Evaluation matrices of the pan-Canadian Digital Health Evaluation Framework for each phase (Planning, Implementing, and Health System Impact) for macro-level users.

MACRO

This involves stakeholders at the federal, provincial, and territorial levels of governance and includes governmental funding agencies and pan-Canadian health organizations. At this level, policies and regulations are set that influence the meso and micro levels.

Planning[1] - What are we doing and why? What should we be considering?

This phase describes the early pre-implementation stage of digital health where the solution is conceptualized and designed. Actions at this phase will include determining service type and target users, identification of team members, community leaders and partners, regulatory and resource requirements, amongst others. The aim is to establish a solid foundation for implementation, health system impact and long-term sustainability.

Engaging should also be considered during this early phase and involves answering the questions of: *Who do we involve/How do we involve them?* Ideally engaging key stakeholders should occur as early as possible, identifying community leaders and partners (including policy, clinical, administrative, and regulatory actors) in addition to potential users and beneficiaries of digital health. Engaging in the right people early will help facilitate buy in, early adoption and utilization, as well as refinement of the technology, where needed. Strategic and purposeful engagement will have an impact on implementation success as well as the short and long-term outcomes.

DIMENSION/ CONSTRUCT	DEFINITIONS	WHAT TO MEASURE/SUB-CONSTRUCT/ VARIABLE	METHODS, TOOLS, & APPROACHES	QUESTIONS/CONSIDERATIONS
EQUITY	**Health equity**[2] implies that everyone has a fair opportunity to attain long and healthy lives and that no one is disadvantaged from achieving this potential irrespective of their social, economic, geographic, demographic, racial or ethnic grouping. **Digital health equity**[3] is achieved when all people have equal opportunity to access, use and benefit from digital health tools and services to attain long and healthy lives.	**Digital literacy**[4]: "interest, attitude and ability of individuals to appropriately use digital technology and communication tools to access, manage, integrate, analyze and evaluate information, construct new knowledge, create and communicate with others". **Digital health literacy**[5]: "ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem". **Availability**[6]: timeliness of accessing digital health information or services when and where needed. **Access**: availability of digital health information or services within reasonable reach of those who need them when they are needed **Representativeness**: does characteristics and profiles of participants included in the evaluation reflect the target populations' characteristics/profiles? **Cultural appropriateness**: the digital health solution is respectful of and responsive to the cultural and religious beliefs, values and norms (e.g., language, communication style, contractual modality, timing) of all users and beneficiaries? **Patient-centred**[7]: digital health information and services are delivered in a way that treats beneficiaries with dignity and		• Is the required information communication technology (e.g., computer, mobile phone, internet connection/bandwidth, software) available in sufficient quantity and quality for all users and beneficiaries? • What steps or precautions[8] are being taken to ensure barriers (e.g., cost, digital literacy skills, privacy) to digital health use do not exist or are minimised? • Is data collected, in disaggregated and aggregated form according to the social determinants of health: sex, gender identity, race, geographical location, socioeconomic group, level of (digital) literacy, age, ability? • How accessible is this intervention? Are there certain populations that may have difficulty with access? • What assumptions are being made about the target population? • Are there a variety of ways to achieve the intended task, or restricted to just one?[9] • Is there IT support available for patients and providers? • Does the service area have high quality Wi-Fi/cell service? • Do all patients have access to any technology required to access the intervention (e.g., smartphone, computer)? • Who do we involve? What teams do we engage? • Diversity and multidisciplinary composition of team • Diverse experience – novice (end-user) to expert (policymakers, academics)

[1] Canada Health Infoway, "Digital Health Equity Analysis: Access to Electronically-Enabled Health Services," 2021, 59.

[2] "Www.Cdc.Gov," n.d.; "Https://Www.Instituteofhealthequity.Org/," n.d.

[3] World Health Organization, *Global Strategy on Digital Health 2020-2025* (Geneva: World Health Organization, 2021), https://apps.who.int/iris/handle/10665/344249.

[4] Government of British Columbia, "Digital Literacy," n.d., https://www2.gov.bc.ca/gov/content/education-training/k-12/teach/resources-for-teachers/digital-literacy.

[5] Cameron D. Norman and Harvey A. Skinner, "EHealth Literacy: Essential Skills for Consumer Health in a Networked World," *Journal of Medical Internet Research* 8, no. 2 (June 16, 2006): e9, https://doi.org/10.2196/jmir.8.2.e9.

[6] Detollenaere Jens et al., "Barriers and Facilitators for EHealth Adoption by General Practitioners in Belgium," Health Services Research (HSR), KCE Reports (Brussels: Belgian Health Care Knowledge Centre (KCE), 2020).

[7] Government of British Columbia, "The British Columbia Patient-Centered Care Framework," n.d.

[8] Tiffany C. Veinot, Hannah Mitchell, and Jessica S. Ancker, "Good Intentions Are Not Enough: How Informatics Interventions Can Worsen Inequality," *Journal of the American Medical Informatics Association: JAMIA* 25, no. 8 (August 1, 2018): 1080–88, https://doi.org/10.1093/jamia/ocy052.

