process A: Identification and preparation for SMBP

Objective: To identify if client is eligible for SMBP, counsel clients on SMBP, guide clients on taking their blood pressure measurements and set up the personal health tracking application (Fig. 6).

Fig. 6. Workflow A: Identification and preparation for SMBP



IDENTIFICATION AND PREPARATION FOR SMBP PROCESS NOTES AND ANNOTATIONS

1. **Identification of a hypertensive condition during ANC contact**
   - » The *Digital adaptation kit for antenatal care: operational requirements for implementing WHO recommendations in digital systems* (ANC DAK)*(20)* describes the clinical protocols that are relevant for diagnosing a hypertensive disorder of pregnancy and identifying whether signs and symptoms are common or if they indicate something more serious. Therefore, some of the data dictionary elements and decision logic tables in this DAK module refer to activities in the ANC DAK.

2. **Determine client eligibility for SMBP**
   - » The health worker identifies whether the client is eligible to use an SMBP intervention, assessing the client's ability to meet any criteria defined by the decision logic in the health worker-facing module for self-care interventions.
   - » For the SMBP intervention, only a facility-based health worker determines eligibility. Also, this intervention may not be appropriate for all pregnant clients, even if they wish to use it.
   - » The health worker requests permission for the client to share SMBP data from the digital personal health record to their facility-based health record. Alternatively, the SMBP data may be recorded on paper, and the client should be counselled that they will be requested to share their BP information. If permission is not granted, skip to Step 5 and continue with routine ANC contacts. Also, if the client opts out initially, they may change their mind, so the health worker should check in with this step during subsequent contacts.

3. **Counsel on and propose SMBP**
   - » The health worker provides counselling on options for SMBP, describing how each of the options work, and the pros and cons of each.

4. **Accepts SMBP?**
   - » Based on the counselling provided by the health worker (as well as any information learned earlier through the client's own research), the client decides whether to conduct SMBP.
   - » The health worker records the client's choice in the facility record.

5. **Continue facility-based monitoring and care**
   - » If the client chooses not to conduct SMBP, the health worker should continue traditional facility-based monitoring and care.

6. **Teach client how SMBP works**
   - » The health worker teaches the client how to conduct SMBP. The health worker demonstrates how to use the BP measurement device and personal health tracking intervention. As the client will need to use these tools on their own, the health worker should spend time on this step, including asking the client to practise using these tools in front of the health worker.
   - » When appropriate, the health worker provides the client with training materials. These include links to training videos and electronic written/visual materials that the client can access through the personal health tracking application, or printed handouts that the client can take home.
   - » For clients using the SMBP intervention, the health worker should tell the client that there will be a follow-up appointment scheduled soon after this one, to check on how the client is doing with the BP measurement device.
   - » The client should also be counselled on how to obtain a BP device for SMBP.

7. **Client wishes to continue?**
   - » The client determines whether they wish to continue. If they do not wish to continue SMBP, they may continue with traditional facility-based monitoring at their next scheduled ANC contact.

8. **Calibrate BP measurement device**
   - » Health workers should calibrate the BP measurement device as needed. This may also include determining the cuff size and preferred arm for measurements.

9. **Download and set up personal health tracking application/intervention**
   - » Together with the health worker, the client selects and downloads a personal health tracking application to use and installs it on their device.
   - » Some clients may need to review instructions or obtain assistance from a health worker, community support worker or a personal contact. Prompt the client to find out if this is needed and give assistance if necessary.
   - » The client inputs basic health data, such as date of birth, height and weight. Included in this set of data is the client's unique ID number, which is used on the client's facility-based health record to enable accurate record look-up as well as authentication for data sharing.
   - » The client should input any past or existing health conditions, as well as any current medications and allergies, that are relevant to the self-monitoring intervention. If medications are input, prompt the client to set up reminders to ensure medication is taken regularly and to re-order their prescriptions.
   - » Prompt the client to undertake set-up tasks for SMBP. They should also take a baseline BP measurement and then record this in the personal health tracking application.
   - » Prompt the client to set up a schedule with reminders for SMBP. The client's facility-based health worker will determine how frequently and at which times of day the BP measurements should be taken. These recommendations will vary depending on the client's condition.

10. **Client demonstrates SMBP procedures**
    - » Encourage the client to demonstrate the procedures for SMBP, so that the health worker can help with doubts or difficulties identified.

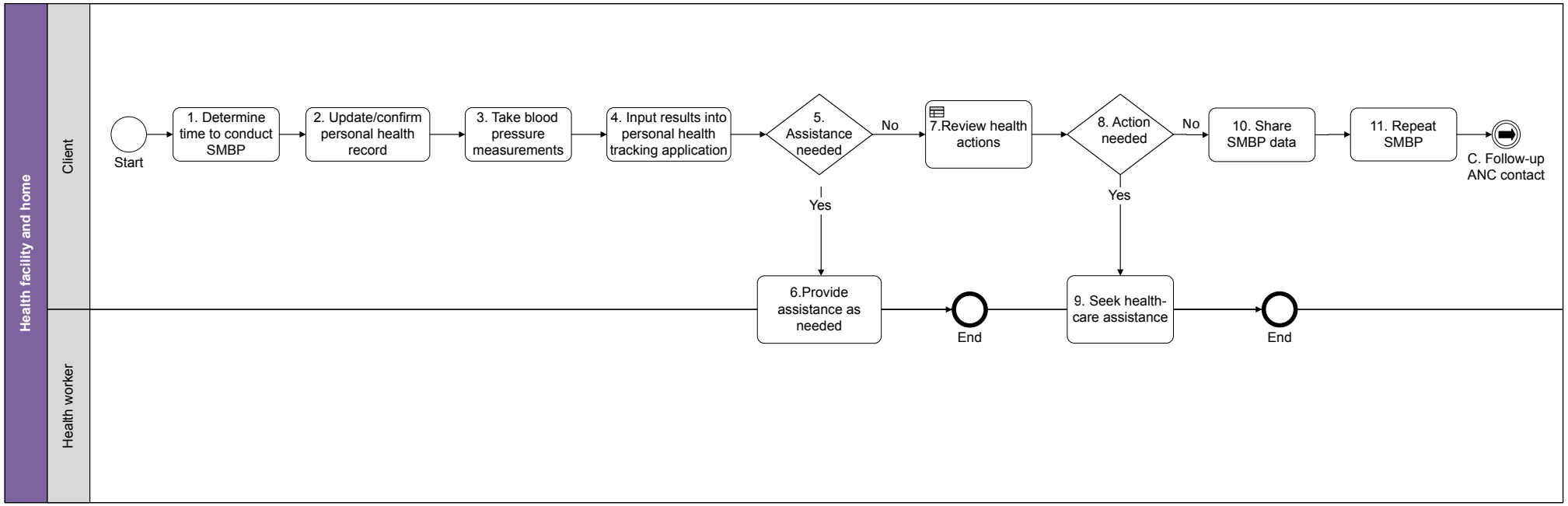
11. **Reinforce and provide assistance as necessary**
    - » Determine whether the client needs assistance with any of the above steps. If no assistance is needed, then the client can fill the system with the relevant information.
    - » Counsel and reinforce to the client the procedures for SMBP, including the need to rest before the reading, the body position, the need to empty the bladder, the arm position, the avoidance of speaking during the measurement and other relevant information.
    - » Help the client on cuff positioning, as needed, and device management for measuring BP.
    - » Some clients may need refresher training or tips on how to use the personal health tracking application, including how to navigate to specific parts of the record, how to input data, how to see results in different formats, etc. Ask the client if they need help using the software.
    - » Prompt clients to use any tools provided to help them use the software effectively. Note that the software help tools should be clear, comprehensive, accessible, appropriate and easy to follow.
    - » For some clients, written instructions may not be sufficient to help them use the personal health tracking application properly. In-person help may be preferred, especially for learning technology. Such help could come from a personal contact or from an organization (including a health facility) that aims to improve users' digital literacy, or even to provide specific support for the self-monitoring intervention and the personal health tracking application.

