IMPROVE

Framework to IMPROVE the Integration of Patient Generated Health Data to Facilitate Value Based Healthcare

D3.5: Data Dashboard V1

Version 1.0

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11.12.2024	1.0	Final version to submit

Statement of Originality

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

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Abbreviations and Acronyms

AI	Artificial Intelligence
CRS	Chronic rhinosinusitis
DoA	Description of Action
EC	European Commission
KPIs	Key Performance Indicators
MVP	Minimum Viable Product
PESTEL	Political, Economic, Social, Technological, Environmental and Legal factors
PPI	Patient Preference Information
PREMs	Patient-reported experience measures
PROMs	Patient-reported outcome measures
SWOT	Strengths, weaknesses, opportunities and threats
UCs	Use Cases
UCD	User Centred Design
VBHC	Value-Based Healthcare
WCAG	Web Content Accessibility Guidelines
WHO	World Health Organization
WP	Work package

Table of Contents

Executive summary

This deliverable presents the definition and conceptualization of the IMPROVE dashboard, a core tool for implementing and monitoring Value-Based Healthcare (VBHC) principles across diverse use cases. It outlines a structured approach to ensure the dashboard aligns with project objectives, stakeholders' needs, and specific requirements of the use cases.

The methodology emphasizes a user-centred design approach, incorporating iterative development cycles following the paradigm of User Centred Design (UCD) and stakeholder engagement to create a functional and intuitive tool. The conceptualization focuses on the dashboard's levels of assessment, addressing both patient-centred outcomes and healthcare system performance, and establishing its role as a decision-support tool.

Stakeholder analysis led to the creation of personas representing typical users, ensuring the dashboard's functionalities and interface are tailored to diverse roles. Use cases were characterized to define assessment levels, required data, and Key Performance Indicators (KPIs), which measure both patient value (e.g., health outcomes, quality of life) and healthcare value (e.g., service quality, intervention efficacy, and costs).

The deliverable details the scope and functionalities of the dashboard, including interactive forms, data aggregation, customizable visualizations, and integration with tools like MAFEIP for health and economic impact analysis. A workflow proposal illustrates user touchpoints such as study characterization, comparator extraction, combined comparative and gap analysis, and recommendations generated through the IMPROVE Oracle or the recommendations module.

The roadmap and validation plan outlines the development steps, beginning with a low-fidelity prototype to visualize functionalities, followed by stakeholder validation through qualitative and quantitative methods. Feedback will guide the development of a high-fidelity prototype, culminating in a Minimum Viable Product (MVP) and incremental improvements.

This deliverable establishes the foundation for the IMPROVE dashboard, ensuring its functionality and adaptability to support VBHC implementation. Future activities will focus on validation, refinement, and deployment to advance value-based healthcare for patients, providers, and systems.

Keywords: Dashboard, UCD methodology, KPIs, Requirements, VBHC

1. Specific methodology for the dashboard

The development of the IMPROVE data dashboard is guided by a User-Centred Design[1] (UCD) methodology to ensure the tool aligns with user needs, enhances usability, and supports the project objectives. This iterative and collaborative approach focuses on involving end users throughout the design and development process, fostering a solution tailored to their preferences, workflows, and requirements.

User involvement is prioritized throughout the design and development process. End users and stakeholders are actively engaged via interviews, workshops, and testing sessions to gather insights into their workflows, preferences, and requirements. This feedback directly informs the dashboard's design, ensuring it reflects real-world applications and addresses specific user challenges.

The development process is iterative, incorporating user feedback into each design cycle. This allows the team to make continuous improvements, adapt to evolving needs, and address usability issues as they arise. Personas and scenarios are created to guide the design, ensuring it is empathetic to the diverse roles, technical expertise, and data needs of its users. Special attention is paid to accessibility and inclusivity, following standards like WCAG[2] (Web Content Accessibility Guidelines) to ensure the dashboard is usable by a wide range of individuals, including those with limited visual impairment.

The process begins with extensive user research, including surveys and interviews, to identify core needs and workflows. Early prototypes and wireframes are then developed to visualize the dashboard's functionalities, focusing on layout, navigation, and user interactions. These prototypes are tested in usability sessions, where qualitative and quantitative feedback helps refine the design.

The first version of the dashboard is built as a Minimum Viable Product (MVP)[3], incorporating key features identified during the research phase. This initial version supports essential functionalities while remaining flexible for future enhancements. Post-launch evaluations are conducted to measure effectiveness and satisfaction through analytics and user feedback. Insights gained from these evaluations will inform further refinements and updates.

This methodology ensures that the data dashboard is a user-friendly, practical, and impactful tool, tailored to meet the specific needs of its stakeholders while maintaining adaptability for future iterations.

To enhance this process, two collaborative workshops were conducted with project partners, including both clinical and technical stakeholders. These workshops, facilitated using an online interactive whiteboard called Miró[4], provided an interactive and dynamic platform for discussions, brainstorming, and feedback collection.

[1] https://www.iso.org/obp/ui/en/#iso:std:iso:9241:-210:ed-2:v1:en
[2] https://www.w3.org/TR/wcag-3.0/
[3] Stevenson, R., Burnell, D., & Fisher, G. (2024). The Minimum Viable Product (MVP): Theory and Practice. Journal of Management, 50(8), 3202-3231. https://doi.org/10.1177/01492063241227154
[4] https://miro.com/

Workshop 1: Consolidating requirements (May 2024)

The first workshop combined principles of brainstorming and user-centered design to consolidate the requirements of WP3. At this stage of the project, this approach was deemed essential to ensure alignment on the core aspects of the dashboard. The main topics of discussion included:

- Identifying the stakeholders who will use the dashboard.
- Defining the overall needs that the dashboard should address.
- Exploring the types of queries and questions the dashboard is expected to answer.
- Discussing the knowledge model required for the IMPROVE project.
- Identifying the data that needs to be imported and processed.
- Determining the types of visualizations that the dashboard should provide.