[9] Annette De Vito Dabbs et al., "User-Centered Design and Interactive Health Technologies for Patients," *Computers, Informatics, Nursing: CIN* 27, no. 3 (June 2009): 175–83, https://doi.org/10.1097/NCN.0b013e31819f7c7c.

		respect. It supports patients being in control of their care and enables shared and informed decision-making in a partnership model between patients, families and care providers.		- How will the results/information be interpreted, understood and used? - To what extent is group representation reflected within the project team? - Are all stakeholders provided with equal opportunities to engage and contribute to deliberations (fairness principle)?
STAKEHOLDER ENGAGEMENT	This involves identification and meaningful partnership with any individuals, groups or institutions that can influence or be impacted by the digital health solution at any timepoint, including the target populations (care providers, patients, families), in order to facilitate uptake and acceptance. The involvement or exclusion of certain groups at the planning impacts implementation success, uptake and long-term sustainability. Some people may fill multiple roles in their capacity as stakeholders. Engagement as a means not an end, recognizing engagement as a continuum. The goal is to ensure that the right and necessary people are involved early on in the process and their input/influence is recognized.	The absolute number, proportion, and representativeness of individuals who are willing to participate in a given initiative, intervention, or program, and reasons why or why not.	- Stakeholder mapping/identification[10] (e.g., use a power-influence grid) - Qualitative interviews - Ethnographic observations (e.g., of meetings, current workflow) - Document analysis - Descriptive reports (e.g., number of consultation/dialogue meetings held with various groups and outcomes of these) - Establishing a charter of principles around which stakeholder engage e.g., related to knowledge ownership, accountability, ethics, roles and expectations, etc. - Ongoing relationships with clinician communities, vendor communities, research communities, FPT, patient groups, other PCHOs	- Are there concerted efforts to involve stakeholders as early as possible in the process? - What is the diversity of stakeholders involved and is it team representative of all groups that will be involved in the project at varying capacities throughout implementation? - Patients and members of the public should be engaged as fully participating partners in health and health care research. - To what extent are patients involved in the development and subsequent iterations of the digital solution? I.e., co-design and participatory approaches - At what phases of the project are respective stakeholders involved/invited into the conversation? Which activities/phase of a project will stakeholders participate and be engaged? What are their roles and influence in the organization or implementation team? - What considerations/consultations informed stakeholder engagement? - Is the table considered inclusive? Are systematically/historically marginalized groups (BIPOC, FNIM) and cadres involved in the phases? - What roles and responsibilities (implicit or explicit) are assigned to various actors or groups/organizations? E.g. funders, opinion leaders, early adopters, informants, implementation leaders, - By what process did participants become involved? E.g. Nomination, Appointment, volunteered - How participatory is the approach of design, implementation and overall cross-stakeholder and cross-institutional engagement? - Which voices/stakeholders are being valued and how? - How do you engage with clinical staff/health teams to clearly identify the problem to solve? - Do the chosen stakeholders work closely with the operations of the digital solutions or the clinical population that can account for the feasibility? - What is at stake for each stakeholder?
VALUE PROPOSITION[11]	This refers to promises that the vendor or proponent makes regarding the benefits to be derived from a digital health solution and its differentiation from other solutions in the market. It includes short or long-	**Use case:** the degree to which the digital solution is viewed as useful and relevant by the rights holders or stakeholders involved in developing, implementing, or adopting and benefiting from the solution.	- Operational data (e.g., jurisdictional investment projects) - Use case analysis - Interviews - Surveys - Focus group, co-design session	- Use case: Is the digital solution viewed as necessary by providers or experts in the relevant field? - Is the proposed digital solution worth developing or implementing in the first place—and for whom does it generate value? What problem is the digital health solution going to solve and for whom? - What is the developer's business case for the technology?

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[10] Derek H. T. Walker, Lynda Margaret Bourne, and Arthur Shelley, "Influence, Stakeholder Mapping and Visualization," *Construction Management and Economics* 26, no. 6 (June 2008): 645–58, https://doi.org/10.1080/01446190701882390.

[11] Trisha Greenhalgh et al., "Analysing the Role of Complexity in Explaining the Fortunes of Technology Programmes: Empirical Application of the NASSS Framework," *BMC Medicine* 16, no. 1 (December 2018): 66, https://doi.org/10.1186/s12916-018-1050-6.

	term value that match a future state that purchasers, users and beneficiaries of the solution prioritize or aspire to attain. Value proposition also addresses issues of sustainability with respect to the technology supply model (how the technology was procured), the client-supplier relationship, and the level of potential substitutability.	**Investment model[12]:** The mechanism for financing wide-scale use of the digital health solution that translates into cost savings at a system (macro, meso, or micro) level. • Upstream value, which follows the supply-side logic of financial markets and investment decisions (and hence depends on preliminary tests of efficacy and safety, and evidence of good business practice)[13] • Downstream value, which follows the demand-side logic of health technology appraisal, reimbursement, and procurement (i.e., relates to evidence of benefit to patients and real-world affordability)[14] • Infoway Pan-Canadian studies and national models (example: "Connected Health Information" summary and technical appendix) • Surveys of clinicians and Canadians about their needs, interest in various tools and experiences • Infoway annual surveys of Canadians and rolling clinician surveys, e.g. insights Benefiting modelling applied as a tool to gather a quantitative understanding of the problems to be solved and opportunity for value. These estimates can inform prioritization and generate important discussions clarifying scope.	• Standardized patient-reported experience measures (PREMs) and patient-reported outcome measures (PROMs).	• What supply and support structures are needed to ensure availability, reliability and maintenance of the technology? Have these been put in place? • What is the opportunity cost of using this digital health solution? Which groups are likely to benefit and which ones could be worse off? • How it will be implemented and who will pay for it? • What are the key metrics of interest for the different rights holders or stakeholders? What indicators will be used to determine if the program is valuable? • Has a clear plan for data collection, monitoring and tracking of key metrics of interest been established? Is the plan inclusive and equity-focused? • How do stakeholder groups decide which projects to prioritize and support? • Is the investment sustainable? • What evidence or metrics (population outcomes) will be collected to assess greatest return on investment? • What strategies have been put in place to make it a sustainable model? • What is known about efficacy or cost-effectiveness (real-world affordability)? • Is there a credible business plan that considers issues of safety and efficacy?[15]
APPROPRIATENESS	This is related to the fit, relevance, and compatibility of the digital health solution for a given setting, provider or patient, to address a specific health condition.[16] Digital health solutions should be clinically relevant and tailored to align with the comfort, needs and preferences of target end user and beneficiaries. It includes ensuring an optimum fit between the solution, policy priorities for health and health system resources to drive population-level outcomes.	• Measure of effectiveness (appropriateness of service) and cost-efficiency (appropriateness of health care setting - inpatient vs outpatient).	• Patient-reported experience measures • Provider-reported experience measures.	• Do we agree on the anticipated benefits of DHI? • Is it compatible with our broader values, ethics and priorities? • Do we understand what we have to do to use it? • Does our organisation support its use? • Do we trust the technology? • How do we evaluate it? (i.e. practice and process of evaluation) • Can we adapt it to suit our needs, or adapt our practice as a result of using it?