12. **Attend ANC follow-up contact**
    - » For clients using the SMBP intervention, it is important for the health worker to schedule one to two follow-up appointments to check how the client is doing with the BP monitoring device.
    - » These appointments should occur relatively soon after the initial visit. The BP monitoring intervention for a pregnant client who is at risk for pre-eclampsia will likely require a check-in within one to two days after the initial visit, because of the risks involved in outpatient management of this condition.
    - » At these follow-up sessions, the health worker should discuss the client's access to and usage of the BP measurement device as well as the personal health tracking application. The health worker should also coach the client on different parts of the SMBP intervention.

Business process B: Conduct SMBP

Objective: To conduct SMBP and understand the health actions in response to the BP measurement/data output (Fig. 7).

Fig. 7. Workflow B: Conduct SMBP



CONDUCT SMBP PROCESS NOTES AND ANNOTATIONS

1. **Determine time to conduct SMBP**
   - » The client conducts SMBP at the agreed time. They could learn this in various ways: from a reminder set within the app or in another app on their device; a note they made on paper; their memory; or from a family member, caregiver, friend or other person from the community.
   - » For SMBP, the client needs to wait at least 30 minutes after eating, drinking or being physically active before they measure their BP.

2. **Update/confirm health profile**
   - » Prompt the client to determine whether any changes need to be made to the health profile they created when setting up the personal health tracking application.

3. **Take BP measurements**
   - » The client takes BP measurements according to the device's usage instructions. Instructions can include educational materials on the intervention and product instructions provided by the device manufacturer. Accurate data collection requires correct device use.
   - » For BP monitoring, one measurement comprises an average of two readings taken 1–2 minutes apart.

4. **Input result into personal health tracking application**
   - » The client inputs the self-monitoring data, such as BP measurements, into the personal health tracking application. In cases where the client is using a smart connected device, this step may be automated.
   - » Some clients may need to review instructions or obtain assistance from a health worker, community support worker or a personal contact.

5. **Assistance needed?**
   - » Client assesses if they need assistance with any of the prior steps.

6. **Obtain assistance as needed**
   - » The client obtains assistance with using the BP measurement device, the personal health tracking application or both. Find out what questions or concerns the client has when self-monitoring.
     - – Is it difficult for them to access a BP device?
     - – Are they having problems using the BP device?
     - – Do they understand the device usage instructions?
     - – Do they need help setting it up?
     - – Do they need to learn how to use it correctly, or have a refresher lesson?
     - – Do they need help determining how to read the results?
     - – Are they having trouble remembering to self-monitor at the right time?
     - – Is it difficult for them to access a device with a personal health tracking application on it?
     - – Are they having problems using the personal health tracking application on their device?
     - – Do they need help inputting information?
     - – Do they wish to discuss the health actions suggested by the personal health tracking application?
   - » Coach client on conducting SMBP
     - – Provide the client with support to use the device or app based on the issues or questions noted.
     - – To check for client comprehension and confidence in using the device or app, ask the client to demonstrate how they use the device.
     - – If you train or retrain the client on the proper use of the device or app, have them demonstrate usage afterwards.
     - – Provide educational materials on SMBP, if available.
   - » Some clients may need refresher training or tips on how to use the personal health tracking application, including how to navigate to specific parts of the record, how to input data, how to see results in different formats.

7. **Review-health actions**
   - » Application provides health action(s) based on the SMBP data and various inputs pertaining to the client's individual health condition, health history, personal information, needs or preferences.

8. **Action needed?**
   - » This depends on whether the client needs to perform health actions provided by the personal health tracking application in response to the self-monitoring measurement results. One health action could simply be to continue self-monitoring.
   - » If additional interventions are not needed, the client continues to conduct SMBP.

9. **Seek health-care assistance**
   - » The client seeks the care services needed for further information about the health condition for which they are self-monitoring.
   - » This step might occur in parallel with others within this workflow since the client may seek further information at different times while self-monitoring.
   - » If a health-care product is needed for the additional self-care intervention that the health action recommends, help the client to determine what is needed and provide information on these products.
   - » Discuss health actions from the personal health tracking application.
     - – Find out if the client needs more information or clarification about the suggested health actions provided by the personal health tracking application in response to the self-monitoring data inputs.
     - – Do they understand the health action(s) and information?
     - – Do they have concerns or questions about the health action(s)?
     - – Do they face any barriers in performing the health action(s)?
     - – How interested are they in performing the action(s)?
     - – Note that the level of information provided will vary depending upon the health worker cadre and their training.

10. **Share SMBP data**
    - » If the client has opted in for electronic data transfer, and the information and communications technology infrastructure supports it, transfer the SMBP data from the client's personal health tracking application to their facility-based health record. If not, the health worker can copy the data by hand into the paper registers or records during the ANC contact.