The workshop aimed to collect the primary requirements and identify relevant stakeholders, as well as define the expected outputs from WP3. A significant focus was placed on determining the visualization style of the data and information. The outcomes of this workshop provided a solid foundation for shaping the dashboard's initial design.

Workshop 2: Refining the dashboard concept (October 2024)

The second workshop aimed to further refine the overall concept and functionality of the WP3 IMPROVE dashboard. Building on the insights gained from the first workshop, discussions revolved around:

- Clarifying the main goals of the dashboard and its functions.
- Defining the dashboard’s audience and types of users.
- Characterizing the levels of assessment and use cases (UCs).
- Specifying the data, comparators, types of analysis, and expected results and recommendations.
- Summarizing the overall process and user journey of the dashboard.

The objective of this workshop was to improve the conceptual definition of the dashboard, validate the stakeholders and main users, and agree on the assessments, analyses, and outcomes it should deliver. Feedback from the session also helped define scenarios and user journeys, ensuring the dashboard design aligns with user expectations and project goals.

These workshops provided a collaborative space for project partners to share their expertise and insights, ensuring the dashboard is developed as a practical and user-focused tool. The iterative process, supported by active stakeholder engagement, continues to drive the dashboard’s evolution, aligning its features with the needs of the IMPROVE project.

2. Conceptualization of the dashboard

The conceptualization of the IMPROVE dashboard builds on the objectives outlined in the project documentation and the insights gathered during collaborative workshops with stakeholders.

As described in the Description of Action (DoA), the dashboard is envisioned as a robust platform designed to enable the intelligent use of patient-generated evidence and input. This platform aims to enhance treatment selection by integrating patient preferences and experiences into healthcare decisions, improve the design of medical devices by incorporating patient feedback, and accelerate market entry for patient-centric and cost-effective integrated care solutions, ensuring broader accessibility to innovative treatments.

Through the workshops conducted with clinical and technical stakeholders, the goals of the dashboard were further refined and expanded. These discussions identified additional operational priorities, including the assessment of target use cases to evaluate healthcare processes, interventions, and digital tools across various domains such as oncology, neurology, cardiovascular diseases, and chronic inflammation.

The dashboard is also intended to facilitate comparative analysis, enabling users to learn from research outcomes and best practices across different healthcare contexts. Furthermore, it will provide actionable suggestions for treatment options, design improvements, and guidelines to support market entry, thereby enhancing its role as a decision-support tool.

The workshops also highlighted the importance of providing accessible and standardized information to stakeholders, ensuring consistent frameworks for the collection and analysis of patient-generated health data. Additional functions include supporting the development of educational programs for patients and leveraging predictive analytics to provide insights into potential health outcomes. These refinements underscore the dashboard's capacity to address a broader range of user needs while maintaining its focus on patient-centric healthcare innovation.

Figure 1 shows the overall concept of the IMPROVE dashboard which integrates key functionalities to support the defined goals. It includes Use Case profiles that classify healthcare services, interventions, and technologies across diverse domains, ensuring comprehensive coverage of relevant topics. The dashboard also incorporates trackers designed to monitor scientific advancements, practical applications, and policy developments, providing stakeholders with a dynamic view of healthcare trends. Advanced analytics capabilities support both quantitative and qualitative analyses, enabling comparisons of cohorts, methods, and effects, while also facilitating gap analyses to identify areas for improvement. Tools such as SWOT and PESTEL frameworks can be utilized to propose actionable plans, and the system will be designed to deliver outcome recommendations aligned with the principles of Value-Based Healthcare.

