



**Managing Personalized Patient Pathways in the Digital Age:
Large-Scale Management of Uniqueness via Human–
Machine Collaboration**

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Abstract:	Personalized care, a cornerstone of healthcare delivery, is being reshaped by digital tools. However, approaches to personalization remain fragmented between competing logics like personalized/precision medicine emphasizing targeted therapies, and patient-centered care, advocating for patient preferences inclusion. Their implementation lacks consistency, highlighting the necessity for an integrative managerial framework. Based on a 12-month longitudinal qualitative study of a digital platform coordinating patient pathways for older adults with poly-pathologies, we theorize a new form of personalized management. While our discoveries align with the canonical steps of mass customization (design, fabrication, assembly, and distribution), we show how human practices, and digital capabilities organize work around the uniqueness of each patient. Instead of subcategorizing client profiles within a mass-production architecture, health professionals manage a multitude of unique patients simultaneously. This new paradigm requires ongoing knowledge of the patient, organizational agility and coordination, three core needs sustained through an evolving collaboration between humans (health professionals, patients and their caregivers) and digital tools (internet of things, digital remote monitoring, and artificial intelligence). The study advances research on personalized care by uncovering the mechanisms to manage uniqueness at scale in the digital age and provides conceptual and empirical tools to analyze its implementation and scope of application.

INTRODUCTION

Although the promise of tailoring care to individuals is embraced by health professionals, policymakers, and patients, its organizational uptake remains contested. Critical perspectives interrogate the agenda’s population-health value and rhetoric (Abettan, 2016; Bayer & Galea, 2015; Juengst et al., 2016; Kostick-Quenet, 2025), while multiple syntheses and trials report positive effects of tailored approaches on patient experiences, clinical outcomes and cost efficiency (Coulter et al., 2015; Ellis et al., 2017; Ford-Gilboe et al., 2018; Suhonen et al., 2008; Swartz et al., 2017). However, conceptual blur persists about what this tailored care entails (Bardes, 2012; Håkansson Eklund et al., 2019; Mead & Bower, 2000). Evidence across seventy cases isolates two coupled failures: the absence of a shared blueprint for personalization and siloed execution; only about half of studies declared an explicit theoretical foundation, and those that did relied on heterogeneous frames (Minvielle et al., 2021).

On this basis, the agenda on personalized care can be understood as an assemblage of three competing logics, shared orientations that organize how actors define problems and coordinate work (Strauss et al., 1982). First, a clinical stratification logic, amplified by personalized/precision medicine, uses genomic and molecular profiling to guide treatment selection (Ashley, 2016; Collins & Varmus, 2015; Hamburg & Collins, 2010; National Research Council et al., 2011). Second, a population-health/equity logic addresses psychosocial needs and unequal access, with demonstrated outcome gains under equity-oriented primary care (Blumenthal et al., 2016; Ford-Gilboe et al., 2018; Hardin et al., 2017; Kertesz et al., 2013; Volpp et al., 2018). Third, a patient-centered “service” logic aligns delivery with preferences and values (Bardes, 2012; Barry & Edgman-Levitan, 2012; Coulter et al., 2015; Håkansson Eklund et al., 2019; Mead & Bower, 2000). Taken together, these logics specify what constitutes ‘personalized care’ and where tensions related to unified management emerge.

The use of digital tools intensifies these managerial tensions. They are a collection of linked technologies, comprising Electronic Health Records (EHRs), Internet of Things (IoT) devices, Artificial Intelligence (AI) algorithms, Digital Twins, and Digital Remote Monitoring (DRM) systems that together mediate data circulation, inference, and coordination across sites of care (Angus et al., 2025; Goh et al., 2024; Kang & Exworthy, 2022; Katsoulakis et al., 2024; National Research Council et al., 2011; Obermeyer et al., 2019; T. Shaik et al., 2023; Vallée, 2024; Williams et al., 2018). While these tools expand what can be personalized, they also redistribute work and accountability across clinical, administrative, and lay actors (Greenhalgh et al., 2017; Langstrup, 2013). For instance, DRM programs reconfigure tasks and alter service use and costs (Minvielle et al., 2025), densifying patient–nurse relations, redividing labor, and introducing new responsibilities and surveillance (Pols, 2012); in turn, layering AI and additional IoT devices might further expand monitoring, triage, education, and data-work, requiring staff upskilling and organizational support (T. Shaik et al., 2023).

Therefore, despite extensive initiatives of personalized care and the rise of digital tools, we still know little about how these developments reconfigure the management of patient pathways, i.e. coordinated sequences of care activities through which patients move across services (from diagnosis to follow-up), sites (hospital, primary care, and home), and professionals over time. Accordingly, this study asks: *what practices shape the management of personalized patient pathways in the digital age?*

To answer this question, we conducted an abductive inquiry over 12 months (May 2024–2025), tracing care practices, technological arrangements, and organizational processes in a French health-tech startup that uses a digital platform to monitor older patients at home with complex chronic conditions, as detailed in the Methods section. Our analysis shows that they manage personalized patient pathways according to each patient’s uniqueness. Far from mass customization that categorizes similar profiles, we discover a new approach that involves

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managing a multitude of unique pathways simultaneously. This large-scale management of uniqueness is made possible, in part, by digital tools that offer the necessary analytical and synthesis capacities, and responsiveness. However, their use depends on a close collaboration with human expertise, particularly provided by nurse navigators (NNs) as they develop new practices. Although our study is based on a single use case, we believe that our four-step framework is likely generalizable to other personalized pathways.

LITERATURE ON PERSONALIZED CARE MANAGEMENT

Emerging in the late 1980s, the managerial concept of Mass Customization (MC) (Davis, 1987) introduces a strategic and operational paradigm: providing individually tailored products and services with near mass-production efficiency. Considering both scalability and variety management, it focuses on how to combine standard components into individualized outputs (Davis, 1987; Gilmore & Pine, 1997; Pine, 1993). At the operational level, the literature decomposes the process into four steps (Da Silveira et al., 2001; Duray et al., 2000; Lampel & Mintzberg, 1996; Piller, 2004; Pine, 1993; Zipkin, 2001): (i) Design/segmentation specifies who is served and on what basis, aligning demand with configurable offerings (Payne & Frow, 2005; Venter et al., 2015); (ii) Fabrication adapts the production system (e.g., service unit/team) to these segments via routings, postponement points, flexible resources, and operating rules (Duray et al., 2000; Kotha, 1995; Pine, 1993; Zipkin, 2001); (iii) Assembly forms individualized variants by recombining standardized sub-systems through design rules and interfaces via modularity and platform logics (Meyer & DeTore, 2001; Pekkarinen & Ulkuniemi, 2008; Salvador et al., 2002; Sanchez & Mahoney, 1996; Schilling, 2000; Ulrich, 1995; Voss & Hsuan, 2009); and (iv) Distribution customizes outputs, managing where and when they arrive, which depends on logistics flexibility, information integration and supply-chain/process synchronization (Jitpaiboon et al., 2013; Q. Zhang et al., 2005).