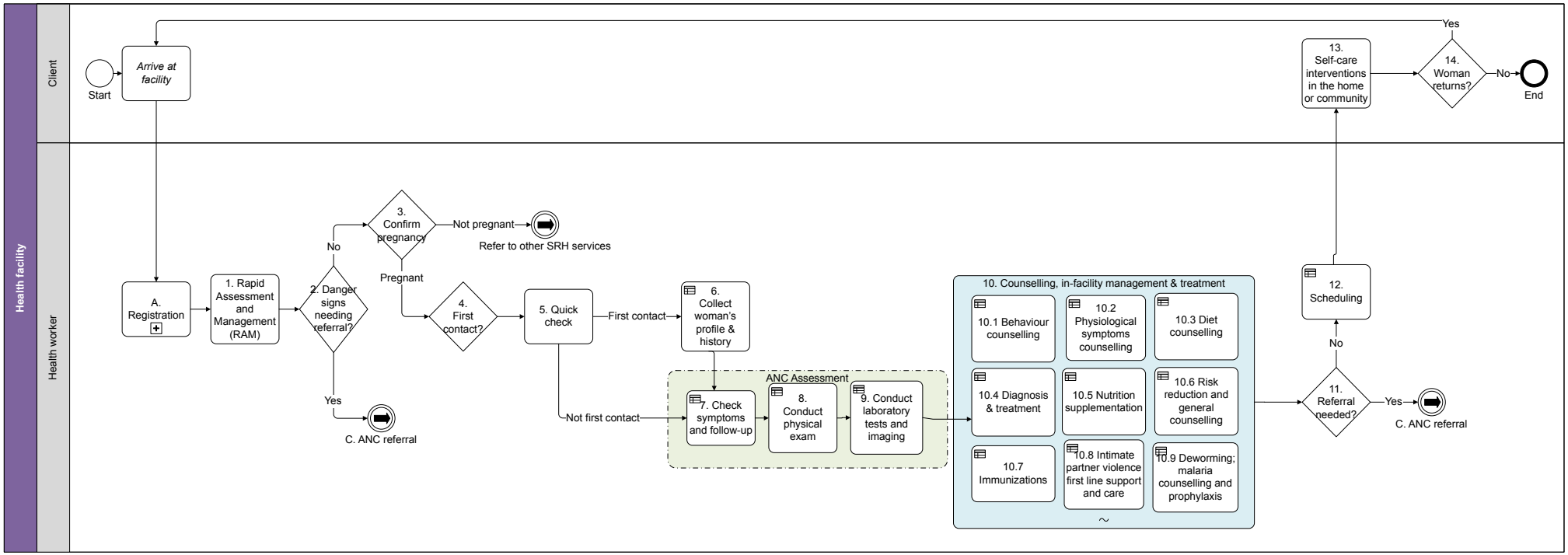
11. **Repeat SMBP**
    - » The client continues SMBP, returning to the start of this workflow at the time of their next measurement event up until their next scheduled ANC contact/SMBP follow-up appointment.

Business process C. ANC contact with additional considerations for SMBP

Objective: To counsel and provide routine ANC services to pregnant women. The workflow for these business processes can be seen in **Figure 8** (see *ANC DAK Business process B. ANC contact [20]* for more information). Additional considerations within Activity 10 (Counselling, in-facility management and treatment) include:

- The health worker reviews the client's self-monitoring data, either within the facility-based client record (or community health information system) if the data were transferred, or directly in the digital HB/PHR if the client opted out of data transfer.
- The health worker first-lines a quality check on the data. The health worker asks the client about any missing days of data, recording any relevant information.
- Based on the client assessment and the review of the self-monitoring data, the health worker provides counselling on the health condition that is being self-monitored by the client.
- The counselling should be appropriate to the health worker's cadre level and the topics discussed will vary by intervention and by a client's specific needs.

Fig. 8. Workflow C: ANC contact



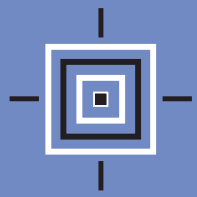
SRH: sexual and reproductive health.

Additional considerations for adapting workflows

As a reminder, these workflows are meant to be generic and high level. They will require a level of customization and adaptation as they are being translated into a digital system for a specific context. These workflows are considered to be around 80% complete, whereby the other 20% will need to be completed through a series of human-centred design methods and mechanisms to complete the workflows for implementation. Although these workflows can be considered as a starting point, it is helpful to conduct further validation through interviews with the targeted personas to obtain a better sense of the differences that would need to be reflected in the digital system.

Component 5

Core data elements



This section outlines the minimum set of data corresponding to different points of the workflow within the identified business processes. This data set can be used on any software system and lists the data elements relevant for service delivery and executing decision-support logic, and for populating indicators and performance metrics. Although this section provides a high-level overview of the data elements, a more complete data dictionary in spreadsheet form detailing the input options, validation checks and concept dictionary codes is available **here** (*https://smart.who.int/dak-smbp/dictionary.html*).

Inclusion of a data element in the table does not by itself indicate that collection of the data is required. Additionally, some data elements are dependent on other data elements, feasibility of their inclusion, and contextual factors.

Simplified list of core data elements

Tables 8 and **9** provide simplified lists of core data elements and are merely snapshots of the comprehensive data dictionary. As with the workflows, this data dictionary is considered 80% generic with the expectation that the other 20% will be supplemented and modified through adaptation for the appropriate context and type of end user.