[12] Maarten van Limburg et al., "Why Business Modeling Is Crucial in the Development of EHealth Technologies," *Journal of Medical Internet Research* 13, no. 4 (December 28, 2011): e124, https://doi.org/10.2196/jmir.1674.

[13] Trisha Greenhalgh et al., "The NASSS-CAT Tools for Understanding, Guiding, Monitoring, and Researching Technology Implementation Projects in Health and Social Care: Protocol for an Evaluation Study in Real-World Settings," *JMIR Research Protocols* 9, no. 5 (May 13, 2020): e16861, https://doi.org/10.2196/16861.

[14] Greenhalgh et al.

[15] "Infoway Benefits Evaluation Framework (Canada)," n.d.

[16] Enola Proctor et al., "Outcomes for Implementation Research: Conceptual Distinctions, Measurement Challenges, and Research Agenda," *Administration and Policy in Mental Health* 38, no. 2 (March 2011): 65–76, https://doi.org/10.1007/s10488-010-0319-7.

FEASIBILITY	This is the ability of the digital health solution to work as intended and the extent to which it can be used successfully in each setting.[17]	Feasibility study - assess predefined progression criteria that relate to: • The evaluation design (reducing uncertainty around recruitment, data collection, retention, outcomes, and analysis) • The intervention itself (e.g., around optimal content and delivery, acceptability, adherence, likelihood of cost effectiveness, or capacity of providers to deliver the intervention)[18]		• A concrete plan is established for how programmatic and outcome data will be collected, managed and used. Metrics of interest and indicators of performance are jointly established in line with the minimum standard.[19] • Prototypes of the digital health solution are created based on requirements and are pilot tested.
COSTS	The financial, infrastructural and operational needs to facilitate digital health implementation. It encompasses the direct and indirect financial resources required to develop, implement and sustain the digital health solution, and the implications of these for overall system performance.	**Remuneration:** The types of compensation available to support day-to-day adoption of the digital health solution. This includes billing codes, alternative payment schemes and reward programs, performance-based models, etc., to incentivize change at the individual, practice and organizational levels.	• Economic analysis • Business case • Market factor analysis	• What supply and support structures are needed to ensure availability, reliability, and maintenance of the technology? • Will the proposed solution save time and money compared to the previous approach? For whom is this important? • What is the actual market climate for vendor/technical procurement? • How long will it take to implement a digital solution? The longer the time from planning to implementation, the greater the costs may be. • What contingency plans are in place? • What limitations or trade-offs will there be? • How long will it take to design and implement the solution? • What resources are required to implement the solution? • What approval is required within the healthcare organization in order to use the solution (for example, sign-off or buy-in from clinician champion)?
DATA PRIVACY AND SECURITY	This includes the National, regional, and territorial standards for data sharing and management (e.g., PHIPA, PIPEDA, OCAP), including data governance agreements between institutions and provinces/territories. Security covers the ability to protect the integrity and use of the data captured, and to ensure only authorized access to the DHI.[20] For instance, privacy impact assessments (PIAs) on a proposed digital solution can identify any real or potential impacts on an individual's privacy.	**Transparency:** The degree to which information about the DHI is made explicit for usage decisions (e. g., details of the intervention author of a DHI are accessible). Ensure due diligence with vendor of record and a privacy impact assessment is planned or will be conducted. • Project adherence to leading practice • Canadians and citizen perceptions • Adherence to jurisdictional privacy legislation • Number of data breaches • Percentage of clinics, hospitals, community care homes, long-term care homes, etc. that are up to date on privacy standards	• Review of privacy/data governance policies or agreements • Infoway requires Privacy Impact Assessments to measure and increase adherence to leading practices. • Infoway routinely measures citizen & clinician perceptions around privacy and has done more comprehensive privacy surveys	• The degree to which the DHI considers legal requirements and aspects with respect to privacy and security aspects.[21] • What safeguard measures are in place for health information privacy and confidentiality? • Who has access to data, health information or health records and are there SOP for defining access? • Where will data be stored? In Canada versus outside of Canada? • What is the rationale for granting access to health information or health system? • Regular monitoring and risk/threat assessment are planned • Does the digital health program adhere to privacy legislation and standards? • What data sharing agreements are in place that facilitate/enable data transfer and full access to complete data?

[17] Brendan Loo Gee et al., *Benefits Realisation: Sharing Insights -- Global Digital Health Partnership (GDHP) White Paper on Evidence and Evaluation*, 2020; Proctor et al., "Outcomes for Implementation Research."

[18] Kathryn Skivington et al., "A New Framework for Developing and Evaluating Complex Interventions: Update of Medical Research Council Guidance," *BMJ*, September 30, 2021, n2061, https://doi.org/10.1136/bmj.n2061.

[19] Harriet Unsworth et al., "The NICE Evidence Standards Framework for Digital Health and Care Technologies – Developing and Maintaining an Innovative Evidence Framework with Global Impact," *DIGITAL HEALTH* 7 (January 2021): 205520762110186, https://doi.org/10.1177/20552076211018617.

[20] "Infoway Benefits Evaluation Framework (Canada)."

[21] Tobias Kowatsch et al., "A Design and Evaluation Framework for Digital Health Interventions," *It - Information Technology* 61, no. 5–6 (November 2019): 253–63.