Modularity provides the architectural mechanism that links the assembly and distribution steps to the overall efficiency goal. By decomposing production into modules connected by standardized interfaces, organizations enable independent development, substitution, and recombination, thus achieving variety without efficiency loss (Baldwin & Clark, 1997; Salvador et al., 2002; Sanchez & Mahoney, 1996; Schilling, 2000; Ulrich, 1995). In services, this logic reappears as service modularity, where modules are bundles of activities and resources flexibly configured through rules, handoffs, or digital interfaces (Meyer & DeTore, 2001; Pekkarinen & Ulkuniemi, 2008; Voss & Hsuan, 2009). Platform thinking (originally designed for product reuse) supports rapid configuration of new services while maintaining back-office economies of scale. Because production and consumption are co-produced, interfaces and coordination rules become central design objects, establishing service modularity as a distinct research stream with its own measures and design principles (Brax et al., 2017).

Since the 2010s, MC has evolved in connection with digital innovations. Classical approaches relied on configuration and postponement, *i.e.* predefined options with differentiation delayed to late stages to protect efficiency (Piller, 2004; Tseng et al., 2005; Zipkin, 2001). The digital turn emphasizes variety management with platform architectures, data–feedback loops, and reconfigurable supply networks (Fogliatto et al., 2012; Medini, 2023; Sheng et al., 2022; M. Zhang et al., 2014). Recent work argues that Industry 4.0 technologies (e.g., additive manufacturing, IoT, digital twins, advanced analytics/AI, and interoperable IT) expand the feasible personalization space and enable more dynamic orchestration while containing coordination costs (Fianko et al., 2025; Naldi et al., 2025; Wang et al., 2017). Within this environment, learning systems (recommenders, configurators, co-design tools) extend the level of achievable personalization, turning the customer from a one-time selector into a continuous co-producer of value (Aheleroff et al., 2021).

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Applying these MC concepts to healthcare has made it possible to recognize a specific service modularity. The care process is decomposed into modules and standardized “packages,” linked through designed interfaces, and personalization is deferred at the distribution step, when clinicians and patients co-create the appropriate configuration (Bartels et al., 2021; de Blok et al., 2010, 2013). Interfaces include both patient-flow continuity and information-flow across modules and providers (Fransen et al., 2019; Lillrank et al., 2022; Meyer et al., 2007). Empirical feasibility appears in mental health, where modularity supports mix-and-match service design and shared decision-making without undermining evidence-based practice: “prototype” pathways suit predictable, tightly sequenced needs, whereas “menu-based” compositions accommodate heterogeneous cases and uncertain interdependencies (Soffers et al., 2014; Van Dam et al., 2021). Beyond the clinical dimension, managers also blend configurations (customized problem-solving, standardized sequences, and multi-actor coordination) depending on available resources (Colldén et al., 2021).

Digital tools are necessary complements to modular, mass-customized care: they add value when they instantiate governed interfaces and support modular design alongside workforce capabilities and evaluation mechanisms (Khalil, 2024; Ma et al., 2024; Minvielle et al., 2014). Properly governed, they embed standardized handoffs, visibility rules, and feedback loops into patient pathway architecture (Lillrank et al., 2022), and IoT/DRM infrastructures circulate data in near real time to redistribute monitoring and decision tasks across professionals and settings, thus sustaining personalization without forfeiting scale (Damera et al., 2025; Kang & Exworthy, 2022; Katsoulakis et al., 2024; T. Shaik et al., 2023).

Despite these applications and promises, the organizational realization of personalization remains elusive. Although the patient pathway is a production process, it differs from industrial production. Its implementation relies on professional judgment, tacit knowledge, and relational coordination within a context of uncertainty, all elements that resist approaches where the

organization of work is predefined and standardized (Bohmer, 2005; Ma et al., 2024; Mannion & Exworthy, 2017; Mayo et al., 2021; Minvielle et al., 2014; Sinsky et al., 2021). In addition, despite a dynamic in favor of patient-centric approaches (Mayo et al. 2021), the fragmentation of the current logics of action between personalized/precision medicine, patient-centered care and others, increases the need for coordination (Minvielle et al., 2021).

Ultimately, digital tools introduce new interdependencies between data and health professional judgment that can harm personalized care. For example, poorly defined inter-organizational interfaces can exacerbate fragmentation in patient pathways, as technology-mediated exchanges dilute responsibilities and desynchronize temporal rhythms (Lillrank et al., 2022). They can also erode situational awareness of care transition phases, accentuating the ad hoc "awareness-raising work" that doctors must undertake (Hilligoss & Vogus, 2015). Last, systems integrating AI can reproduce existing social and clinical biases (Obermeyer et al., 2019) and thus restrict clinical reasoning by privileging codified and measurable signals at the expense of tacit knowledge (Kostick-Quenet, 2025). Thus, the integration of digital tools into the personalized management of the patient pathway can be a problem, which motivates a practice-oriented approach to monitor how their use is implemented and stabilized in daily work (LeBaron et al., 2016).

Therefore, given the remaining questions regarding the application of MC concepts and the risks associated with implementing digital tools, theoretical perspectives are necessary to understand the management of personalized care pathways in the digital age. To highlight the practices that shape this management, we adopt an abductive approach to explore the use case presented below.

METHODS

We conducted a collaborative, abductive field study of MonitorSanté (pseudonym), a startup launched in 2019 that remotely monitors older adults with chronic conditions across two French regions (~40 staff; ~1,200 active patients; 7,333 cumulative enrollments by December 2024). Fieldwork ran May 2024–May 2025, during the pre-reimbursement phase (*i.e.*, before inclusion on a national reimbursement schedule, when firms operate via pilots, grants, and local contracts while generating evidence to secure coverage). In this period, clinical workflows and service operations had stabilized since launch yet remained relatively new to actors to be self-aware of their practices before digital care arrangements “black-box.” Given the firm’s small scale, we adopted a holistic view with no exclusions, observing Nurse Navigators (NNs), geriatricians, platform managers, supporting staff, and partners.