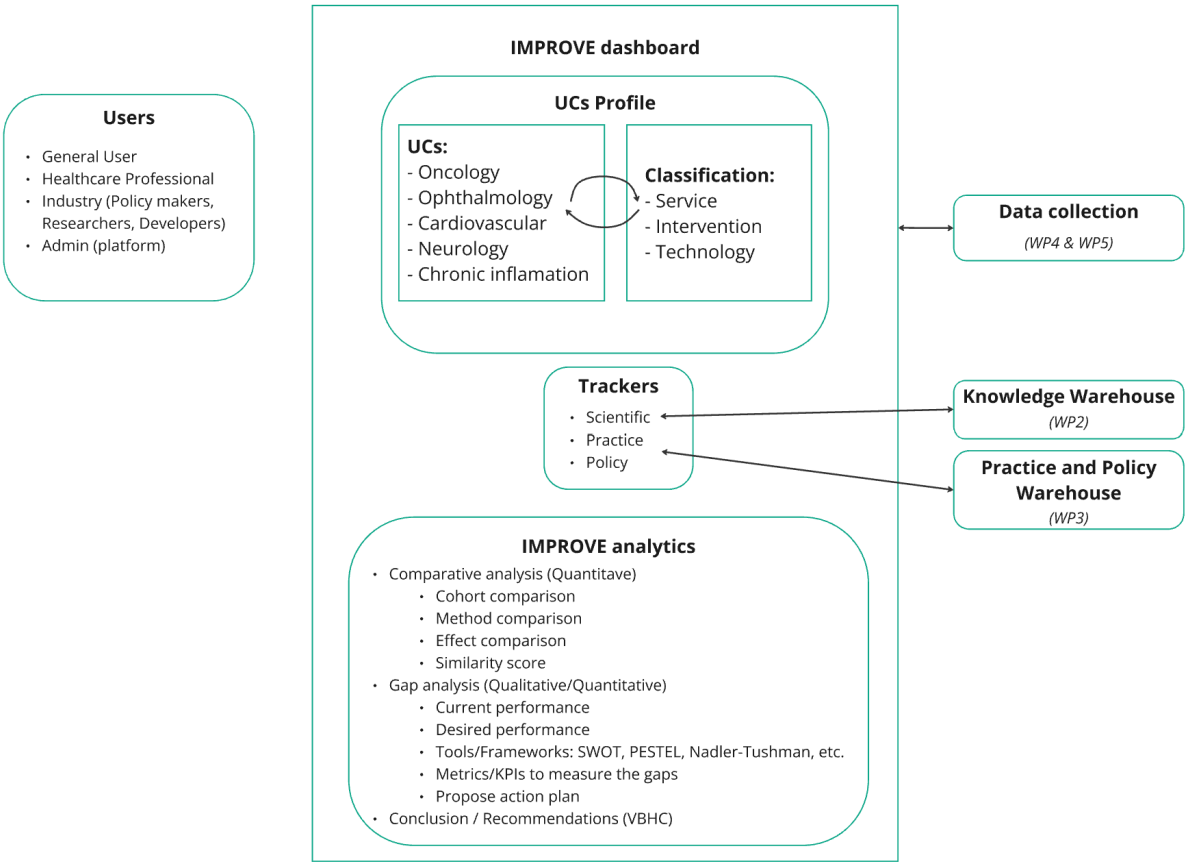

Figure 1 Overall concept of IMPROVE Dashboard.

The dashboard's development is closely integrated with other components of the project. It leverages data from the Knowledge Warehouse (WP2) and the Practice and Policy Warehouse (WP3), with additional input from data collection activities in WP4 and WP5. This interconnected approach ensures a robust data foundation and enhances the dashboard's ability to generate meaningful insights. By connecting these elements, the IMPROVE dashboard is positioned as a central tool for achieving the project's objectives and supporting healthcare professionals, policymakers, industry stakeholders, and patients in advancing patient-centric care.

2.1. Levels of assessment

To address the goals of the IMPROVE dashboard and ensure a comprehensive approach to evaluating healthcare processes, interventions, and tools, three distinct assessment levels have been established: Service, Intervention, and Technology. The definitions for each of these levels are derived from the World Health Organization (WHO) to ensure alignment with globally recognized standards. This approach enables the dashboard to deliver actionable insights for healthcare improvement while maintaining consistency with established healthcare frameworks.

The **Service level** focuses on the organized provision of healthcare to individuals or communities, encompassing a wide range of activities designed to promote, maintain, and restore health. Services include preventive, diagnostic, therapeutic, rehabilitative, and palliative care, delivered across various

settings such as hospitals, clinics, community health centres, or even in-home care. These services may be publicly or privately funded and span multiple domains of medical, dental, pharmaceutical, and psychological care, along with broader efforts to promote health and prevent disease. By analyzing health services, the dashboard seeks to assess their accessibility, quality, efficiency, and impact on patient outcomes.

The **Intervention level** evaluates specific actions or strategies designed to address health challenges. Interventions are broadly classified into two categories: preventive and therapeutic. Preventive interventions aim to reduce the incidence of disease by stopping it before it occurs, while therapeutic interventions address existing health issues to mitigate, treat, or manage their effects. This level of assessment includes analyzing the effectiveness, efficiency, and broader impact of interventions, whether aimed at individuals, groups, or populations. It also explores how interventions align with patient preferences and healthcare system goals, ensuring a patient-centred perspective in decision-making.

The **Technology level** examines the application of organized knowledge and skills in the form of devices, medicines, vaccines, procedures, and systems developed to solve health problems and improve quality of life. Health technologies include both tangible elements, such as pharmaceuticals and medical devices, and intangible systems, such as organizational frameworks and computer-supported information systems. By assessing the usability, effectiveness, and cost-efficiency of these technologies, the dashboard supports the identification of innovative solutions that align with the needs of patients and healthcare providers while ensuring alignment with regulatory and market expectations.

These levels of assessment provide a structured framework for analyzing diverse aspects of healthcare, ensuring the IMPROVE dashboard captures the complexity and interconnectedness of health services, interventions, and technologies. This approach allows stakeholders to draw meaningful insights, compare outcomes, and identify actionable strategies to enhance patient-centred care and promote value-based healthcare practices.

According to these definitions, every Use Case can fit one or more of the assessment levels as the following Table 1 shows.

Table 1 Assessment levels applied to each Use Case.

UC	Topics	Retrospective data	Prospective data	Assessment of service	Assessment of intervention	Assessment of technology
Oncology	Prostate cancer	X			X	X
	Cervical cancer	X	X		X	X
	Head and neck	X	X	X	X	X
	Breast cancer	X	X	X		
Ophthalmology	Macular degeneration	X	X	X	X	X
Cardiovascular	VBHC (heart failure, coronary artery diseases, atrial fibrillation)		X	X		
	Severe aortic stenosis		X	X	X	X
Neurology	Multiple sclerosis	X	X	X	X	
Chronic inflammation	Chronic rhinosinusitis (CRS)	X	X	X	X	X

3. From Stakeholders to Personas

The IMPROVE project has identified and classified stakeholders critical to the design, implementation, and adoption of its tools and platform. As detailed in D3.1, stakeholders are divided into three groups: end users, stakeholders involved, and stakeholders informed. These groups include healthcare professionals, researchers, patients, caregivers, service providers, public health entities, and financial entities. The classification ensures tailored engagement strategies for each group, aligning with their roles and interests in the project.

Building upon this initial classification, the stakeholders most relevant to the IMPROVE dashboard have been defined as "end users." These users are further categorized into three distinct types:

- **Health professionals** (researchers/clinicians): Includes healthcare professionals and researchers who directly interact with the platform to assess interventions, clinical processes, or health technologies.
- **Industry/Health policy leaders**: Comprising decision-makers, MedTech and pharma representatives, and medical society leaders, this group focuses on the implementation, performance, and broader system insights.
- **General public**: Encompasses patients, citizens, and non-specialist users who can access information openly and engage with the IMPROVE community.

This refined understanding translates into tailored access types and goals for the dashboard users, as summarized in Table 2.

Table 2 Classification of dashboard users.