INTEROPERABILITY[22] & PORTABILITY	Interoperability can be defined as the ability of digital health solutions to "talk to each other" (i.e., information access, exchange and use) and work with other technologies within the system in a seamless and coordinated manner. Depending on the complexity and use case of a digital solution, interoperability may be foundational, structural, semantic or organisational.[23]	Current research around specific questions: • Completeness of information for care[24] • Impact on wait times • Impact on clinician / patient time wastage • Impact on resource utilization • Timeliness • Clinician availability of interoperable tools (access records, send patient information, e-prescribe, etc.) Targeted studies to look at information availability and exchange of the impact on care • Informational continuity of care • Access to connected health information systems, modes of access, primary sources of clinical information, satisfaction with EMR and connected information systems	Measured in Clinician surveys (physician, nursing, and pharmacist) – see Infoway resource	• How do digital systems related to the intended digital solution currently interact? Does the new solution align with or change the flow of information (access, exchange and use)? • What is the level of interoperability that will be established or maintained with the introduction of this new digital solution (foundational, structural, semantic or organisational)[25]? • What system-level and practice changes are needed to ensure or enhance interoperability? Which persons may need to be trained to adjust to these new changes? • Can data collected by the technology be transferred across systems? • Is information (system outputs) readily available when and where needed?
CONTEXTUAL FACTORS[26]	This encompasses the wider institutional, sociocultural and economic environment of digital health implementation at the macro, meso, and micro levels that can act to enable or constrain implementation.	**Societal trends:** encompass the general expectations of the public towards healthcare and digital health and the related policy and political climate. **Social influence[27]:** the degree to which an individual perceives that others (e.g., supervisors, peers, patients, regulatory bodies) believe she or he should adopt or not, the new technology **Facilitating conditions[28]:** the managerial practices and policies put in place to support and reward technology use. The extent to which digital health use is encouraged, supported, and rewarded in the organization. • Digital health services of interest to Canadians • Gap between interest and uptake • Digital health interest and intention to use for clinicians Broader perceptions of digital health and the health system captured periodically, most recently through the "Healthy Dialogue" national consultation. Various measures collected in national surveys: • Annual survey of Canadian citizens • Survey of Canadian physicians / nurses / pharmacists • "Healthy Dialogue" consultation with Canadian citizens	• Snowballing interviews • Focus group, co-design session • Dialogues and consultation meetings	• Do health providers value the digital health supported task? • Is the new technology perceived as consistent with existing work processes? Does workflow need to be modified to accommodate its use? • How will the system fit with the organization's strategy, culture, structure/processes, information infrastructure and return on value? • What are the general expectations of the public towards healthcare and digital health? • What is the general political climate towards digital health? • What is the general economic investment climate towards digital health? • What trends may aid or constrain the implementation of the intervention? • Are there social pressures and incentives for technology use that may foster compliant technology use? • How open to change is the culture of the practice/organization? • Is there a process in place to learn from the implementation process to make future initiatives more successful? • Consider broad issues (i.e., social determinants of health) as well as settings of care • Refer to public expectations, and the overall socio-political and economic climates toward technologies, eHealth and health care as a whole.

[22] Health Information Managements Systems Society (HIMSS), "Https://Www.Himss.Org/Resources/Interoperability-Healthcare," n.d.

[23] Canada Health Infoway, "Https://Www.Infoway-Inforoute.ca/En/Digital-Health-Initiatives/Interoperability," n.d.

[24] Lauren Korosec, Krista Balenko, and Simon Hagens, "Impact of Information Technology on Information Gaps in Canadian Ambulatory Care Encounters," *JMIR Medical Informatics* 3, no. 1 (January 8, 2015): e1, https://doi.org/10.2196/medinform.4066.

[25] Health Information Managements Systems Society (HIMSS), https://www.himss.org/Resources/Interoperability-Healthcare.
    Foundational: the inter-connectivity requirements needed for one system or application to securely communicate data to and receive data from another is established
    Structural: the format, syntax and organization of data exchange including at the data field level for interpretation is established
    Semantic: Provides for common underlying models and codification of the data including the use of data elements with standardized definitions from publicly available value sets and coding vocabularies, providing shared understanding and meaning to the user
    Organizational: Includes governance, policy, social, legal and organizational considerations to facilitate the secure, seamless and timely communication and use of data both within and between organizations, entities and individuals

[26] Greenhalgh et al., "Analysing the Role of Complexity in Explaining the Fortunes of Technology Programmes"; Francis Lau, Morgan Price, and Karim Keshavjee, "From Benefits Evaluation to Clinical Adoption: Making Sense of Health Information System Success in Canada," *Healthcare Quarterly (Toronto, Ont.)* 14, no. 1 (2011): 39–45, https://doi.org/10.12927/hcq.2011.22157; Detollenaere Jens et al., "Barriers and Facilitators for EHealth Adoption by General Practitioners in Belgium."

[27] Patricia J Holahan et al., "Beyond Technology Acceptance to Effective Technology Use: A Parsimonious and Actionable Model," *Journal of the American Medical Informatics Association* 22, no. 3 (May 1, 2015): 718–29, https://doi.org/10.1093/jamia/ocu043.

[28] Holahan et al.

DIMENSION/ CONSTRUCT	DEFINITIONS	WHAT TO MEASURE/SUB-CONSTRUCT/ VARIABLE	METHODS, TOOLS, & APPROACHES	QUESTIONS/CONSIDERATIONS
REGULATORY COMPLIANCE	This is the adherence and compliance to benchmarks, regulations, or policy as it relates to digital health technologies and the data collected from its use. It is accompanied by evidence of endorsement, certification, accreditation, or recommendation by relevant regulatory bodies.[29]		- Direct input from relevant bodies - Environmental scanning	- Is there evidence of endorsement, certification, accreditation, or recommendation by relevant regulatory bodies? - What are the licensing requirements within province/regional contexts (intra/inter)? - Adheres to principles of the CHA (Canada Health Act) - Who owns the intellectual property?

Implementing - What does implementation rollout look like in real-world settings?