This study draws on a formal collaboration initiated in 2022 that has yielded two co-authored articles in geriatrics (a scoping review of DRM systems and a retrospective cohort study of MonitorSanté), two technology feasibility studies, and support for market access and impact assessment via a randomized controlled trial process (primary mandate). As part of this collaborative program, the research presented was acted upon as a complementary activity and conducted independently: publication without veto; no sponsor involved in the design, analysis, interpretation, or publication decisions; the authors control all analyses and archives. Beyond the study-specific data collection, each author dedicated approximately 400 to 600 hours to MonitorSanté, gaining in-depth knowledge of the research context. Ethical approval was obtained from the *Comité d’Éthique pour la Recherche de l’Institut Polytechnique de Paris* (CoER), reference no. 2024-55-271-34.

Research Setting

MonitorSanté uses a proprietary digital platform to provide personalized and continuous care to older adults (typically >75) living at home with complex chronic conditions

(≥ 3 comorbidities). This population is one of the most vulnerable and resource-intensive within the healthcare system, partially due to the high number of unplanned hospitalizations. MonitorSanté monitors them through: (1) IoT devices capturing 24/7 physiological data; (2) the centralization of records and prioritization of tasks (with AI-supported functions); and (3) a multidisciplinary team (NNs, system-operating geriatricians, platform managers, and medical assistants) responding to these tasks and coordinating the many interventions.

Personalized Patient Pathway overview. Patient referrals originate from emergency departments ($\approx 50\%$), hospitals ($\approx 40\%$), and community-based providers. Within 48 hours after patient consent, a NN conducts a home visit for assessment (biometric, clinical, and socio-environmental dimensions) and, at the end of the visit, a geriatrician by teleconsultation to define together the follow-up. During follow-up, multimodal inputs (device streams, geriatrician notes, patient/caregiver reports) are centralized in a shared dashboard that supports triage, tasking, and communication as summarized in Table 1.

Insert Table 1

Alerts are prioritized by severity and risk; NNs distinguish between signals and noise and escalate to actions ranging from appointment scheduling to home visits or hospital admissions.

Figures 1 and 2 depict alerting and patient pathway flow.

Insert Figure 1.

Insert Figure 2.

Continuous Improvements. MonitorSanté’s digital tools evolve through feedback from the geriatricians, medical assistants, and external partners. A dedicated development team iteratively enhances usability, adds features, codes personalized thresholds with clinical input, and extends automation and AI. Currently, AI use is modest: a syndromic algorithm parses echocardiography reports to identify relevant findings, with human verification required before the information is entered into the patient record. Ongoing work aims to parse additional unstructured data (free-text notes, imaging reports) to flag symptoms (*e.g.*, dyspnea, deterioration), generate pre-analyses, and ultimately support predictive follow-up.

Logistics and Technical Support. A logistics/technical team oversees device provisioning and maintenance, ensures availability, manages field logistics, and troubleshoots issues (first remotely and via on-site interventions if necessary) to sustain continuous monitoring.

Data Collection

We conducted longitudinal fieldwork from May 2024 to May 2025 (pre-reimbursement), combining 88 hours of observations, 23 interviews, 15 internal documents, and a mock-up platform access. Ongoing discussions among investigators and engagement with relevant literatures allowed for an abductive approach with iterative learning and theoretical refinement. Investigators meet weekly to coordinate collection and analysis. Early meetings served to disseminate field observations and interviews, and surface emergent phenomena before coding (Creswell, 2007). For instance, preliminary analysis of the data, focused on the application of MC, led to a later focus on the human–machine interactions in personalization, as the key theme emerged. Our data collection is expanded upon below and summarized in Table 2.

Observations. An initial exploratory immersion consisted of 40 hours of targeted observation focused on critical junctures in the work, first based on MonitorSanté’s leadership suggestions and then on the research team's discussions. For instance, we shadowed a NN during a home

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3 visit for a new patient enrollment to understand how intake data were collected. Later, our
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5 attention turned to how practitioners engaged with digital artifacts, particularly when a NN's
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7 clinical intuition overrode an algorithm's alert priority. We expanded written notes into
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9 structured fieldnotes (scene, actors, digital artefacts, and decisions) and then shared oral
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11 debriefings with the rest of the research team, consolidating emerging questions.
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15 Weekly meetings with MonitorSanté leadership helped clarify these issues and guided us on
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17 other key processes. We attended 48 weekly meetings with MonitorSanté leadership and
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19 platform/development teams (60-90 minutes; recurring agenda covering operations,
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21 alerts/backlog, device logistics, and release planning, as well as our research). We processed
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23 data from patient flow decisions, alert policies, workflow changes, or exceptions; otherwise, it
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25 served as access and context. We took real-time notes and drafted meeting summaries.
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29 *Interviews.* Building on early observations, we conducted two waves of semi-structured
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31 interviews (n=23) targeting core roles, which offered different vantage points and, when
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33 combined, provided a comprehensive picture (Rubin & Rubin, 2011). Wave 1 (May-Sept 2024;
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35 n=14) mapped the end-to-end pathway and the organization's structure, supporting activities
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37 and development (NNs=6; geriatrician=1; operational support=3; development=4). Wave 2
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39 (early 2025; n=9) revisited care work (e.g., alert prioritization), traced MonitorSanté's
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41 evolution, and probed tensions surfaced after Wave 1, adding external partners to better
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43 understand coordination (NNs=2; geriatrician=2; platform supervisor=1; medical secretary=1;
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45 general practitioner and community nurse=2). Participants were identified collaboratively to
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47 ensure role diversity, while the research team retained final say over inclusion. Interviews were
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49 conducted either in person or via video (lasting 40-60 minutes), audio-recorded with the
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51 participants' consent, and transcribed. The interviewers wrote brief analytic memos to share
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53 with the research team. We used a flexible, empirical and theory informed guide, covering
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55 patient inclusion and segmentation, remote monitoring workflows and alert management, use
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and perceptions of connected devices, coordination across clinical and non-clinical actors, and challenges in delivering personalization.

Documents. We assembled 15 internal documents (~200 pages), selected for operational relevance (used in day-to-day work). The corpus included communication materials, triage guidelines, intake/assessment templates (*e.g.*, CCI/ADL forms), PCP templates, training decks, meeting notes, product release notes, and workflow diagrams. They helped familiarize with the different activities, lead better interviews, and triangulate data. For instance, they revealed the breadth of data collected for each patient, detailing which clinical, functional, and socio-environmental aspects of patients’ lives were collected, and how they were used.

Platform access. We were granted read-only access to the developer interface with mock-up patient profiles to respect privacy. Access covered key modules, like patient record, alert queue, dashboard visualizations, tasking, and audit trails. It allowed to examine its core functionalities, technological architecture, and operational workflows.

Data Analysis

We analyzed data abductively and iteratively (Timmermans & Tavory, 2012; Tracy, 2024), in parallel with collection. To sustain rigor and in line with iterative analysis best practices, data collected was shared across authors for immersion and joint sense-making.