Table 8. Core data elements for preparation for SMBP

Activity ID and name	Data element ID	Data element name	Description and definition
Business process SMBP.A: Preparation for SMBP			
SMBP.A1 Identification of a hypertensive condition during ANC	See WHO's *Digital adaptation kit for antenatal care: operational requirements for implementing WHO recommendations in digital systems* (ANC DAK) *(20)*		
SMBP.A2 Determine client eligibility for SMBP	N/A – No data are recorded during this activity		
SMBP.A3 Counsel and propose SMBP as an option of management	N/A – No data are recorded during this activity		
SMBP.A4 Accept SMBP	N/A – No data are recorded during this activity		
SMBP.A5 Continue traditional facility-based monitoring	N/A – No data are recorded during this activity		
SMBP.A6 Teach client how to perform SMBP	N/A – No data are recorded during this activity		
SMBP.A7 Wishes to continue	N/A – No data are recorded during this activity		
SMBP.A8 Calibrate BP measurement device	N/A – No data are recorded during this activity		
SMBP.A9 Download and set up personal health tracking	SMBP.A9.DE1	Unique identification	Unique identifier generated by the health system or a universal ID, if used in the country
	SMBP.A9.DE2	Date of birth	Client's date of birth, if known, or age
	SMBP.A9.DE3	Height	The client's current height in centimetres
	SMBP.A9.DE4	Current weight	The client's current weight in kilograms
	SMBP.A9.DE5	Body mass index (BMI)	BMI: calculated by taking weight in kilograms divided by the squared height in metres, i.e. kg/(m^2)
	SMBP.A9.DE6	Expected date of delivery	Client's expected date of delivery
	SMBP.A9.DE7–8	Alternative contact's name and phone number	Name and phone number of an alternative contact, which could be next of kin (e.g. partner, mother, sibling) or a friend; this contact is used in an emergency situation
	SMBP.A9.DE9–11	Contact information of closest hospital or clinic	Name, phone number and address of closest hospital or clinic
	SMBP.A9.DE12–14	Contact information of health worker	Name, phone number and address of client's facility-based health worker
	SMBP.A9.DE15–17	Contact information of pharmacist or pharmacy	Name, phone number and address of the pharmacist or pharmacy the client uses
	SMBP.A9.DE18–20	Contact information of community health worker (CHW)	Name, phone number and address of the client's community-based health worker contact (if applicable)
	SMBP.A9.DE21–25	Type of hypertensive disorder of pregnancy	Which hypertensive disorder of pregnancy the client has been diagnosed with
	SMBP.A9.DE26–32	Current health conditions	Current health conditions the client has that are relevant to self-monitoring of blood pressure (SMBP) intervention
	SMBP.A9.DE33–40	Current medications	Medications the client is currently taking that help manage BP
	SMBP.A9.DE41–43	Pre-pregnancy blood pressure (BP) reading is available?	Whether the BP measurement before becoming pregnant is available to be used as the baseline measurement

Activity ID and name	Data element ID	Data element name	Description and definition
	SMBP.A9.DE44–45	Pre-pregnancy systolic BP reading	The client's last systolic BP measurement result taken before becoming pregnant
	SMBP.A9.DE46–47	Pre-pregnancy diastolic BP reading	The client's last diastolic BP measurement result taken before becoming pregnant
	SMBP.A9.DE48–49	Systolic BP reading taken by health worker when SMBP prescribed	The client's last systolic BP measurement taken by the health worker when SMBP was recommended
	SMBP.A9.DE50–51	Diastolic BP reading taken by health worker when SMBP prescribed	The client's last diastolic BP measurement taken by the health worker when SMBP was recommended
	SMBP.A9.DE52–58	SMBP cuff previously fitted properly?	Whether or not the client has already determined the proper cuff size for the SMBP cuff, if using cuff-based device
	SMBP.A9.DE59–65	BP cuff fit	Fit of the BP cuff on the client's arm as determined by decision logic
	SMBP.A9.DE66–69	Arm determined for SMBP measurements?	Whether or not the arm for all SMBP measurements has been determined, either by the client themselves or at the health facility
	SMBP.A9.DE70–72	First seated systolic reading in left arm	First of two systolic BP readings taken from the left arm, 1–2 minutes apart, while the client is seated
	SMBP.A9.DE73–75	First seated diastolic reading in left arm	First of two diastolic BP readings taken from the left arm, 1–2 minutes apart, while the client is seated
	SMBP.A9.DE76–78	First seated systolic reading in right arm	First of two systolic BP readings taken from the right arm, 1–2 minutes apart, while the client is seated
	SMBP.A9.DE79–81	First seated diastolic reading in right arm	First of two diastolic BP readings taken from the right arm, 1–2 minutes apart, while the client is seated
	SMBP.A9.DE82–86	Arm for SMBP measurements	Arm to be used for all SMBP measurements, based on the arm producing the higher average numbers during set-up
	SMBP.A9.DE87–88	First seated systolic reading in arm for SMBP measurements	First of two systolic BP readings taken from the designated arm determined during set-up
	SMBP.A9.DE89–91	Second seated systolic reading in arm for SMBP measurements	Second of two systolic BP readings taken from the designated arm determined during set-up
	SMBP.A9.DE92–93	First seated diastolic reading in arm for SMBP measurements	First of two diastolic BP readings taken from the designated arm determined during set-up
	SMBP.A9.DE94–97	Second seated diastolic reading in arm for SMBP measurements	Second of two diastolic BP readings taken from the designated arm determined during set-up

Table 9. Core data elements for conducting SMBP

Activity ID and name	Data element ID	Data element name	Description
Business process SMBP.B: Conduct SMBP			
SMBP.B1 Prepare to conduct SMBP	N/A – No data are recorded during this activity		
SMBP.B2 Any updates to health profile?	See SMBP.A9 Download and set up personal health tracking		
SMBP.B3 Take blood pressure measurements	N/A – No data are recorded during this activity		
SMBP.B4 Input result into personal health tracking application	SMBP.B4.DE1	Time of measurement	Date and time for self-monitoring of blood pressure (SMBP) measurement
	SMBP.B4.DE2	First seated systolic reading in arm for SMBP measurements	First of two systolic blood pressure (BP) readings taken from the designated arm determined during set-up
	SMBP.B4.DE3	Second seated systolic reading in arm for SMBP measurements	Second of two systolic BP readings taken from the designated arm determined during set-up
	SMBP.B4.DE4	Average seated systolic reading in arm for SMBP measurements	Average of two systolic BP readings taken from the designated arm, 1–2 minutes apart, while the client is seated
	SMBP.B4.DE5	First seated diastolic reading in arm for SMBP measurements	First of two diastolic BP readings taken from the designated arm determined during set-up
	SMBP.B4.DE6	Second seated diastolic reading in arm for SMBP measurements	Second of two diastolic BP readings taken from the designated arm determined during set-up
	SMBP.B4.DE7	Average seated diastolic reading in arm for SMBP measurements	Average of two diastolic BP readings taken from the designated arm, 1–2 minutes apart, while the client is seated
	SMBP.B4.DE8–39	Contextual data for measurement required	Whether or not the client needs to input contextual data for the SMBP measurement, such as current symptoms, recent food or drink consumed, recent physical activity
	SMBP.B4.DE40–50	Danger signs	Symptom classified as a danger sign of pregnancy; select “No danger signs” if none at the moment
SMBP.B5 Assistance needed?	N/A – No data are recorded during this activity		
SMBP.B6 Provide assistance as needed	N/A – No data are recorded during this activity		
SMBP.B7 Review health actions based on SMBP results	N/A – No data are recorded during this activity		
SMBP.B8 Action needed?	N/A – No data are recorded during this activity		
SMBP.B9 Seek health-care assistance	N/A – No data are recorded during this activity		
SMBP.B10 Share SMBP data	N/A – No data are recorded during this activity		
SMBP.B11 Repeat SMBP	N/A – No data are recorded during this activity		

BP: blood pressure; SMBP: self-monitoring of blood pressure.