Type of dashboard users	Type of stakeholder	Access Type	Goals
Health professionals (researchers/clinicians)	Health professionals and researchers	Restricted (Login)	• Assess a new intervention, clinical process or health technology. • Compare with existing results available in scientific journals. • Use the study results to assess a specific patient. • Consider aspects related to the health economy.
Industry/Health policy leaders	Hospital managers, Decision makers, MedTech, Pharma, Research organizations, Medical society leaders	Restricted (Login)	Gain insights on the implementation details and performance to improve the implementation of the solutions: including user experience, quality performance, barrier analysis, SWOT, VBHC principles, and regulatory assessment.

Type of dashboard users	Type of stakeholder	Access Type	Goals
General public	Patients, Citizens, Technological staff, Research and medical societies, Hospital managers, Decision makers	Open access (Not login)	• Understand the usefulness of PHGD. • Understand how IMPROVE took profit from secondary usage of data. • See examples and results of IMPROVE UCs. • Join the IMPROVE community. • Join as a new Use Case.

3.1. Personas for Dashboard users

To provide a more practical and user-centred perspective, three personas have been created, each representing one of the dashboard user types:

Persona 1: Dr. Clara Moreno (Health Professional)

- **Role**: Oncologist and researcher at a public hospital.
- **Goals**: Assess the effectiveness of new therapeutic interventions for cancer treatment, compare patient outcomes from similar use cases, and incorporate health economic data into treatment decisions.
- **Needs**: Access to clinical data and comparative results, personalized patient analysis, and support for evidence-based decision-making.
- **Interaction with Dashboard**: Uses a secure login to explore evidence, compare cohorts, and generate reports for patient-specific insights.

Persona 2: Mr. Alex Carter (Industry/Health Policy Leader)

- **Role**: MedTech company executive focused on regulatory compliance and innovation.
- **Goals**: Analyze user experience and quality performance of new medical devices, conduct barrier analysis, and align solutions with VBHC principles.
- **Needs**: Detailed insights on implementation metrics, user feedback, and guidance for regulatory approval processes.
- **Interaction with Dashboard**: Leverages restricted access to gain data-driven insights, participate in benchmarking studies, and refine product strategies.

Persona 3: Ms. Emma Jones (General Public)

- **Role**: Patient advocate and member of a patient association.
- **Goals**: Understand the use of secondary data in healthcare, view case studies of innovative solutions, and engage with the IMPROVE community.
- **Needs**: Open access to user-friendly resources, examples of successful interventions, and opportunities to contribute to discussions on new use cases.

- **Interaction with Dashboard**: Accesses public sections of the platform to review case studies, join forums, and promote patient-centred care initiatives.

These personas guide the design and development of the dashboard to ensure it meets the diverse needs of its users while aligning with the project's overarching goals.

The goals and needs identified for each persona will serve as a reference framework during the dashboard's design and development. Every effort will be made to address these requirements as comprehensively as possible. However, while these objectives are achievable, the dashboard will also consider the specific requirements of the defined Use Cases and endeavour to align them closely with the project's general objectives.

4. Use Cases characterization and assessment

In the context of the IMPROVE project, UCs serve as practical examples to evaluate the impact of healthcare services, interventions, and technologies. To ensure a comprehensive and systematic approach, these UCs are analyzed across the three previously defined key assessment levels: **service**, **intervention**, and **technology**. Each level provides a unique perspective on healthcare delivery and innovation, with distinct data requirements to assess performance, outcomes, and overall value. The following sections elaborate on these assessment levels, introduce key performance indicators (KPIs) that support the evaluation process, and present detailed scenarios that align with real-world clinical applications.

4.1. Assessment levels and required data

The assessment of healthcare systems and innovations requires tailored approaches depending on the focus, whether it involves evaluating the delivery of services, the implementation of interventions, or the introduction of technologies.

Health services encompass a wide range of activities aimed at maintaining and improving individual and community health. The assessment of services focuses on accessibility, efficiency, and the quality of care delivered to patients. To evaluate services effectively, the data required includes:

- **Service description**: Detailed information on the nature of the service, such as outpatient care or diagnostic facilities.
- **Process information**: Data on the deployment, geographical reach, and human resources allocated.
- **Patient-centered metrics**: Patient Preference Information (PPI), governance KPIs like waiting times, and time to access care.
- **Costs and outcomes**: Financial data and healthcare outcomes, such as improved survival rates or reduced readmissions.

The importance of this level of assessment lies in its ability to uncover barriers to access, disparities in care, and inefficiencies in service delivery, which are crucial for implementing equitable healthcare solutions.

The healthcare interventions are designed to prevent, treat, or manage health conditions. This level of assessment emphasizes the impact of specific therapeutic or preventive actions. The data required includes:

- **Intervention details**: Deployment geography, timelines, and implementation specifics.
- **Clinical outcomes**: Evidence of effectiveness in improving health conditions (e.g., reduction in tumour size for oncology).
- **Patient-reported measures**: PROMs and PREMs that reflect the patient's perspective on outcomes and experiences.
- **Costs**: Economic feasibility and affordability.

The value of intervention assessment lies in its ability to provide actionable insights into what works in specific clinical contexts, thereby enabling healthcare providers to optimize patient care and outcomes.

Finally, health technologies include medical devices, digital tools, and organizational systems that enhance healthcare delivery. This level of assessment focuses on innovation, usability, and cost-effectiveness. Data requirements include:

- **Technology type and usability**: Descriptions of the technology and metrics on its ease of use by healthcare professionals and patients.
- **Clinical effectiveness**: Data demonstrating improved diagnostic accuracy or therapeutic success.
- **Cost analysis**: Assessment of economic value compared to traditional methods.
- **Patient feedback**: PREMs and PPI to ensure alignment with user needs.

Technology assessment is crucial to identify innovations that not only enhance care quality but also improve efficiency and reduce costs, making healthcare systems more sustainable.

4.2. Key Performance Indicators (KPIs)

KPIs provide measurable values that reflect the performance and impact of healthcare services, interventions, and technologies. Their inclusion ensures that assessments are objective, standardized, and aligned with the project's overarching goals.