In cycle 1, we started with a codebook based on the four MC steps (design/segmentation, fabrication, assembly, distribution) and coded the Wave 1 interviews, and triangulating with the rest of the data.

However, as the analysis progressed, it proved insufficient. Given the first analysis of the empirical material, we had to revisit the codes, like the importance for feedback and evaluation loops to constantly adjust the steps. In tandem, we brought in data-work ideas (*e.g.*, interpretation, articulation, cross-artifact coordination (see Grisot et al., 2019) to reframe “tool use” as human–machine collaboration shaping personalization.

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3 In cycle 2, we updated the interview guide for Wave-2 to test and deepen these additions
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5 (*e.g.*, how specific patient data were captured and later mobilized, or how staff resolved daily
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7 dilemmas). Two authors (the second and fourth) independently open-coded Wave-2; their
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9 interpretations were then compared and discussed with the other two authors (the first and
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11 third). Rather than relying on a reliability test, discussions enhanced interpretive rigour, as
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13 divergent readings were debated to reach a consensus, and triangulated across interviews,
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15 observations, documents, and platform logs to anchor the final model in convergent evidence.
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17 We used MonitorSant  's meetings to probe blind spots and further clarify the mechanism.
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21 Overall, we triangulated across (i) data sources (interviews, observations, documents,
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23 platform artifacts), (ii) investigators (three authors involved in collection and four authors
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25 involved in coding), and (iii) theories (MC, data-work, sociomaterial perspectives) in line with
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27 Denzin's types (2009).
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39 FINDINGS

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41 At MonitorSant  , managing personalized patient pathways is executed through four
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43 operational steps: (i) segmentation, (ii) design, (iii) assembly, and (iv) distribution.
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45 Coordination operates via a digital platform by NNs and other health professionals. Below, we
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47 illustrate what each step looks like in practice, including the digital tools and records used, the
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49 roles of each team member, and how work is passed on to the next step.
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53 Step 1: Segmentation

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55 At MonitorSant  , the process begins with an in-home visit led by a NN. The nurse conducts
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57 an in-depth assessment that combines clinical factors (*e.g.*, medical history, comorbidities and
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clinical risk scores), with social (e.g., caregiver support and digital literacy) and environmental (e.g., living conditions) ones, as well as personal preferences (e.g., preferred mode of communication and transportation, emergency contact person, and advance directives). As one NN described: *“We are dealing with someone who is fragile. We cannot take care of them without addressing the social aspect, their emotions, how their morale is, how their support network is doing”* (Interview 12). Structured questionnaires then deepen profiling by eliciting preferences, priorities, and life goals: stance toward life-sustaining treatments along the intervention–comfort spectrum; desired amount and mode of information; and caregiver participation in major decisions (e.g., stay at home, relocate, or enter a nursing home). These value signals are bound to the record, so subsequent decisions track what matters to the patient. The full intake feeds a geriatrician-led teleconsultation, where care-plan goals are set with the patient.

Segmentation continues throughout follow-up. After enrollment, IoT devices (e.g., BP cuffs, pulse oximeters, scales) feed the digital platform; preprocessing algorithms structure readings and flag threshold breaches. NNs consolidate the dossier by retrieving external clinical records (laboratory and imaging reports, discharge summaries) and administrative/legal information (coverage status, advance directives), contacting hospitals, GPs, and caregivers as needed. Patients co-produce the profile, by reporting concerns by phone or email, as well as completing proprietary questionnaires and Patient-Reported Outcomes (based on validated quality-of-life instruments, pain scales, etc.). Each new input updates the profile and can trigger reclassification and adjustments to the treatment.

Segmentation is reactive. Patients are continuously reclassified as “stable,” “at-risk,” or “critical” based on data trends and context. NNs then add a subjective triage score derived from call cues (e.g., voice tone, coherence) and interpret each flag. For example, they can contact patients to better define the severity of an osteoarthritis flare-up after an alert, to see if

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3 physiotherapy or sports sessions are possible. For every anomaly, NNs distinguish meaningful
4 clinical deterioration from noise using contextual clues that the system cannot capture. False
5 alerts may stem from sensor misplacement or battery failure, but significance is assessed in
6 context: “*You can’t just look at oxygen levels and decide. If the caregiver just left or the house*
7 *is freezing, that changes everything [...] Our caregiver spirit [is] there to analyze not just data*
8 *on a graph, but also everything we hear, the exchanges we have with the family, with the patient*
9 *[...] A beep doesn’t mean panic. Sometimes the beep is a nudge to dig deeper*” (Interview 2).

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12 Segmentation operates as a continuously updated workflow that integrates clinical
13 information, social and environmental determinants, and patient preferences to steer
14 personalized care and optimize treatment decisions. It runs across the entire pathway:
15 professionals detect changes and revise profiles, while the platform captures systematic data.

26 27 28 **Step 2: Design**

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30 Building on the segmentation, MonitorSanté’s team configures a collaborative Personalized
31 Care Plan (PCP), in discussion with the patient (and their caregiver) as well as the referring
32 geriatrician or general practitioner. The PCP is a structured, adaptative framework for treatment
33 and follow-up: it sets therapeutic objectives; selects IoT devices and data streams, and specifies
34 monitoring protocols and threshold parameters. It also integrates contextual supports aligned
35 with the patient’s living conditions, (e.g., administrative assistance for social or financial aids).
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37 “*We include alert levels, but also: does the patient want a morning or afternoon call? Can the*
38 *caregiver handle the tech that shapes our protocol?*” (Interview 5).

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40 The digital platform operationalizes the PCP through four core components: (i) patient goals
41 and preferences; (ii) evidence-based monitoring protocols (IoT devices, sampling rates); (iii)
42 task management dashboard (dated tasks with priority bands and assignees); and (iv) a care-
43 team roster associated with the patient. The architecture uses standardized modules calibrated
44 to risk profiles: clinical activities (medication monitoring, physical therapy, assessments,
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teleconsultations), administrative/logistics (scheduling, labs/imaging, admissions, social services), and practical assistance (documentation, transport, equipment logistics).

Yet the team will instantiate and tailor these modules for each case. Health professionals adjust them to address nuances beyond algorithmic capture, such as shifts in patient mood, caregiver dynamics, or digital literacy: *“Templates are helpful, but they’re just starting points. We tailor from there”* (Interview 4). Based on these principles, the PCP is regularly updated, either every three months or if the patient’s situation changes before then: *“Every three months, four times a year is good for chronic patients, and if we notice a vulnerable situation that requires a more rapid reassessment, we reassess it”* (Interview 4). For example, immobilization following a fall at home (a common occurrence) may, depending on the context, necessitate home care and support for planned transportation.