Component 6

Decision-support logic

The decision-support logic component of the DAK provides the decision logics and algorithms, and the scheduling of services, in accordance with WHO guidelines. In this DAK, the decision logics and algorithms deconstruct the recommendations for SMBP in pregnancy into a format that clearly labels the inputs and outputs that would be operationalized in a digital decision-support system.

Decision-support logic overview

Table 10 provides an overview of the decision-support tables and algorithms for the SMBP in pregnancy business processes. The structure of the decision-support tables is based on an adaptation of the Decision Model and Notation (DMN), an industry standard for modelling and executing decision logic *(43)*. These decision-support tables detail the business rules, data inputs and outputs to support SMBP in pregnancy module.

Table 10. Overview of decision logic tables for SMBP in pregnancy

Activity ID and name	Decision table ID and name	Decision table description	Reference/source
SMBP.B4 Input results into personal health tracking application	SMBP.B4.DT.01 Contextual data for SMBP	Determine if the system should prompt the client to enter contextual data about their behaviours, mental state and environment when the SMBP measurement was taken	*Managing complications in pregnancy and childbirth: a guide for midwives and doctors, second edition* (2017) *(27)* *HEARTS: technical package for cardiovascular disease management in primary health care: evidence-based treatment protocols* (2018) *(30)* *WHO technical specifications for automated non-invasive blood pressure measuring devices with cuff* (2020) *(29)*
SMBP.B7 Review health actions based on SMBP results	SMBP.B7.DT.01 SMBP health actions	Determine the health actions a client should take, based on their SMBP measurement and other health conditions that affect BP cut-off values	*Managing complications in pregnancy and childbirth: a guide for midwives and doctors, second edition* (2017) *(27)* *HEARTS: technical package for cardiovascular disease management in primary health care: evidence-based treatment protocols* (2018) *(30)*
SMBP.B7 Review health actions based on SMBP results	SMBP.B7.DT.02 Danger signs	Determine if the client's current symptoms are danger signs of pregnancy or not, and the health actions that need to be taken based on this determination	*Managing complications in pregnancy and childbirth: a guide for midwives and doctors, second edition* (2017) *(27)* *Pregnancy, childbirth, postpartum and newborn care: a guide for essential practice, third edition* (IMPAC) (2015) *(33)*

SMBP: self-monitoring of blood pressure.

Decision-support tables

Each of the decision logics listed in the overview table is elaborated in the decision-support implementation tool found **here** (*https://smart.who.int/dak-smbp/decision-logic.html*). These decision-support tables include the components described in **Table 11**. **Table 12** is an example of a decision-support logic table for danger signs as an example.

Note that the decision-support logic is translated directly from the WHO guidelines and guidance documents and has been reviewed by the panel of experts who have created these guidelines. Although some level of adaptation may be needed depending on changes to the workflow or changes to the data dictionary, any changes to the decision-support logic should be considered carefully because an embedded decision-support system can greatly affect the quality of care. As helpful as decision-support logic can be to the health worker or client, an incorrect decision-support logic can also be detrimental. Thus, any new decision-support logic should be carefully reviewed and agreed upon by in-country clinical experts.

Table 11. Components of the decision tables

<table>
<tr><td>Decision ID</td><td colspan="4">The name of the decision describing what algorithm or logic is represented (e.g. health actions from SMBP measurement). The decision ID should correspond to the number in the overview table above.</td></tr>
<tr><td>Business rule</td><td colspan="4">The description of the decision that needs to be made based on IF/THEN statements with the appropriate data element name for the variables. The rule should demonstrate the relationship between the input variables and the expected outputs and actions within the decision-support logic (e.g. if BP is higher than 160 systolic BP/110 diastolic BP, then the client should go to the closest health facility right away).</td></tr>
<tr><td>Trigger</td><td colspan="4">The event that would indicate when this decision-support logic should appear within the workflow, such as the activity that would trigger this decision to be made.</td></tr>
<tr><td colspan="2">Input(s)</td><td>Output</td><td>Action</td><td>Annotations</td></tr>
<tr><td>These are the variables or conditions that need to be considered to determine the consequent actions or outputs.</td><td>If there are multiple input entries on the same row, these different inputs are considered as AND conditions that need to be in place at the same time.</td><td rowspan="2">The resulting action or decision based on the combination of input entries. This the statement that immediately follows the THEN. Examples of outputs may include a qualitative measure of the client’s blood pressure (BP) level (e.g. high or not high), whether contextual data are required to accompany the self-monitoring of blood pressure (SMBP) measurement, the presence of pregnancy danger signs and eligibility for the SMBP intervention. Note that some outputs are system variables for use in other decision-support tables.</td><td rowspan="2">Concrete measures to be taken based on the output (e.g. contact a health worker, try a self-care intervention [to manage routine symptoms of pregnancy]). In some cases, output and action may be the same. Some outputs may yield multiple actions, each denoted in a separate column. Actions with the first word in sentence case versus all capital letters (e.g. use versus USE) are actions that the client should undertake. Actions with the first word in all capital letters are actions that the system should take.</td><td rowspan="2">Additional explanations or descriptions, including possible pop-up alert messages and relevant background information. This section can also include the written content that would appear in the pop-up messages notifying the client on the appropriate health actions to take and, in some cases, the reason for these recommended actions. This can include health information to accompany the action to provide context and motivation for the client to take the health action, referrals to a health worker, facility or community organization, or health information to explain the self-monitoring result.</td></tr>
<tr><td colspan="2">Inputs placed on different rows are considered as OR conditions that can be considered independently of the inputs on other rows.</td></tr>
</table>

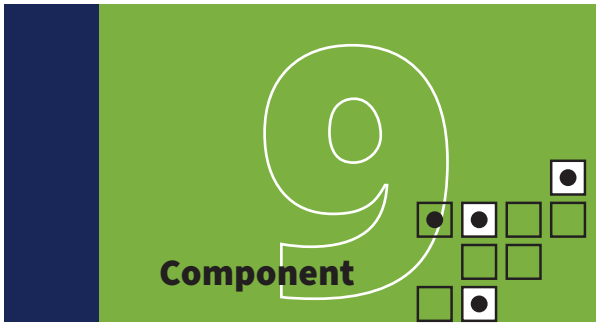
BP: blood pressure; SMBP: self-monitoring of blood pressure.