The service KPIs focus on the delivery and accessibility of care. Examples include:

- **Waiting times**: Average time from referral to treatment.
- **Patient access rates**: Proportion of eligible patients who receive the service.
- **Cost per patient**: Financial efficiency in service provision.
- **Adherence to protocols**: Governance indicators reflecting compliance with best practices.

These KPIs help identify inefficiencies and disparities in service delivery, ensuring that healthcare systems meet patient needs effectively.

The KPIs to evaluate the interventions provide an evaluation of the success of therapeutic or preventive measures. Examples include:

- **Clinical success rate**: Outcomes such as tumour response in oncology.
- **PROMs and PREMs**: Measures of patient quality of life and satisfaction with care.
- **Deployment efficiency**: Time required to implement the intervention.
- **Cost-effectiveness**: Economic analysis relative to health outcomes achieved.

Such KPIs enable the comparison of different interventions and support evidence-based decision-making for healthcare providers.

Moreover, the technology KPIs measure the impact of innovative solutions in healthcare. Examples include:

- **Usability metrics**: Feedback from users on ease of adoption and operation.

- **Diagnostic accuracy**: Precision and reliability of technology in clinical applications.
- **Cost-efficiency**: Reduction in healthcare costs achieved through technological adoption.
- **Patient engagement**: Interaction rates and satisfaction with digital tools and the overall health care service.
- **Patient Preference Information**: Qualitative or quantitative data of the relative desirability or acceptability to patients, of features that differ among alternative health states, health interventions, or health services

These KPIs ensure that new technologies contribute to healthcare improvements while remaining practical and cost-effective.

5. Scope and functionalities of the dashboard

The IMPROVE Dashboard aims to provide an innovative and integrated platform to support the assessment of health services, interventions, and technologies in alignment with the VBHC paradigm. Its primary scope is to enable stakeholders to evaluate the impact, efficiency, and outcomes of healthcare processes and tools by leveraging cutting-edge methodologies and technologies.

The dashboard's functionalities will seamlessly integrate with the overall IMPROVE architecture (see D3.1 and D3.2), which serves as a foundation for its design and operation. This alignment ensures a seamless interplay between architecture and functionality, enabling robust and scalable integration of the dashboard into the broader system.

In particular, the knowledge modelling components within the architecture play a crucial role in supporting dashboard functionalities. These components are designed to model care processes, define key performance indicators (KPIs) for these processes, and verify the adherence of the real use cases to the predefined care processes and KPIs. This capability allows stakeholders to monitor and evaluate healthcare delivery in a structured and measurable manner.

Specifically, the dashboard will take advantage of:

- **A robust data infrastructure**: A foundational framework enabling secure, efficient, and scalable data collection, storage, and management. This infrastructure will facilitate the seamless integration and harmonization of data from diverse sources, including clinical centres, scientific databases, and patient-reported outcomes, ensuring comprehensive and reliable datasets for analysis.
- **Business intelligence tools and AI-driven features**: An advanced suite of tools designed to support data-driven decision-making. These include:
    - **Literature screening and knowledge extraction tools**: Automated systems to extract and analyze relevant information from scientific literature to support evidence-based assessments.
    - **Knowledge modelling**: A structured approach to represent and utilize domain-specific knowledge for enhanced interpretation and contextualization of data.
    - **Machine learning and AI algorithms**: Advanced computational models that enable pattern recognition, predictive analytics, and the generation of insights to support healthcare interventions and outcomes evaluation.
    - **Expert systems**: AI-driven systems designed to mimic clinical decision-making processes, aiding healthcare professionals in evaluating complex scenarios and identifying optimal solutions.
- **IMPROVE toolkit for clinical centres**: A set of practical tools tailored for use by clinical centres, facilitating the implementation and monitoring of healthcare interventions. These tools are designed to improve operational efficiency, data collection accuracy, and stakeholder engagement while ensuring alignment with the VBHC framework.

Through its integrated approach, the IMPROVE dashboard will serve as a comprehensive resource for healthcare professionals, researchers, policymakers, and other stakeholders. It will enhance their

ability to assess healthcare services and interventions, promote evidence-based practices, and ultimately contribute to improving patient outcomes and the overall quality of care.

5.1. Specifications

The overall concept of the IMPROVE dashboards has been further analyzed to produce the preliminary specification of the dashboard. These technical details follow the platform architecture principles outlined in D3.1 and provide a more detailed specification of the proposed dashboard. The dashboard development will be the last Proof of Concept (PoC#6) that will take profit from the first development to consolidate and refine the visualization techniques according to the specific type of assessment defined by each use case of WP5.

Table 3 shows the core functional requirements for each functionality presented in the previous section.

Table 3 Functional requirements of the IMPROVE dashboard.

	Specific requirements of the dashboard
Study characterization	• Interactive forms that guide used to insert the study details, facilitate the identification of wrong or missed data. • Selection of monitored KPIs and creation of semantic information on the data, what represents and if has a terminology reference. • Progress bars to make the user aware of the status of the data collection. • Clear prompt of messages and instructions.
Comparison	• Interactive forms to trigger new screening activities to extract knowledge from the literature review. • Prompt of selected publication with an indicator of similarity score. • Selection of specific comparators. • Selection of the parameter to be extracted from the selected publication. • Selection of qualitative (methods, technology, patient cohort) metrics to be extracted using the LLM approach. • Selection of quantitative indicators as numerical comparators with the monitored KPI of the target study.
Patient value	• Aggregate data from the knowledge service of IMPROVE. • Display data in customizable charts, graphs, and reports.
Healthcare value	• Aggregate data from the knowledge service of IMPROVE. • Display data in customizable charts, graphs, and reports.
Cost assessment	• Interactive forms to collect economic and health data. • Export and Import functionality to use the MAFEIP Tool. • Link to the manual of the MAFEIP Tool.