Collaboration is routine. Centralized records and shared access let hospital geriatricians, nursing homes, and territorial care centers view progress, add observations, and co-adjust protocols. *“Yes, they [the geriatricians] have access (log into the platform and specify the type of monitoring). All our partners have access to the platform”* (Interview 18). The patient’s assessment and the PCP are systematically transmitted to the referring geriatrician or general practitioner.

Governance remains medical. Responsibility for thresholds and protocols rests with the referring physician, who usually comes from a hospital. In such cases, the MonitorSanté geriatrician coordinates with this referent physician, jointly with the NNs and partner teams, intervening in emergencies or to maintain continuity of care during weekends and holidays: *“As for the thresholds and the monitoring, these are rather prescribed by the doctor, the so-called referring geriatrician for the program. If it’s a patient referred by their attending physician, it’s the MonitorSanté doctor. If it’s a patient within the government experimentation area, it’s*

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3 *the geriatrician of the reference hospital”* (Interview 18). *“And if the physician is not available,*
4 *on vacation, unavailable, or doesn’t do home visits, that’s when our geriatricians’ step in and*
5 *take over”* (Interview 17).

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10 In practice, algorithms propose, health professionals dispose. Algorithms draft structured
11 proposals, but health professionals (primarily NNs and geriatricians) hold design authority: they
12 validate or override thresholds, tailor templates to patient literacy and caregiver capacity, adapt
13 to territory-specific resource constraints, set a revision cadence, coordinate partners through
14 shared access, and keep the PCP traceable on-platform and aligned with patient goals. In sum,
15 personalization is engineered as editable modules plus human judgment under medical
16 governance.

27 **Step 3: Assembly**

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29 With a validated attending physician, the team creates a personalized service package for each
30 patient, referred to the different modules (clinical activities, administrative/logistical aspects
31 and practical assistance) :*“When patients need it, we schedule their medical appointments and*
32 *arrange transportation if we are the prescribers. If we’re not, we organize the ambulances,*
33 *follow up on the appointment, and collect the medical report to send to the prescribing*
34 *physician”* (Interview 16).

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43 Internally, MonitorSanté provides continuous medical monitoring, telehealth expertise, and
44 support to patients and caregivers via its digital platform. Staff, and particularly NNs,
45 emphasize the combined value of monitoring and coordination: *“it isn’t just a platform; it’s a*
46 *whole scheme working with many partners, and that’s our strength”* (Interview 15). Externally,
47 MonitorSanté orchestrates a broad ecosystem of partners (hospitals, general practitioners,
48 community nurses, and even meal delivery services) based on patient location and needs. *“We*
49 *have informal partnerships with several health providers. We alternate based on the patient’s*
50 *geolocation and what’s best for them”* (Interview 10).

Modular assembly varies by region due to resource availability, professional networks, and institutional conditions. For instance, the countryside tends to be scarce with equipment and access to specific health professionals, requiring general practitioners or advanced practice nurses to adapt. *“There is a shortage of nurses in the Paris region, whereas this is not the case at all, or at least much less so, in Nantes. On the other hand, in the Paris region, if you want an appointment with a specialist, you can get one quickly, whereas here in Nantes, you have to wait months. So the challenges are not the same... We need to understand the territory in which we operate to respond as best as possible”* (Interview 2).

The digital platform supports coordination by structuring the inventory of available services and tasks, yet the final say still hinges on human judgment and situated knowledge. *“In cases where a patient needs a follow-up action, for example, something longer-term that isn’t necessarily urgent, we organize it by creating tasks. For instance, if a prescription needs to be renewed, which is more on the administrative side, we create a task and assign it to the relevant person. We schedule it for a specific day and prioritize the tasks accordingly. It’s the same for contacting a patient about their health status, we can create a task for two days later and assign a priority level (red, orange, or yellow) based on urgency »* (Interview 17).

Modular personalization here is distributed assembly work. *“Each case is like a puzzle: same pieces, different configurations”* (Interview 12). While digital care assemblages provide standardization and traceability, coherence and contextual fit depend on professional reactivity and judgment to internal and external resources.

Step 4: Distribution

Distribution is conceived as the operational implementation of the PCP. It focuses on real-time responsiveness as the platform assembles care and service modules, then assigns executable tasks to professionals.

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3 Task orchestration is visible on the professional dashboard (see Figure 1). Pending tasks are
4 tallied alongside active alerts: *“Yes, we see it in the section where alerts appear, small numbers*
5 *are displayed. This means there are tasks”* (Interview 16). At the patient level, color-coded
6 alerts flag incomplete work, and a dedicated task panel lists items by status (to be completed,
7 in progress, completed), with deadlines and assignees. These features make priorities and
8 accountability legible in real time. This system is at equilibrium, with a log of more than 240
9 tasks waiting at every moment, while fewer than 30 professionals monitor 1,000 to 1,200
10 patients. When simultaneous urgent alerts arise across multiple patients, platform managers
11 support NNs and MonitorSanté geriatricians take over escalations.

12
13 Although the platform facilitates logistical operations (e.g., recording available services,
14 automating scheduling, and linking follow-up tasks to the family doctor), coordination between
15 organizations remains irreducibly human. Besides the internal informal distribution of slack,
16 coordination adaptation also happens externally. When pharmacies, home nurses, or social
17 workers are involved, professionals still have to call, negotiate, and adapt to unforeseen
18 circumstances. As one NN explained: *“We managed to find a nursing home within 48 hours.*
19 *We had to fight to get it, but we made it [...] the platform doesn't know the local nurse's*
20 *schedule. I had to make that call”* (Interview 5). Automated coordination is thus limited.
21 Although digital platform structures and distributes tasks, human intervention is still required
22 to bridge organizational silos and situational gaps.

23
24 In summary, MonitorSanté's approach to personalization unfolds through a four-step
25 process that is continuously updated. Each step combines digital infrastructures with
26 professional judgment, particularly that of NNs, who act as frontline coordinators within
27 emerging forms of collaborative work in the digital age. Across steps, digital tools render data
28 and tasks visible and recombable; professionals interpret and bridge gaps across settings. The
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resulting mechanism enables large-scale management of uniqueness for older adults with multimorbidity.