Full scale implementation of the digital health solution in real-world settings based on what has been planned occurs at this phase. Implementation should ideally take a staggered approach to allow for incremental learning, feedback cycles and modification of the technology or implementation strategy as needed. This also allows for adjusting personnel and clinical or administrative routines, if needed. A clear plan for data collection, monitoring and tracking of key metrics of interest should have been established in the planning phase.

Evaluating and reflecting in the implementing phase broadly seeks to answer these questions:

- *What does implementation rollout look like in real-world settings?*
- *What (if any) changes (intended and un-intended) have occurred as a result of implementation?*
- *What have we learnt so far and how can we revise policy, practice or implementation in response to these lessons?*
- *What are the short, medium or long-term outcomes of the digital health solution? *This may be dependent on funding cycles*

DIMENSION/ CONSTRUCT	DEFINITIONS	WHAT TO MEASURE/SUB-CONSTRUCT/ VARIABLE	METHODS, TOOLS, & APPROACHES	QUESTIONS/CONSIDERATIONS
EQUITY	**Health equity**[30] implies that everyone has a fair opportunity to attain long and healthy lives and that no one is disadvantaged from achieving this potential irrespective of their social, economic, geographic, demographic, racial or ethnic grouping. **Digital health equity**[31] is achieved when all people have equal opportunity to access, use and benefit from digital health to attain long and healthy lives.	**Digital literacy**[32]: "interest, attitude and ability of individuals to appropriately use digital technology and communication tools to access, manage, integrate, analyze and evaluate information, construct new knowledge, create and communicate with others". **Digital health literacy**[33]: "ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem". **Availability**[34]: timeliness of accessing digital health information or services when and where needed. **Access**: availability of digital health information or services within reasonable reach of those who need them when they are needed **Representativeness**: does characteristics and profiles of participants included in the evaluation reflect the target populations' characteristics/profiles? **Cultural appropriateness**: the digital health solution is respectful of and responsive to the cultural and religious		- Is the required information communication technology (e.g., computer, mobile phone, internet connection/bandwidth, software) available in sufficient quantity and quality for all users and beneficiaries? - What steps or precautions[36] are being taken to ensure barriers (e.g., cost, digital literacy skills, privacy) to digital health use do not exist or are minimised? - Is data collected, in disaggregated and aggregated form according to the social determinants of health: sex, gender identity, race, geographical location, socioeconomic group, level of (digital) literacy, age, ability? - Does early data suggest any negative or positive impact on equity?

[29] Detollenaere Jens et al., "Barriers and Facilitators for EHealth Adoption by General Practitioners in Belgium."
[30] "Www.Cdc.Gov"; "Https://Www.Instituteofhealthequity.Org/."
[31] World Health Organization, *Global Strategy on Digital Health 2020-2025*.
[32] Government of British Columbia, "Digital Literacy."
[33] Norman and Skinner, "EHealth Literacy."
[34] Detollenaere Jens et al., "Barriers and Facilitators for EHealth Adoption by General Practitioners in Belgium."
[36] Veinot, Mitchell, and Ancker, "Good Intentions Are Not Enough."

		beliefs, values and norms (e.g., language, communication style, contractual modality, timing) of all users and beneficiaries? **Patient-centred[35]**: digital health information and services are delivered in a way that treats beneficiaries with dignity and respect. It supports patients being in control of their care and enables shared and informed decision-making in a partnership model between patients, families and care providers.		
SUSTAINABILITY[37]	This is the process by which the digital health solution and the practices and policies that support it become institutionalized or integrated within the structures and systems for health care delivery.	It can be measured by the number of patients or providers who have used the digital health solution or have recommended it to others during a given time period; frequency of use; or evidence of sustained use following the end of the assessment period.	• Program Sustainability Index scores • System Utilization Data • Rate of usage over time • Embeddedness • Integration • Number of log-ins, clicks, or modules completed • Number of app downloads and interactions over time may also capture sustained uptake	• The specific time frame for assessing sustainability and maintenance of a digital health solution varies across projects. • What structures, resources or processes are needed to ensure long term continuity and systemic embeddedness of the digital health solution? • How stable is the DHI in the organization? • What are the predictors of sustainability over time? • Why were programs sustained or not sustained? • How would you identify and distinguish meaningful use of a digital solution?
CONTEXTUAL FACTORS[38]	This encompasses the wider institutional, sociocultural and economic environment of digital health implementation at the macro, meso, and micro levels that can act to enable or constrain implementation.	**Social influence[39]:** the degree to which an individual perceives that others (e.g., supervisors, peers, patients, regulatory bodies) believe she or he should adopt or not, the new technology. **Facilitating conditions[40]:** the managerial practices and policies put in place to support and reward technology use. The extent to which digital health use is encouraged, supported, and rewarded in the organization.		• Do health providers value the digital health supported task? • Is the new technology perceived as consistent with existing work processes? Does workflow need to be modified to accommodate its use? • How will the system fit with the organization's strategy, culture, structure/processes, information infrastructure and return on value?
ACCEPTABILITY[41]	Acceptability is "a multi-faceted construct that reflects the extent to which people delivering or receiving healthcare using a digital health solution consider it to be appropriate based on anticipated or experienced cognitive and emotional responses to the intervention".	**Affective attitude:** how do users and beneficiaries feel about the digital health solution? **Burden:** what is the perceived amount of effort required to use or implement the digital health solution? **Perceived effectiveness**: to what extent do users perceive the digital health solution will achieve its purpose? **Ethicality:** to what extent is the digital health solution aligned to the value proposition of rights holders or stakeholders? **Intervention coherence**: the extent to which users understand the digital health solution and how it works	• Analysis of system utilization data • Rates & time series analysis of technology adoption and utilization over time • Dropout rates • Project-level adoption data (identify milestones with specific adoption targets) • Periodically collect adoption data, for example, performance dashboard pages 1,2,3) • Market research and landscape analysis (surveys) • Landscape surveys (longitudinal measurement of key citizen and clinician adoption metrics for a core set of functions and services including patient e-view, e-	• Who are the "first users" or "early adopters"? • How do you engage participants to be part of the early initiatives?