Table 12. Example decision-support logic table for danger signs

Decision-support table ID	**SMBP.B7.DT.02**
Decision name	**Danger signs**
Activity ID	**SMBP.B7 Review health actions based on SMBP results**

Inputs	Outputs	Action	Annotations	References
"Danger sign" = "Breathing difficulty"	"Danger signs present?" = TRUE	Contact health worker right away	You should contact a health worker and go to your nearest health facility right away.	*Managing complications in pregnancy and childbirth: a guide for midwives and doctors, second edition* (2017) *(27)* *Pregnancy, childbirth, postpartum and newborn care: a guide for essential practice, third edition* (IMPAC) (2015) *(33)*
"Danger sign" = "Bleeding vaginally"	"Danger signs present?" = TRUE	Contact health worker right away	You should contact a health worker and go to your nearest health facility right away.	
"Danger sign" = "Convulsing"	"Danger signs present?" = TRUE	Contact health worker right away	You should contact a health worker and go to your nearest health facility right away.	
"Danger sign" = "Severe headache"	"Danger signs present?" = TRUE	Contact health worker right away	You should contact a health worker and go to your nearest health facility right away.	
"Danger sign" = "Visual disturbance"	"Danger signs present?" = TRUE	Contact health worker right away	You should contact a health worker and go to your nearest health facility right away.	
"Danger sign" = "Severe abdominal pain"	"Danger signs present?" = TRUE	Contact health worker right away	You should contact a health worker and go to your nearest health facility right away.	
"Danger sign" = "Fever"	"Danger signs present?" = TRUE	Contact health worker right away	You should contact a health worker and go to your nearest health facility right away.	
"Danger sign" = "Severe vomiting"	"Danger signs present?" = TRUE	Contact health worker right away	You should contact a health worker and go to your nearest health facility right away.	
"Danger sign" = "No danger signs"	"Danger signs present?" = FALSE	Continue SMBP	Your current symptom is not a danger sign of pregnancy. Continue to self-monitor regularly for danger signs though.	

SMBP: self-monitoring of blood pressure.



High-level functional and non-functional requirements

This section provides an overview of illustrative functional and non-functional requirements that may be considered to kick-start the process of designing or adapting the personal health tracking application. Functional requirements describe the capabilities the system must have to meet the end users' needs and achieve tasks within the business process. Non-functional requirements provide the general attributes and features of the digital system to ensure usability and overcome technical and physical constraints. Examples of non-functional requirements include ability to work offline, multiple language settings and password protection.

Table 13 highlights some key functional requirements for executing the business processes listed in Component 4 of this document. Table 14 provides non-functional requirements as general characteristics of the overall system. The complete set of functional and non-functional requirements can be accessed in the functional and non-functional requirements implementation tool, available here (*https://smart.who.int/dak-smbp/system-requirements.html*). Please note that these are not exhaustive lists and should be modified according to context and user persona needs.

Functional requirements

Table 13. Functional requirements

Requirement ID	Activity ID and name	As a...	I want...	So that...
Business process A: Identification and preparation for SMBP in pregnancy				
SMBP.FXNREQ.1	SMBP.A9 Download and set up personal health tracking application	Pregnant woman conducting self-monitoring of blood pressure (SMBP)	To view location information for the health worker	I can contact a health worker when needed.
SMBP.FXNREQ.2	SMBP.A9 Download and set up personal health tracking application	Pregnant woman conducting SMBP	To be able to enter contact information	I can have my information for sharing with the health worker.
SMBP.FXNREQ.3	SMBP.A9 Download and set up personal health tracking application	Pregnant woman conducting SMBP	To view the steps I need to follow for setting up the SMBP intervention	I can initiate SMBP with all the right information.
SMBP.FXNREQ.4	SMBP.A9 Download and set up personal health tracking application	Pregnant woman conducting SMBP	To view brief explanations of the importance of each set-up task	I can initiate SMBP with all the right information.

Requirement ID	Activity ID and name	As a...	I want...	So that...
SMBP.FXNREQ.5	SMBP.A9 Download and set up personal health tracking application	Pregnant woman conducting SMBP	The system to provide prompts for each step of a set-up task	I can ensure all necessary information has been completed.
SMBP.FXNREQ.6	SMBP.A9 Download and set up personal health tracking application	Pregnant woman conducting SMBP	To view links to information or training materials that demonstrate the set-up tasks for the SMBP intervention	I can initiate SMBP with all the right information.
Business process B: Conduct SMBP				
SMBP.FXNREQ.7	SMBP.B2 Updates/confirms personal health record	Pregnant woman conducting SMBP	A prompt reminding me to perform the SMBP intervention if I have set up a scheduled health event	I can take the appropriate health actions and conduct SMBP safely.
SMBP.FXNREQ.8	SMBP.B2 Updates/confirms personal health record	Pregnant woman conducting SMBP	A prompt reminding me about any protocols I need to follow in advance of taking a measurement with the SMBP device, if applicable	I can take the appropriate health actions and conduct SMBP safely.
SMBP.FXNREQ.9	SMBP.B2 Updates/confirms personal health record	Pregnant woman conducting SMBP	A prompt asking me to input any new health conditions I was diagnosed with into the personal health tracking application after set-up or the last health profile update	I can take the appropriate health actions and conduct SMBP safely.
SMBP.FXNREQ.10	SMBP.B4 Input results into personal health record	Pregnant woman conducting SMBP	A prompt reminding me of any key symptoms I need to watch for when conducting symptom monitoring	I can take the appropriate health actions and conduct SMBP safely.
SMBP.FXNREQ.11	SMBP.B4 Input results into personal health record	Pregnant woman conducting SMBP	A prompt reminding me of any key steps I need to remember when using the SMBP measurement device, if applicable	I can take the appropriate health actions and conduct SMBP safely.
SMBP.FXNREQ.12	SMBP.B4 Input results into personal health record	Pregnant woman conducting SMBP	To view a brief explanation of the importance of using the SMBP measurement device correctly	I can take the appropriate health actions and conduct SMBP safely.
SMBP.FXNREQ.13	SMBP.B4 Input results into personal health record	Pregnant woman conducting SMBP	To view links to training materials that I can use to learn and review how to use the SMBP device	I can conduct SMBP appropriately.
SMBP.FXNREQ.14	SMBP.B4 Input results into personal health record	Pregnant woman conducting SMBP	To compare measurement data input against indicators for the health condition being monitored	I can take the appropriate health actions and conduct SMBP safely.
SMBP.FXNREQ.15	SMBP.B7 Review health actions	Pregnant woman conducting SMBP	A list of health actions I should do in response to the SMBP data input	I know what actions to take when I am conducting SMBP.
SMBP.FXNREQ.16	SMBP.B7 Review health actions	Pregnant woman conducting SMBP	The system to provide context-sensitive, real-time decision support in response to entry of SMBP data (alerts, advice, resources)	I know what actions to take when I am conducting SMBP.
SMBP.FXNREQ.17	SMBP.B7 Review health actions	Pregnant woman conducting SMBP	To view context-specific information in response to the entry of SMBP data	I know what actions to take when I am conducting SMBP.
SMBP.FXNREQ.18	SMBP.B7 Review health actions	Pregnant woman conducting SMBP	A prompt that suggests I need to contact a health worker based on decision support	I know what actions to take when I am conducting SMBP.