DISCUSSION

In this paper, we show how the management of personalized patient pathways is achieved through the case of a digital platform. Subsequently, we identify three discoveries that, together, specify how to manage uniqueness at scale. Unlike mass customization and service modularity, which scales variety by categorizing similar profiles, our setting centers on individuality and industrializes the orchestration of many unique patient pathways through four steps: Segmentation, Design, Assembly, and Distribution. Managing this shift requires: (i) continuous, accurate knowledge of each patient’s needs and preferences (via digital analytics and NNs systematic questioning); (ii) agility to revise plans and adjust to the changing situations (supported by digital responsiveness and service modularity); and (iii) coordination across internal and external professionals handling concurrent cases (enabled by modular services, digital synthesis, and mutual adjustments). Effective operation depends on humans-machine collaboration. Figure 3 synthesizes this mechanism.

Discovery 1: Individuality as the Unit of Management in Personalized Patient Pathways

Personalized patient pathway work unfolds through Segmentation, Design, Assembly, and Distribution, with individual case as the unit of management. This distinction clarifies how personalization proceeds. Segmentation “profiles” each patient by identifying needs and preferences. A personalized response is then decomposed into Design (creating the Personalized Care Plan), Assembly (bundling the requisite goods and services on the platform), and Distribution (administering them within time constraints). Moreover, each step corresponds to specific activities carried out by health professionals using digital tools. For example,

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3 Distribution involves careful coordination of tasks such as medication management, scheduling
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5 physiotherapy sessions, or organizing the arrival of a housekeeper.
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8 A specific characteristic emerges: individuality is an entity to be managed. Rather than
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10 assigning predetermined pathways to patients with similar conditions, care and services are
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12 tailored to each person's particularities by considering the full set of clinical, socio-economic,
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14 and behavioral traits. For instance, a socially isolated patient requires very different monitoring
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16 and support than a patient with a similar clinical condition but strong family backing. Each
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18 patient presents a unique combination of needs and preferences that resists categorization by
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20 shared criteria. Hence, uniqueness of profiles implies uniqueness of responses. Each identified
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22 profile triggers a specific response in Design, Assembly, and Distribution. In the MonitorSanté
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24 case this distinctiveness is visible, yet it is shaped by the organizational context: local and
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26 regional differences affect how responses are organized; specialty physicians may be more or
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28 less accessible and may require support from general practitioners or advanced practice nurses.
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30 The production space imposes constraints and opens possibilities that structure how responses
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32 are configured. Uniqueness therefore has a dual meaning: it concerns both the patient's needs
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34 and preferences and the organization's capacity to respond.
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40 Because personalization entails managing a multitude of unique processes, three
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42 organizational consequences follow. First, it requires continuous, fine-grained understanding
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44 of patients' needs and preferences. This knowledge conditions subsequent Design, Assembly,
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46 and Distribution. Oversights or misinterpretations, especially around alert severity and
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48 frequency, can disrupt the entire system. The demand is ongoing: each new request reshapes
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50 the situation and reorganizes the process, so changes must be perceived accurately and
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52 immediately. Second, it requires agility. Frequent adjustments arise throughout personalization.
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54 Updates to Segmentation cascade: the PCP (Design step) is revised, and the personalized
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56 response (Assembly and Distribution) is reconfigured (*e.g.*, initiating financial assistance for
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home care during immobilization after a fall). Managing multiple cases concurrently intensifies these adjustments by forcing dynamic reprioritization. Agility is therefore a constant requirement. Third, it requires continuous coordination. A wide variety of individual cases generates numerous interactions. Coordination must ensure: (i) consistency across clinical and non-clinical actions in light of unified needs and preferences; (ii) management of combinatorial interactions across cases; and (iii) orchestration of the exchanges produced by ongoing adjustments.

Combined, these three challenges explain why coordination demands recur at every step: during Segmentation, in collecting and reconciling diverse data; during Design, in convening the expertise needed to build the Personalized Care Plan; during Assembly, in integrating services and goods into a coherent bundle; and during Distribution, in executing delivery and monitoring completion.

Discovery 2. Digital tools enhance knowledge, coordination, and agility in personalized management

IoT devices placed in patients’ homes, AI-assisted alerting, and the digital remote monitoring form a connected digital platform enabling real-time data flow. This interconnection affects organizational requirements along three dimensions: knowledge, coordination, and agility. First, for knowledge, these tools enable a more comprehensive expression of patient needs. Multimodal capture (clinical, socioeconomic, behavioral) provides the basis for deeper analysis and more precise profiling (see Table 1). Clinical alerts from IoT, secure-messaging exchanges, and phone calls concerning social and behavioral determinants together provide more immediate and specific updates on each patient’s needs.

Second, data synthesis and processing capabilities produce an actionable worklist contributing to the coordination of interventions. Dashboard-level prioritization, generated after incident synthesis, offers a reliable baseline for coordinating tasks; professionals can still adjust the order

as needed. Likewise, shared data on the platform facilitates coordination across internal teams and external actors (*e.g.*, hospital geriatricians, nursing-home staff, local resource centers).

Third, feedback from IoT devices and the alerting system supports rapid detection of clinical incidents. Priority displays on the dashboard allow NNs to assess sequence and importance of tasks promptly, while shared platform data enables the quick involvement of other health professionals, that can in turn propose follow-up measures or additional tasks more quickly (*e.g.*, renewing prescriptions, arranging home visits).

These capabilities strengthen as the digital tools evolve. Appointments are integrated into platform-managed patient records; automatic reminders for priority tasks guide nurses; updates to PCP are automated without manual entry. Field feedback, like false negatives (*i.e.* where an alert fails to detect an existing clinical issue), is routed to developers, driving iterative improvements. Digital tools thus evolve dynamically, guided by health professional feedback to the MonitorSanté development team.

Discovery 3: Nurse Navigators operationalize personalization: data sensemaking, coordination, and patient enablement

NNs are the operational core of coordination and agility. They maintain continuous communication with patients and caregivers to check on their health status, questioning them about their preferences as they evolve, confirm appointments, and provide guidance on clinical issues. Through these interactions, they elicit and update patients' needs and preferences. They also initiate and sustain exchanges with all health professionals involved, both inside and outside MonitorSanté.

Digital tools add complementary activities. First, NNs assemble distributed data streams, from automatic dashboard feeds to structured questionnaires, to external document, into a coherent profile for each patient (see Table 1), because even if much of this data is produced

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automatically at the platform level, results from questionnaires or other external files are still necessary. Second, they interpret alerts, separating signal from noise and investigating likely false positives (*e.g.*, loose bracelet, battery failure) and potential false negatives. Third, when digital traces are ambiguous, they re-contact patients to refine assessments (*e.g.*, clarifying rehabilitation options for osteoarthritis).