[35] Government of British Columbia, "The British Columbia Patient-Centered Care Framework."

[37] R E Glasgow, T M Vogt, and S M Boles, "Evaluating the Public Health Impact of Health Promotion Interventions: The RE-AIM Framework.," *American Journal of Public Health* 89, no. 9 (September 1999): 1322–27, https://doi.org/10.2105/AJPH.89.9.1322.

[38] Greenhalgh et al., "Analysing the Role of Complexity in Explaining the Fortunes of Technology Programmes"; Lau, Price, and Keshavjee, "From Benefits Evaluation to Clinical Adoption."

[39] Holahan et al., "Beyond Technology Acceptance to Effective Technology Use."

[40] Holahan et al.

[41] Mandeep Sekhon, Martin Cartwright, and Jill J. Francis, "Acceptability of Healthcare Interventions: An Overview of Reviews and Development of a Theoretical Framework," *BMC Health Services Research* 17, no. 1 (December 2017): 88, https://doi.org/10.1186/s12913-017-2031-8.

		Opportunity costs: what value, processes, benefits or resources are given up in order to use or benefit from the digital health solution **Self-efficacy:** what is the confidence of users that they can perform the actions required to use the digital health solution	book, video visits, remote monitoring, clinician EMR, peer messaging, patient messaging, etc.) Full set of surveys here conducted by Infoway: • A Healthy Dialogue • Annual citizen surveys (2018, 2019, 2020) • COVID tracking survey • 2021 National Survey of Canadian Physicians • 2020 National Survey of Canadian Nurses • 2018 Canadian Physician Survey • 2019 Commonwealth Fund Physician Survey • 2016 Community-Based Pharmacists Survey • Outcomes modeling applying Pan-Canadian studies and related methods	
APPROPRIATENESS	This is related to the fit, relevance, and compatibility of the digital health solution for a given setting, provider or patient, to address a specific health condition. Digital health solutions should be clinically relevant and tailored to align with the comfort, needs and preferences of target end user and beneficiaries. It includes ensuring an optimum fit between the solution, policy priorities for health and health system resources to drive population-level outcomes.		• Collaborative research with clinical communities • Landscape surveys • Standardized PREMs (Patient-reported experience measures) and PROMs (patient-reported outcome measures)	• To what extent do the regulatory and clinical benchmarks enable implementation and aligned with achieving the quadruple aims?
EFFICIENCY	Efficiency refers to optimal use of available resources (financial & human) to achieve set goals of a digital health solution. It can also refer to how well a digital health solution or tool is designed. Poor user interface design can reduce efficiencies increasing the likelihood of data or inputting errors, e.g. too many menus, alerts, high proficiency required to use.[42]	• Health system utilization: Reduction of ineffective care, unnecessary tests, hospitalization and length of stay • Provider experience: Time savings for clinicians[43], workforce productivity, prolonged use and fatigue • Economic growth • Innovation growth in the healthcare sector • Patient safety – adverse effects[44]	• Previous studies and funded research on this topic, modality, technology, etc. (environmental scans, literature reviews, clinical studies, etc.) • Market research and landscape analysis (surveys)	• How well does a digital health solution improve efficiency of health care delivery and workforce productivity? • What performance measures are collected and prioritized to assess ability of DHI to deliver care efficiently? • What is the desired level of professional competency, knowledge, skills and performance in the workplace? • What does the implementation rollout look like? • How many implementing sites are there (staggered approach recommended)?

[42] Saif Khairat et al., "Association Between Proficiency and Efficiency in Electronic Health Records Among Pediatricians at a Major Academic Health System," *Frontiers in Digital Health* 3 (2021): 689646, https://doi.org/10.3389/fdgth.2021.689646.

[43] Detollenaere Jens et al., "Barriers and Facilitators for EHealth Adoption by General Practitioners in Belgium."

[44] Kowatsch et al., "A Design and Evaluation Framework for Digital Health Interventions."

Health System Impact- *What are the results/outcomes? What changes have been triggered?*

This phase is a central point for evaluation and focuses on the wider system level results. It involves the collection and analysis of indicators to assess the overall impacts of digital health on the quadruple aim outcomes: improved patient experience, improved provider experience, improved patient (population) outcomes and reduced per capita cost of care to inform long term planning, growth, and scale. Digital health end-users may include consumers, patients, and clinicians. Other healthcare stakeholders also include end-users not directly involved in the delivery of health care, such as healthcare administrators, digital health designers, policy makers, and researchers.

DIMENSION/ CONSTRUCT	DEFINITIONS	WHAT TO MEASURE/SUB-CONSTRUCT/ VARIABLE	METHODS, TOOLS, & APPROACHES	QUESTIONS/CONSIDERATIONS
EQUITY	**Health equity**[45] implies that everyone has a fair opportunity to attain long and healthy lives and that no one is disadvantaged from achieving this potential irrespective of their social, economic, geographic, demographic, racial or ethnic grouping. **Digital health equity**[46] is achieved when all people have equal opportunity to access, use and benefit from digital health to attain long and healthy lives.	**Digital literacy**[47]: "interest, attitude and ability of individuals to appropriately use digital technology and communication tools to access, manage, integrate, analyze and evaluate information, construct new knowledge, create and communicate with others". **Digital health literacy**[48]: "ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem". **Access**: availability of digital health information or services within reasonable reach of those who need them when they are needed **Availability**[49]: timeliness of accessing digital health information or services when and where needed. **Patient-centred**[50]: digital health information and services are delivered in a way that treats beneficiaries with dignity and respect. It supports patients being in control of their care and enables shared and informed decision-making in a partnership model between patients, families and care providers. **Representativeness**: characteristics of participants that are able to access the digital health solution reflects the target populations' characteristics.		• Is the required information communication technology (e.g. computer, mobile phone, internet connection/bandwidth, software) available in sufficient quantity and quality for all users and beneficiaries? • What steps or precautions[51] are being taken to ensure barriers (e.g. cost, digital literacy skills, privacy) to digital health use do not exist or are minimised? • Is data collected, in disaggregated and aggregated form according to the social determinants of health: sex, gender identity, race, geographical location, socioeconomic group, level of (digital) literacy, age, ability?
SUSTAINABILITY[52]	This is the process by which the digital health solution and the practices and policies that support it become institutionalized or integrated within the structures and systems for health care delivery. The long-term effects of a program on outcomes after a	Other terms for sustainability include **routinization, maintenance, sustainment** or **long-term follow-up** but can also include terms that reflect discontinuation, such as **deadoption.**	It can be measured by the number of patients who have used an app or providers who have recommended an app during a given time period, the frequency of app use, or evidence of sustained use following the end of assessment period (trial, study, etc.).	