Non-functional requirements

Table 14. Non-functional requirements

Requirement ID	Category	Non-functional requirement
SMBP.NFXNREQ.1	System requirements – general	Provide a unique version number for each revision
SMBP.NFXNREQ.2	System requirements – general	Enable earlier versions of a record to be recoverable
SMBP.NFXNREQ.3	System requirements – general	Enable deployment in an environment subject to power loss
SMBP.NFXNREQ.4	System requirements – general	Work in an environment that is subject to loss of connectivity
SMBP.NFXNREQ.5	System requirements – general	Report version number when saving data to the database
SMBP.NFXNREQ.6	System requirements – general	Be designed to be flexible to accommodate future changes
SMBP.NFXNREQ.7	System requirements – general	Allow for offline and online functionality
SMBP.NFXNREQ.8	System requirements – general	Show the number of records that are not yet synchronized
SMBP.NFXNREQ.9	System requirements – general	Have ability to easily back up information
SMBP.NFXNREQ.10	System requirements – general	Warn user if no valid back-up for more than a predefined number of days
SMBP.NFXNREQ.11	System requirements – general	Able to store images and other unstructured data
SMBP.NFXNREQ.12	System requirements – general	Provide ability for users to share data with other systems, including remote ones
SMBP.NFXNREQ.13	System requirements – configuration	Configure business rules in line with guidelines and standard operating procedures
SMBP.NFXNREQ.14	System requirements – configuration	Configure error messages
SMBP.NFXNREQ.15	System requirements – configuration	Configure workflows and business rules to accommodate differences between facilities
SMBP.NFXNREQ.16	System requirements – hardware and connectivity	Allow for data exchange and efficient synchronization across multiple facilities and points of service when internet is available, even when it is intermittent and slow
SMBP.NFXNREQ.17	System requirements – interoperability	Communicate with external systems through mediators
SMBP.NFXNREQ.18	System requirements – interoperability	Provide access to data through application programming interfaces
SMBP.NFXNREQ.19	System requirements – interoperability	Be interoperable with external systems through mediators
SMBP.NFXNREQ.20	System requirements – interoperability	Link with financial systems that process insurance claims, vouchers or other health financing options in order to verify eligibility and submit claims
SMBP.NFXNREQ.21	System requirements – interoperability	Exchange data with other approved systems
SMBP.NFXNREQ.22	System requirements – interoperability	Accept data from multiple input methods including paper, geocoding (geopolitical positioning system [GPS])
SMBP.NFXNREQ.23	System requirements – usability	Be end user-friendly, including for people with low computer literacy
SMBP.NFXNREQ.24	System requirements – usability	Provide informative error messages and tooltips
SMBP.NFXNREQ.25	System requirements – usability	Alert the end user when navigating away from the form without saving
SMBP.NFXNREQ.26	System requirements – usability	Support real-time data entry validation and feedback to prevent data entry errors being recorded
SMBP.NFXNREQ.27	System requirements – usability	Simplify data recording through predefined drop-down or searchable lists, radio buttons, checkboxes
SMBP.NFXNREQ.28	System requirements – usability	Support multiple languages
SMBP.NFXNREQ.29	System requirements – usability	Use industry standard user-interface practices and apply them in a consistent manner throughout the system

Requirement ID	Category	Non-functional requirement
SMBP.NFXNREQ.30	System requirements – usability	Easy to learn and intuitive to enable end user to navigate between pages
SMBP.NFXNREQ.31	System requirements – usability	Provide guidance to end users to better support clinical guidelines and best clinical practices
SMBP.NFXNREQ.32	System requirements – usability	Be reliable and robust (minimize the number of system crashes)
SMBP.NFXNREQ.33	System requirements – usability	Be designed and tested with local end users to ensure an appropriate and approachable user experience/user interface (UX/UI)
SMBP.NFXNREQ.34	System requirements – usability	Provide help menu content that is understandable, including for end users with limited language and digital literacy
SMBP.NFXNREQ.35	System requirements – usability	Use culturally appropriate icons instead of text where possible
SMBP.NFXNREQ.36	Security – authentication	Notify the system user to change their password the first time they log in
SMBP.NFXNREQ.37	Security – authentication	Adhere to password requirements
SMBP.NFXNREQ.38	Security – authentication	Provide a mechanism to securely change a system user's password
SMBP.NFXNREQ.39	Security – authentication	Notify the system user of password change to their account
SMBP.NFXNREQ.40	Security – authentication	Provide role-based access to the system
SMBP.NFXNREQ.41	Security – confidentiality and privacy	Provide a means to ensure confidentiality and privacy of personal health information
SMBP.NFXNREQ.42	Security – confidentiality and privacy	Provide password-protected access for authorized system users
SMBP.NFXNREQ.43	Security – confidentiality and privacy	Provide ability for allowed end users to view confidential data
SMBP.NFXNREQ.44	Security – confidentiality and privacy	Anonymize data that are exported from the system
SMBP.NFXNREQ.45	Security – confidentiality and privacy	Prevent system remembering username and password
SMBP.NFXNREQ.46	Security – confidentiality and privacy	Log out the system user after specified time of inactivity
SMBP.NFXNREQ.47	Security – confidentiality and privacy	Provide encrypted communication between components
SMBP.NFXNREQ.48	Security – user management	Allow system user to create a new username and temporary password with permission
SMBP.NFXNREQ.49	Security – user management	Provide role-based access
SMBP.NFXNREQ.50	Security – user management	Allow system user to change their own password
SMBP.NFXNREQ.51	Security – user management	Notify the system user to regularly change their password
SMBP.NFXNREQ.52	Security – user management	Allow each system user to be assigned to one or more roles
SMBP.NFXNREQ.53	Security – user management	Support definitions of unlimited roles and assigned levels of access, viewing, entry, editing and auditing
SMBP.NFXNREQ.54	Security – confidentiality and privacy	Allow end users to choose the delivery medium of messages, either voice, text or email, as well as the means, opting for either push or pull content
SMBP.NFXNREQ.55	Security – confidentiality and privacy	Use discreet words and symbols for messages, application names, icons and content sources
SMBP.NFXNREQ.56	Security – confidentiality and privacy	Allow end user to choose whether to receive personalized content or general content that can be shared
SMBP.NFXNREQ.57	Security – confidentiality and privacy	Provide a mechanism for the end user to leave a page or screen quickly
SMBP.NFXNREQ.58	Security – confidentiality and privacy	Provide prompts advising end users to delete messages or searches if concerned about privacy
SMBP.NFXNREQ.59	Security – confidentiality and privacy	Allow end users to choose whether to enable automated data tracking
SMBP.NFXNREQ.60	Security – confidentiality and privacy	Allow end users to choose whether to share data and which data to share
SMBP.NFXNREQ.51	System requirements – configuration	Configure workflows and business rules to accommodate differences between facilities
SMBP.NFXNREQ.62	System requirements – interoperability	Communicate with external systems through mediators