Practices	• Interactive table with a list of practices. • Flexible forms to filter practices. • Interactive form to add or modify practices.
Regulations	• Interactive table with a list of regulations. • Flexible forms to filter practices. • Interactive form to add or modify practices.
IMPROVE Oracle /recommendations	• Selection of a specific type of analysis. • Interactive output on comparison with literature. • Suggested KPI associated with value according to recommendations. • Extraction of qualitative information from similar studies. • Gap analysis using SWOT, PESTEL tools
Living lab	• Repository of instruments, documents and tools to support the process proposed by IMPROVE. • Agenda of events. • Contact form. • Manual of the IMPROVE platform.

The dashboard will take advantage of advanced visualization features that will leverage on graph representation of the information. This representation will add two aspects:

- **Natural Representation**: Visualizing graph data (nodes and edges) mirrors real-world relationships, making it easier to understand connections.
- **Pattern Recognition**: Helps detect patterns, clusters, or anomalies that might be difficult to discern in raw data or tabular formats.

Finally, the visualization will cover the following characteristics:

- **The interactivity of the information**: the end users will be able to navigate in the data, click on specific areas or notes, reorganize the view and zoom and pan to navigate in more complex graphs.
- **Filtering and clustering**: is possible to filter the retrieved information and cluster similar entities for a better understanding of relationships of a specific metric
- **Color coding**: a proper set of colours will be used to differentiate entity types, relationship categories, or weights.
- **Tooltip and labels**: at any moment the user will be able to understand the context of the data, thanks to the supporting functionality of the tooltip and labels, which ensure the auto explainability of the graphical solution.
- **Temporal views**: will make possible to visually inspect the evolution of the data and how relationships in the data evolve.

6. Workflow and interaction design

Based on the specific requirements of the IMPROVE dashboard, a preliminary version of the workflow has been designed to guide users through the main functionalities of the platform. This workflow outlines the key processes involved in healthcare assessment, emphasizing user interaction and data analysis at every stage. Below, the primary touchpoints of this workflow are explained in detail, showcasing how users can navigate the dashboard to accomplish their objectives efficiently and systematically.

The workflow begins with study characterization (Figure 2), where users define the scope and key details of their healthcare intervention or use case (UC). After securely logging into the dashboard, users can access a list of existing UCs or opt to create a new one. When creating a UC, users are guided through an interactive process to input essential information, including the UC's name, classification, and disease area of focus. This step also involves specifying clinical outcomes, PREM, PROM, and economic metrics. Finally, users define the type of analysis they wish to perform, such as comparative or gap analysis, to determine the desired evaluation process. The workflow ensures that users are supported through interactive forms, validation mechanisms, and clear instructions to facilitate data entry and accuracy.

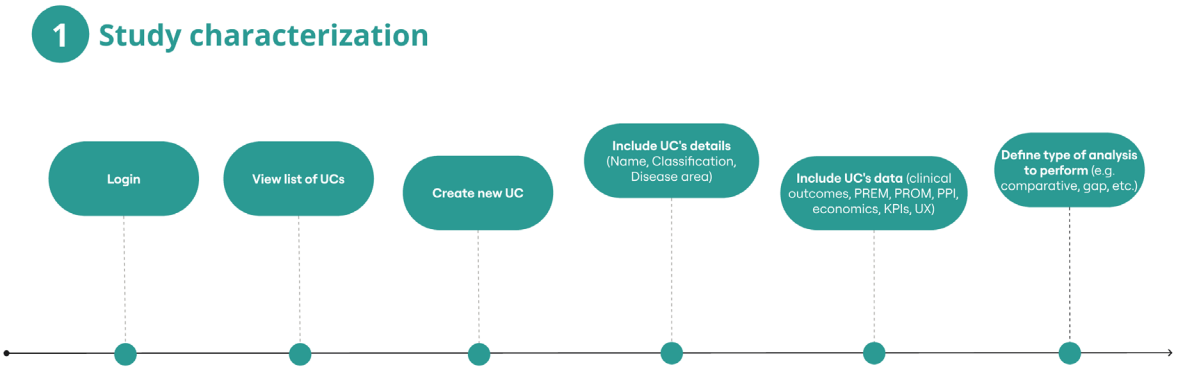

Figure 2 Dashboard touchpoints: Study characterization.

Once the UC is defined, users proceed to the comparator extraction phase (Figure 3). This process enables the identification of relevant studies, policies, and practices to benchmark the UC against. Users can explore a curated database to view and select studies aligned with their defined parameters, such as clinical outcomes, patient preferences, or intervention methodologies. The workflow allows users to incorporate specific policies and practices into their analysis to ensure a comprehensive evaluation. By systematically organizing this information, users can refine their selection criteria, ensuring that the comparators chosen are relevant and impactful for the UC's context. Future iterations of this workflow aim to include advanced features such as automated similarity scoring to streamline this process further.

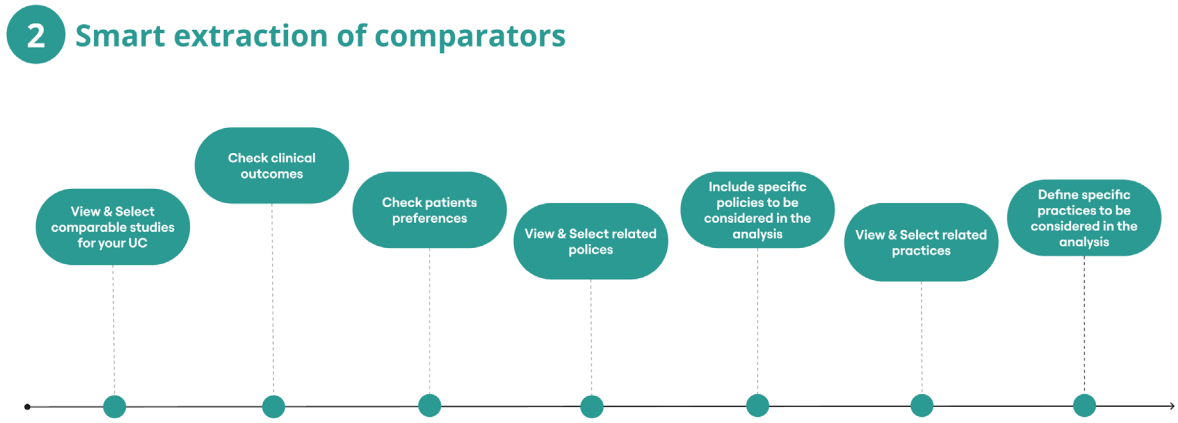

Figure 3 Dashboard touchpoints: Smart extraction of comparators.