While the previous activities are related to knowledge, giving room to a deeper analysis and understanding of each patients’ needs, riggers coordination and agility across actors. For example, persistent heart-failure indicators on the dashboard prompt NNs or geriatricians to assign follow-up tasks (*e.g.*, prescription renewal) to the responsible hospital clinician. Last but not least, NNs enable continuous patient feedback. They onboard patients and caregivers to IoT devices and the digital platform, prevent misunderstandings that hinder use, and issue targeted reminders via phone or secure messaging as patients may be confused or find the data feedback request too time-consuming; these micro-interventions sustain reliable feedback loops, consistent with ePRO initiatives (Basch et al., 2022).

These visible and “invisible” practices extend Discoveries 1 and 2: NNs convert multimodal data into situated knowledge, translate knowledge into coordinated tasks, and maintain the responsiveness required for individualized pathways.

Contributions of the Large-Scale Management of Uniqueness framework

Our discoveries reposition personalized management by specifying an approach to “managing uniqueness at scale,” summarized in Figure 3. The conceptual contributions to in healthcare unfold in three consecutive moves. We then situate this framework within the broader MC literature and conclude with its implications for practice.

Move 1: an inverted organizational approach of personalization. We formalize the

management architecture of personalized pathways as four steps (Segmentation, Design, Assembly, Distribution) clarifying who does what, with what information, and to what effect. This sequence aligns with MC schemata (design/segmentation; fabrication; assembly; distribution) while separating Segmentation from Design in our setting and bracketing Fabrication given scope. It also parallels integrated-care sequences of diagnosis/needs assessment, care-package composition, and delivery (Bartels et al., 2021; de Blok et al., 2010, 2013). MonitorSanté functions as a service platform in the MC sense, *i.e.* a centralized base that enables complementary services by external professionals and organizations (Fogliatto et al., 2012; Meyer & DeTore, 2001; A. M. Shaik et al., 2015).

However, relative to conventional MC, the design logic is reversed. Rather than starting from mass profiles refined into variants, individuality is primary: the individual case is the unit of analysis, and industrialization consists in organizing a portfolio of singular processes from the outset. Coordination operates over this organized set of individualities, not over a small number of predefined tracks. This inversion specifies how large-scale operation can be built from individualized processes rather than adjusted profiles.

We thus reframe the standardization–personalization debate. This uniqueness has a double meaning: (i) recognizing the patient’s needs and preferences and (ii) configuring the organizational response. It thus assumes a “pure personalization”, in the debate which opposes it to standardization (Mannion & Exworthy, 2017; Sinsky et al., 2021). The uniqueness is quite the opposite of the “one size fits all”, which isn’t contradictory with local forms of standardization in the organizational processes: the final response results from a mix of standardized and personalized procedures. For example, inclusion follows common protocols (initial consultation; standardized geriatric evaluation); follow-up uses approved procedures; patient-specific tasks (*e.g.*, coordination with a specialist for diagnostic confirmation) tailor the response. Hence standardization and personalization

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can be pursued jointly and continuously in health-care work (Greenfield et al., 2017), and, more generally, in organizing (Lampel & Mintzberg, 1996). This clarifies the level of analysis: outcomes can be purely personalized even when production routines combine standardization with situational adaptation.

Move 2: knowledge, coordination, agility as organizational needs for uniqueness management. We identify three organizational needs to support this new form of management: knowledge, coordination, and agility. Without them, efforts to manage each unique case can become chaotic and time-consuming, leading to suboptimal outcomes. While these needs are recognized in mass-personalization theories, here we specify their joint operationalization in healthcare and detail their content, thus opening-up perspectives.

The increasingly precise and comprehensive analysis of patient needs, both through digital tools and by health professionals, underscores the importance of the Segmentation step. Although Segmentation is fundamental in commercial activities to understand consumer preferences (Gensler & Rangaswamy, 2025), it has rarely been recognized as such in healthcare, or, when attempted, it focuses solely on clinical aspects. We propose a broader vision that integrates clinical, socioeconomic, and behavioral needs and preferences. Our study also demonstrates the contribution of digital tools: as IoT devices and AI are deployed, a more precise and immediate understanding of these needs becomes possible.

In terms of agility and coordination, our discoveries shed new light on the solutions typically proposed in healthcare. MC highlights their role in supply chains and modularity (Fogliatto et al., 2012; Medini, 2023; Naylor et al., 1999; Sheng et al., 2022; M. Zhang et al., 2014). In the healthcare, the existing literature underscores the crucial role of modular service solutions (Bartels et al., 2021; de Blok et al., 2010, 2013). Given the low predictability of patient needs in our context, modular service solutions are favored over prestandardized rule sets (Van Dam et al., 2021). Even if health professionals are unaware of the formal design rules, core principles

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3 appear in MonitorSanté's organization: each module has a specific function (consultation,
4 physiotherapy session, home assistance); modules exhibit relative independence; and interfaces
5 (IoT devices, patient records, questionnaires, emails with patients and between professionals)
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7 are partially standardized at the platform level, enabling interaction and communication.
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12 However, this modular combination is effective only if agility and coordination are enacted
13 continuously. The forms of coordination and agility highlighted here operate at the level of
14 work organization: they rest on exchanges between health professionals, where NNs play an
15 essential role, and on capabilities offered by digital tools. NNs coordinate and update tasks
16 within the MonitorSanté team and with external professionals by mutual adjustments. They thus
17 promote a multidisciplinary approach, recognized as central to personalized management in
18 other clinical contexts (Avis et al., 2013; Mercer et al., 2015; von Dadelszen et al., 2015).
19 Digital tools also enhance agility (alerts enabling immediate reporting of new needs;
20 teleconsultations allowing faster remote contact) and coordination (task-prioritization and
21 information sharing via the dashboard). Similarly, the study highlights the importance
22 MonitorSanté's platform, which allows for the integration of all tasks performed by team
23 members and external professionals (Meyer et al., 2007; Q. Zhang et al., 2005). This
24 combination of human effort and technological capabilities appears vital for delivering
25 personalized patient processes. These practices are indispensable in a context marked by
26 continual adjustments and interactions. For full effectiveness, another condition is required.
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47 *Move 3: Human-machine collaboration to integrate the three organizational needs.* We
48 specify a necessary condition for effectiveness: health professionals, patients, and digital tools
49 must collaborate to realize the organizational goals above. We refer these actions as human-
50 machine collaboration.
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56 A core example is the interaction between digital tools and NNs. While digital tools help
57 meet organizational needs through their capabilities, NNs conduct comprehensive data work
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that contextualizes and interprets results. We identify five NN practices, the first three echoing those observed by Grisot et al. (2019) in remote monitoring for chronic diseases. These practices (i) prompt additional coordination—e.g., with other professionals or with the patient to interpret specific alerts; (ii) adjust system-set task priorities; and (iii) correct system errors (false positives). They thereby add analysis, coordination, and agility that enable a higher degree of personalization. A second example is patients’ responses to data-feedback requests and their learning to use the provided IoT devices. Their collaboration is essential for efficient system use and affirms their role as co-producers in personalized management. A third example is the improvement of digital tools through professional feedback: by reporting errors to developers, machine capabilities improve, progressively transferring situated human expertise into machine competence.