Requirement ID	Category	Non-functional requirement
SMBP.NFXNREQ.63	System requirements – interoperability	Provide access to data through application programming interfaces (APIs)
SMBP.NFXNREQ.64	System requirements – interoperability	Be interoperable with external systems through mediators
SMBP.NFXNREQ.65	System requirements – interoperability	Link with insurance systems to verify eligibility and submit claims
SMBP.NFXNREQ.66	System requirements – interoperability	Exchange data with other approved systems
SMBP.NFXNREQ.67	System requirements – interoperability	Accept data from multiple input methods including paper, geocoding (GPS)
SMBP.NFXNREQ.68	System requirements – hardware and connectivity	Allow for data exchange and efficient synchronization across multiple facilities and points of service when internet is available, even when it is intermittent and slow

For the full set of functional and non-functional requirements, please refer to the **functional and non-functional requirements implementation tool** (*https://smart.who.int/dak-smbp/system-requirements.html).*

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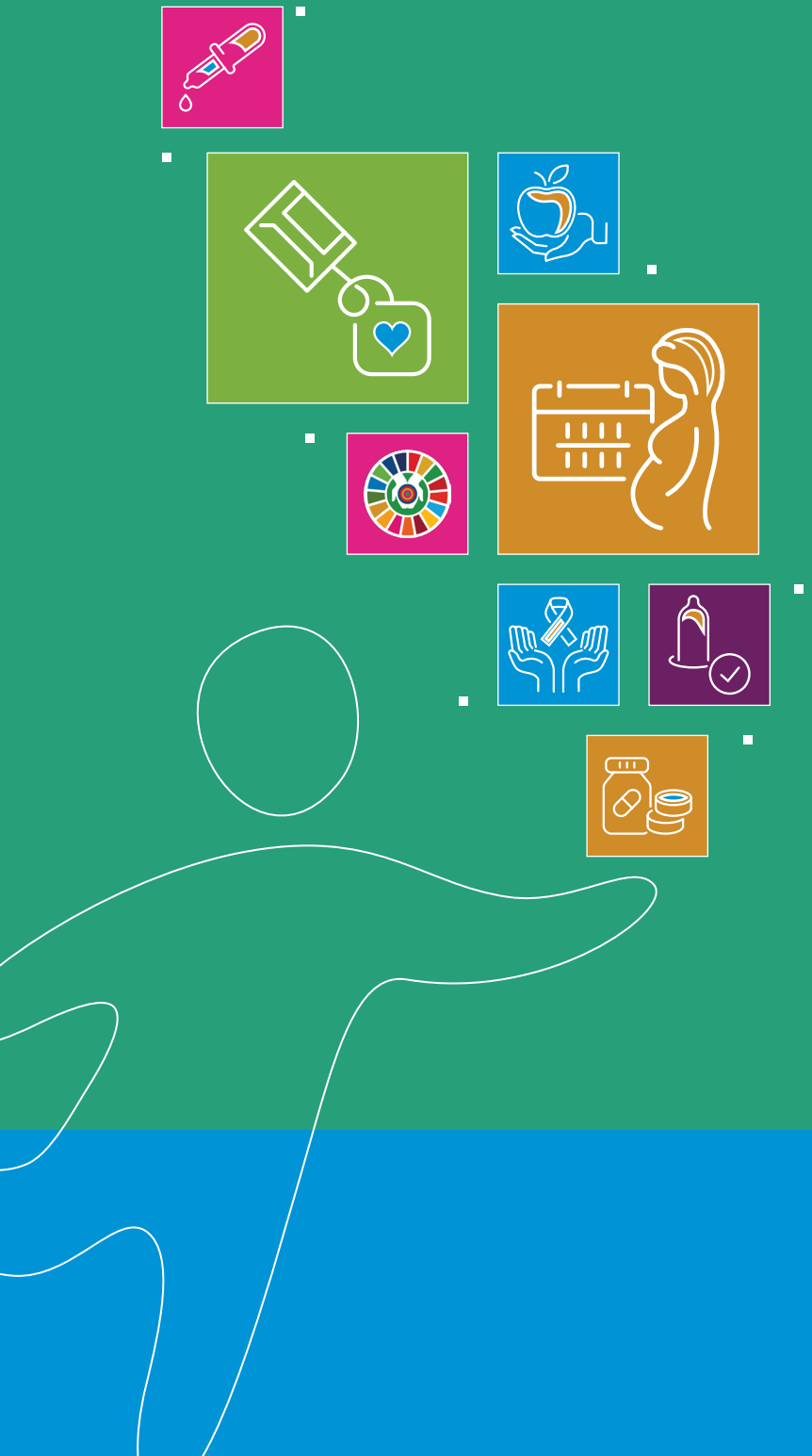

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