The third stage of the workflow focuses on comparative and gap analysis (Figure 4). This phase combines two critical aspects of the workflow: evaluating the target study or intervention against comparable benchmarks and identifying performance gaps. This integrated phase aims to provide users with a comprehensive understanding of the strengths, weaknesses, and opportunities for improvement in their UC.

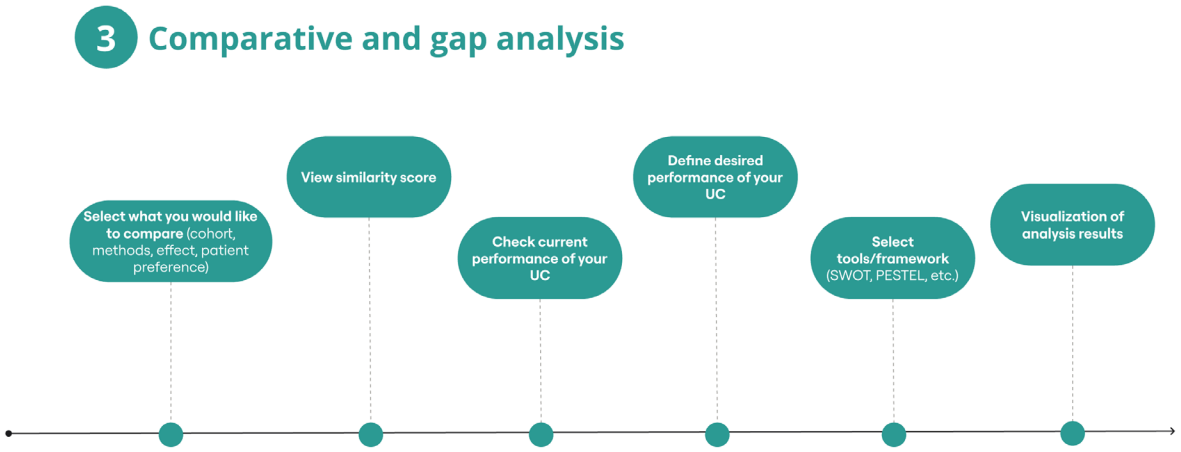

Figure 4 Dashboard touchpoints: Comparative and gap analysis.

In this phase, users first select the parameters they wish to compare, such as patient cohorts, intervention methods, or outcomes, using intuitive forms. The system provides a similarity score to highlight the relevance of comparable studies or interventions, helping users contextualize their evaluation. Once the comparison is established, users can visualize the results through clear and interactive displays, enabling them to draw meaningful insights from the analysis.

Building on this comparative approach, the gap analysis allows users to identify discrepancies between their current performance and desired outcomes. Users define performance objectives for their pilot or project and select appropriate analytical frameworks, such as SWOT or PESTEL. This process highlights specific areas requiring improvement or adaptation, guiding stakeholders to address barriers and optimize their interventions effectively.

The results of this phase provide actionable insights, which are carried forward to the subsequent stages of the workflow.

The last stage of the workflow (Figure 5), is designed to provide users with actionable insights and guidance derived from the analysis performed in earlier phases. At this stage, users can access a comprehensive report that consolidates the results of the analysis, including key findings, conclusions, and lessons learned throughout the evaluation process. This report is presented in a structured and intuitive format, ensuring clarity and accessibility for all stakeholders.

Additionally, the system offers tailored recommendations for incorporating VBHC principles into the user's pilot or project. These recommendations are informed by best practices, literature comparisons, and identified gaps, helping users to align their interventions more effectively with VBHC goals.

To facilitate collaboration and dissemination, users can download or print the report directly from the dashboard. A sharing feature is also available, enabling users to distribute the findings and recommendations to relevant stakeholders or team members efficiently. This stage ensures that the knowledge generated through the IMPROVE platform is not only actionable but also easily shareable, fostering informed decision-making and wider adoption of VBHC principles.

This phase serves as the culmination of the workflow, equipping users with the tools and insights necessary to enhance healthcare interventions and contribute to the broader objectives of the IMPROVE project.