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[45] "Www.Cdc.Gov"; "Https://Www.Instituteofhealthequity.Org/."
[46] World Health Organization, *Global Strategy on Digital Health 2020-2025*.
[47] Government of British Columbia, "Digital Literacy."
[48] Norman and Skinner, "EHealth Literacy."
[49] Detollenaere Jens et al., "Barriers and Facilitators for EHealth Adoption by General Practitioners in Belgium."
[50] Government of British Columbia, "The British Columbia Patient-Centered Care Framework."
[51] Veinot, Mitchell, and Ancker, "Good Intentions Are Not Enough."
[52] Glasgow, Vogt, and Boles, "Evaluating the Public Health Impact of Health Promotion Interventions."

	program is completed or the "continued use of program components and activities for the continued achievement of desirable program and population outcomes"[53]		

Patient Experience			
Engagement, motivation and enablement of all patients to play an active role in matters related to their health and wellness in a holistic and equitable manner.			
PATIENT EXPERIENCE	This relates to a broad spectrum of dimensions, domains and constructs that explore the human health care experiences beyond the clinical encounter. It highlights the central role of the patient but also includes interactions among patients, families, care partners and the health care providers.[54] The experience of the end-user (patient) as they interact with a digital health technology or service. The usefulness, ease-of-use, and competency of working with eHealth services. *How user-friendly is it?*	• Patient Satisfaction: Covers the extent to which the users feel gratified from using the DHI to accomplish their tasks, as well as how easy to learn and easy to use the digital health solution. • Ease of Use: The degree to which effort is required to take adequate advantage of the digital health solution. • Patient-centredness • Appropriateness • Intention to use • Features such as size, sounds, aesthetics, and "clunkiness" have significant impact on the technology's actual and perceived usability and appropriateness.[55] • Digital health literacy: Some patient-facing technologies require no knowledge form the patient; others require clinical knowledge, technical knowledge, and the ability to make judgments about (for example) what counts as urgent.	• Standardized PREMs (Patient-reported experience measures) and PROMs (patient-reported outcome measures) • Longitudinal surveys • Real time surveys • Sector comparisons and benchmarking • Partnerships with patient advocacy groups, patient navigator programs, patient-safety groups, patient and family advisory networks etc. (PAN) • Patient surveys • Program evaluations • Links to studies we've led or funded with methods of relevance: [Direct Lab Study](#)	• Does the design follow best practices for effective user experience, and consider digital health literacy levels of its end-users? • What **quality measures** are important to assess overall patient experience? (e.g. patient adherence to medical advice, clinical outcomes, patient safety, and lower use of unnecessary services)

Provider Experience			
Enhanced work conditions for healthcare providers through increased access to tools, innovations, and efficient work processes to prevent burnout and dissatisfaction (clinical value).			

PROVIDER EXPERIENCE	This is related to the well-documented link between provider experience and the quality of care provided and experienced by patients.[56] And by extension, the provider experience can have an impact on the overall performance of the health system.
	
	Ensuring that the solution does not contribute negative experiences in the delivery of care due to:
	• Inefficient workflows
		Optimization:
		• Cost savings to the provider
		• Time savings to the provider
		• Streamlining processes:
		  ○ To what degree does the digital health solution prevent provider burnout and dissatisfaction?
		  ○ To what extent does the digital health solution allow for increased care for more patients in a more efficient and productive manner?
		
		Appropriateness/clinical relevance: To what degree does the digital health solution/tool align with care delivery or address the clinical issue.
		• Was the selected virtual care modality appropriate for patient's condition/ health concern?
				• To what extent does technology and workflow optimization mitigate burnout among providers?
				• What models of health care delivery enable improved provider experiences?
				• Is there a process for supporting cultural and service change management to ensure successful eHealth implementation among providers and other healthcare staff?

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[53] Glasgow, Vogt, and Boles.

[54] Jason A Wolf et al., "Reexamining 'Defining Patient Experience': The Human Experience in Healthcare," *Patient Experience Journal* 8, no. 1 (April 28, 2021): 16–29, https://doi.org/10.35680/2372-0247.1594.

[55] Kowatsch et al., "A Design and Evaluation Framework for Digital Health Interventions"; Trisha Greenhalgh et al., "Beyond Adoption: A New Framework for Theorizing and Evaluating Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability of Health and Care Technologies," *Journal of Medical Internet Research* 19, no. 11 (November 1, 2017): e367, https://doi.org/10.2196/jmir.8775.

[56] Mark W. Friedberg et al., "Factors Affecting Physician Professional Satisfaction and Their Implications for Patient Care, Health Systems, and Health Policy," *Rand Health Quarterly* 3, no. 4 (2014): 1.

	• Uncoordinated communication Information overload, e.g., too many notifications, alerts, etc.	• To what extent does a patient's behaviour follow medical advice or whether the patient's behaviour corresponds to the expected outcomes of the intervention? **Health information system quality:** The completeness, accuracy, relevance and comprehension of the content in the eHealth system influences its uptake[57]. Physicians prefer to see an analysis of the data rather than raw data to get an overview of their patients and clinical work What data (patient reported outcomes) would be most relevant and meaningful to inform clinical decisions and clinical management?[58]		

Cost Implications

Increasing quality of care at lower costs through efficient use and allocation of resources and reduction of readmissions, unnecessary emergency department (ED) visits, and misappropriate use of health care.

| **COST IMPLICATIONS** | This can be related to both cost savings (cost-effectiveness, resource allocation, reduction in unnecessary health care utilization, etc.) and time savings (efficiency).

When considering cost per capita or other monetary outcomes, economic evaluations help to inform decision makers about the relative value for money of those interventions against specified alternatives. | The new digital health tool, solution or technology should save on costs compared to the previous approach or in-person care (where appropriate).

System capability: A "health system's ability to reliably and consistently deliver a distinctive outcome, relevant to its business, through the right combination of processes, tools, knowledge, skills and organization."

Efficiency: Includes the optimal use of available resources (financial & human) in order to achieve set goals and outcomes.

Productivity: Optimal use of available resources (financial & human) to achieve set goals. | • Cost-utility analysis (CUA)
• Cost minimization analysis (if no difference in clinical outcomes anticipated)
• Cost per case of death or disease prevention
• Program data
• Pan-Canadian studies
• Benefit modelling
• Economic analyses
• Program evaluations (these are conducted by Infoway as part of the program lifecycle)
• Virtual visits experience and utilization in BC study
• EMR ROI Study
• Infoway Pan-Canadian studies and national models (example: "Connected Health Information" summary and technical appendix) | • What are the net costs considerations (e.g., monetary avoidance, reduction and cost savings)?
• Can same/better quality of care be achieved at a lower cost?
• What is the quality of the digital and system infrastructure? Connectivity issues and the inability to provide real-time access to eHealth systems entail loss of time and potential loss of revenue. |

Patient (Population) Outcomes

Prevention, management and health promotion activities are effective in reducing individual and societal burden of disease, including in underserved groups.

| **HEALTH OUTCOMES** | This involves assessing both the short-term clinical outcomes and longer-term change in the health status of patients that can be attributed to digital health interventions. | **Digital health safety:** Describes threats to patient safety and preventable harm associated with the use of digital health solutions.

Patient safety[59]: The extent to which the usage of a digital health solution is safe with respect to side effects. It accounts for adverse events, prevention, surveillance, and risk management. | • Standardized PREMs (Patient-reported experience measures) and PROMs (patient-reported outcome measures)
• Clinical effectiveness outcome measures
• Health utilization and health system data
• Remote monitoring project evaluations (Infoway)

Links to Infoway studies with methods of relevance:
• Information Gaps Study
• Repeat Imaging Study
• Drug Profile View Study | • What improvements are evident in relevant outcomes in order to make decisions?
• Does current evidence show that techniques used in the digital health solutions are recognized and show desired behaviour change, health-specific outcomes, etc.?
• Which users have been unintentionally excluded from accessing the digital health solution?

What health quality indicators?
• Positive behaviour change
• Improved patient self-management |

[57] Detollenaere Jens et al., "Barriers and Facilitators for EHealth Adoption by General Practitioners in Belgium."

[58] Deliya B. Wesley et al., "A Socio-Technical Systems Approach to the Use of Health IT for Patient Reported Outcomes: Patient and Healthcare Provider Perspectives," *Journal of Biomedical Informatics* 100 (2019): 100048, https://doi.org/10.1016/j.yjbinx.2019.100048.

[59] Kowatsch et al., "A Design and Evaluation Framework for Digital Health Interventions."

			• RCT/non-randomized studies; systematic review of these studies • Real world data (RWD/RWE) collection and analysis • Landscape surveys with common measures for satisfaction and ability to self manage • Remote monitoring project evaluations (Infoway)	

Cross-Cutting: Foundational Constructs

SUSTAINABILTY[60]

- Successful implementation
- Environmental impact: What is the long-term environmental impact of the technology? Will it result in reduced use of energy? Will it produce more digital waste during production or use that could be harmful to the environment?
- Does it help build sustainable relationships by going beyond single visits, and instead integrating virtual teams to serve patients better?

SCALABILITY/SPREAD[61]

Successful implementation

DIGITAL HEALTH GOVERNANCE

- Types of accountability and decision-making structures in place regarding eHealth adoption are included in this category
- What policies govern data sharing privacy and confidentiality?
- What legislative acts govern eHealth adoption?
- Is there an information governance agreement between different organizations and decision-makers involved?
- What accountability and decision-making structures are in place?

DIGITAL HEALTH EQUITY

This benefits category relates to health equity, being the absence of avoidable, unfair or remediable differences among groups of people, whether those groups are defined socially, economically, demographically or geographically or by other means of stratification. Health equity implies that, ideally, everyone should have a fair opportunity to attain their full health potential and that no one should be disadvantaged from achieving this potential.

Cross-cutting: Processes

ENGAGEMENT

Engaging is an ongoing process and an important initial first step in the evaluation strategy. Ideally engaging key stakeholders should occur as early as possible, identifying community leaders and partners (including policy, clinical, administrative, and regulatory actors) in addition to potential users and beneficiaries of digital health. It involves answering the questions of: *Who do we involve/How do we involve them?* Engaging in the right people early will help facilitate buy in, early adoption and utilization, as well as refinement of the technology, where needed. Strategic and purposeful engagement will have an impact on implementation success as well as the short and long-term outcomes. The people involved (or excluded) from this process impacts implementation success, uptake, and long-term sustainability.

REFLECTING

What have we learnt?

What are we learning as we go along?

- Feedback cycles, frequency of monitoring & data verification expert review (min annually)

What are the opportunities for quality improvement?

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[60] Greenhalgh et al., "The NASSS-CAT Tools for Understanding, Guiding, Monitoring, and Researching Technology Implementation Projects in Health and Social Care."
[61] Greenhalgh et al.