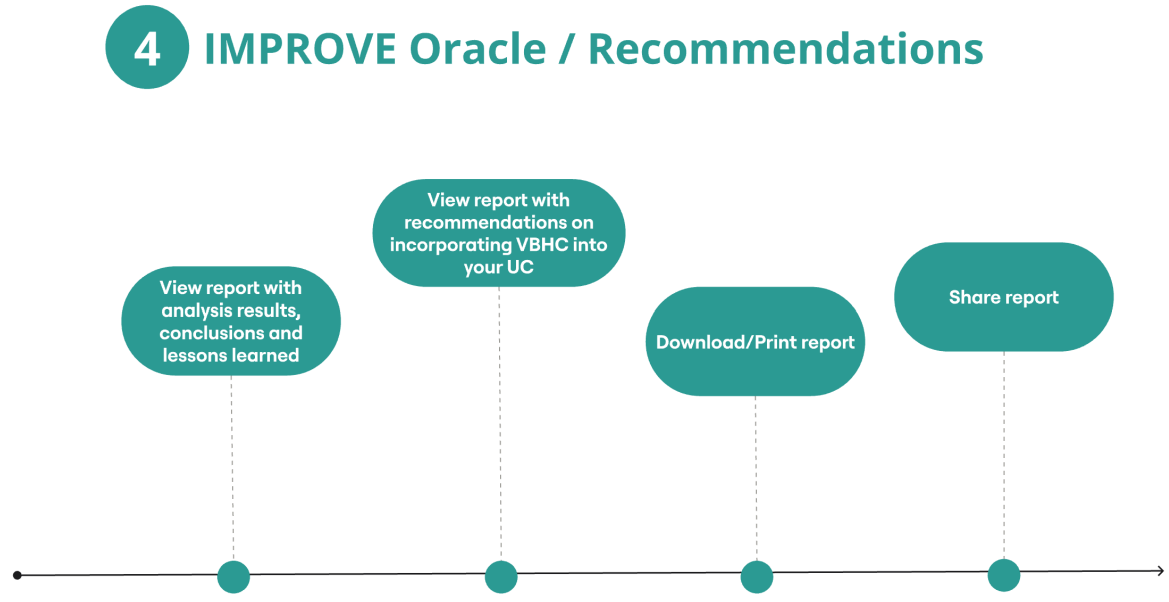

Figure 5 Dashboard touchpoints: Recommendations.

7. Roadmap and Validation plan

This section outlines the initial proposal for the IMPROVE dashboard, including a preliminary set of functionalities that will be refined and tailored to meet the specific needs of each use case. The development and validation of the dashboard will follow a user-centered design approach, ensuring that the final solution aligns with stakeholder expectations and project requirements. The concept will evolve through the following key steps:

1. **Development of a low-fidelity prototype**: A wireframe will be created to demonstrate the primary functionalities and user journeys of the dashboard. This tangible representation of the initial concept, as outlined in this document, will serve as the foundation for further discussions. The low-fidelity prototype will be presented during WP3 teleconferences, where feedback from WP5 partners will help evaluate whether the solution addresses the requirements of each use case.
2. **Validation through qualitative and quantitative methods**: WP3 will conduct a study involving internal stakeholders (consortium partners) and external stakeholders to validate the proposed solution. The study will assess the acceptability and usefulness of the dashboards using methods such as individual interviews and focus groups.
3. **Development of a high-fidelity prototype**: Feedback from the validation study will inform the creation of a more advanced version of the dashboard. This high-fidelity prototype will be consolidated with consortium partners to ensure that it fully satisfies the requirements of each use case.
4. **Final specification of the dashboards**: Based on insights gathered during the iterative design process, the final specifications of the dashboard will be documented to guide subsequent stages of development.
5. **Development of the Minimum Viable Product (MVP)**: An MVP version of the dashboard will be developed, prioritising with target end users and Use Cases leader the finalized specifications and core functionalities outlined in the section 5.1 (specifically in Table 3), which details the essential features required for implementation. Additionally, the workflow described in the section 6 will be integrated into the MVP to ensure a practical and cohesive user experience aligned with the project's objectives.
6. **Incremental development of the dashboards**: Following the MVP release, further developments will be implemented incrementally to enhance functionalities, usability, and alignment with use case-specific needs.

This roadmap ensures that the IMPROVE dashboard evolves through a structured and iterative process, resulting in a robust, user-centered solution that effectively supports the objectives of the project.

Conclusions and next activities

In conclusion, this deliverable establishes a robust foundation for the conceptualization and development of the IMPROVE dashboard, offering a detailed framework that integrates its envisioned functionalities, scope, and design principles. This framework represents a significant step towards creating a tool that facilitates the implementation of VBHC across diverse use cases.

The next phase of the project will focus on validating the proposed functionalities and workflows through a user-centered and iterative approach. This validation will include engaging with both internal and external stakeholders to ensure the dashboard meets the practical needs and expectations of its end users. Insights gained from this process will guide the refinement of the dashboard's design, ensuring it is both user-friendly and comprehensive in addressing the requirements of healthcare professionals, industry leaders, and patients.

Additionally, efforts will be directed toward the development of a high-fidelity prototype and MVP, informed by the outcomes of validation studies. These iterative advancements will include enhancements to the dashboard's usability, integration with relevant tools such as the MAFEIP platform, and incorporation of key metrics and data visualization features. Future activities will also involve ongoing collaboration with the UCs to address specific requirements and refine the associated KPIs and assessment levels.

Ultimately, the IMPROVE dashboard aspires to serve as a pivotal enabler of VBHC practices, supporting decision-making processes and fostering greater alignment between patient outcomes, healthcare system performance, and cost-effectiveness. This collaborative and systematic approach ensures that the dashboard will not only advance the objectives of the IMPROVE project but also contribute to the broader goal of enhancing healthcare delivery for patients, providers, and systems at large.

About IMPROVE

IMPROVE aims to be a dynamic, ready-to-use framework for seamlessly integrating patient-reported information. This adaptable system constantly evolves with the latest evidence, using PGHD and health system data to provide cost-effective solutions for diverse treatment conditions in real settings. The project follows Ontology, Epistemology, and Methodology principles. Ontology defines structures in patient-reported outcomes; Epistemology ensures valid knowledge; Methodology links techniques to outcomes, systematically addressed in its work.

IMPROVE optimizes patient-reported information in real settings, offering a deep understanding of patient behaviors. The project sets up ontology, epistemology, and methodology to minimize the burden on stakeholders cost-effectively. It adopts a scalable, data-driven approach with NLP-driven knowledge extraction. Real World Data is integrated into the Federated Causal Evidence module for comprehensive understanding. Evidence collected enables visualizing attributes affecting patient-reported outcomes through IMPROVE Engagement Factors and Indicators Knowledge Graphs.

IMPROVE's toolkit includes resources for decision-makers, featuring plausible scenarios via the Copenhagen Method. Patient engagement via the MULTI-ACT model ensures sustainable healthcare aligned with patient priorities. This project delivers a modular, open access strategy, providing a trustworthy ecosystem of evidence-based applications. Patient engagement and co-creation scenarios solidify its role in transforming healthcare research and care.

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