All these practices show how human–machine collaboration conditions organizational effectiveness. Without it, the quality of work by both health professionals and digital tools degrades (e.g., uncorrected false negatives accumulate). Although such collaboration is regarded as strategic in other organizational contexts (Haesevoets et al., 2021; Lu et al., 2021; Xiong et al., 2023), it remains underrecognized in approaches to personalization in healthcare and is increasingly central as digital innovation advances.

Positioning within MC: from service modularity to large-scale management of uniqueness. Developed in health care, the framework generalizes beyond this domain and contributes to MC. It specifies how service modularity, digitally mediated coordination, and human–machine collaboration organize uniqueness at operational scale.

Aligned with the idea that managing personalized patient pathways can be viewed as an application of MC, our findings intersect with the concept of modular service. However, the goal and organizational challenge are not identical. MC, developed for manufacturing and later

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3 extended to services, aims to create variety (Piller, 2004). Consequently, even as
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5 personalization levels increase, organization remains characterized by predefined combinations
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7 based on modular architectures, with a dominant role for supply-chain and logistics functions.
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10 In comparison, our framework focuses on a service activity that recognizes uniqueness and
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12 involves multiple adjustments and interactions. This yields a different conception of agility and
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14 coordination needs. While in MC, these are integrated operational dimensions that foster
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16 modular capabilities, here they are intrinsically linked to daily work and embodied in digital
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18 capabilities and health professionals' practices. Therefore, our framework aligns more closely
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20 with the Mass Personalization perspective (Wang et al. 2017). which emphasizes Industry 4.0
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22 technologies to handle each case uniquely. Yet, although these technological capabilities are
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24 significant, we emphasize the equally vital role of human mutual adjustment and its essential
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26 collaboration with technological capabilities. While collaboration is often justified as a key
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28 aspect of decision-making and production processes, to our knowledge it has not been
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30 incorporated into theories of personalized management.
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35 Ultimately, the positioning question remains: is our framework an extension of MC or a
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37 different approach? Our study does not settle this. Further research should probe these relations
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39 in other contexts. Still, domains with similar characteristics appear suitable. E-learning can be
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41 conceived as learning pathways continuously adapted to students' needs and contextual
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43 constraints (Sharma et al., 2017). Skills development and professional mobility can be viewed
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45 as personalized pathways in which employees integrate firm resources (budgets, mentors,
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47 project participation) with values and preferences. More generally, the framework is pertinent
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49 wherever a user-centric logic dominates and experience unfolds as a continuous pathway.
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54 *Contributions to practice.* The large-scale management of uniqueness framework guides
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56 current personalization initiatives. This integrated approach enables personalized medicine,
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58 patient-centered care, and related approaches to be implemented concurrently within patient
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pathways. Yet, for this to happen, healthcare managers must adopt specific practices. These practices adhere to a fundamental principle: prioritize a demand-based approach (meeting patients’ needs and preferences) over a supply-based approach common in many healthcare systems, where services and products are determined by clinical and administrative expertise.

This requires, first, systematically recording expressed needs and preferences (Vuik et al., 2016). During the Segmentation step, managers should encourage collecting data that cover all patient characteristics, including those less frequently studied. While typical characteristics such as age, sex, clinical status, and education level are often available, data enabling analysis of socioeconomic criteria and patient preferences are generally under collected (McConnell et al., 2017; Waelli et al., 2021). Considering a broader range of characteristics allows modern profiling methods (especially AI-based) to identify each patient’s needs and preferences. Next, affirm the role of personalized care plans as a strategic tool to guide professional practice. Their joint development requires more systematic multidisciplinary exchanges, supported by shared information systems. Finally, emphasize the importance of the assembly and distribution steps within healthcare systems. These topics are not always well understood by managers and health professionals and deserve greater attention, given their role in enhancing agility and coordination.

Furthermore, healthcare managers need to allocate resources for the personalization initiative. It is vital to foster feedback enabled by e-PROs, acknowledge new NN-type roles, and encourage adoption of digital tools. Nevertheless, these investments must be complemented by organizational principles that guarantee practical implementation and collaborative use. For example, platform development is crucial because of its integrative role. The question of locus (within a health organization or external) merits deeper examination; the MonitorSanté case suggests an external platform does not hinder interprofessional coordination. Similarly, effective human–machine collaboration requires frequent exchanges between health

professionals and data analysts during tool design and use. These exchanges help improve performance (e.g., alert systems, especially false positives) and enhance ergonomics (e.g., dashboard information display). The rise of AI tools raises further questions about how algorithmic results are understood; improved interpretability could reduce health professionals' distrust (Goh et al., 2024).

Limitations and Future Research

Our study is based on a single case focused on a specific clinical condition. Although it involves multiple care centers and diverse patient groups, we must interpret the discoveries cautiously. As noted, the framework requires testing beyond this context. We encourage further research to examine it across (i) clinical settings (other chronic diseases), (ii) sectors and geographies (beyond French care organizations), and (iii) technologies (alternative digital tools).

A second limitation concerns the technological dimension and our focus on digital tools in establishing personalized management. On the one hand, AI is not prominent at MonitorSanté (it is integrated into alerting and task prioritization), yet it could be consequential for profiling and engagement, task automation, prediction of clinical/organizational events, and decision support (Chawla & Davis, 2013). Rapid innovation in this field necessitates closer examination of present and future contributions. The limited presence of AI in our case, despite an in-house development team, may also reflect implementation challenges (Angus et al., 2025). On the other hand, questions persist about how digital tools collaborate with human expertise. While such cooperation is vital for managing uniqueness at scale, its specific content remains underdefined. Opportunities for mutual learning between machine and human may be especially instructive, clarifying their role within indirect learning processes that enhance collective performance across teams (Edmondson et al., 2007) and within teams (Myers, 2021).

A third limitation concerns conditions for large-scale deployment. MonitorSanté is early-stage, and we lack empirical evidence on scaling. We observed regional variation in organizational arrangements but did not identify conditions for broader expansion. What conditions are required, how should they adapt to local circumstances, and what payment models and evidence support medical and economic impact? Assuming more personalization yields better outcomes and experiences, cost implications require scrutiny. Investments may increase costs: enhanced segmentation analytics (even if algorithmically assisted), new services (*e.g.*, therapies, “concierge” systems, home services), and new roles such as NNs. At the same time, personalization can generate savings: by increasing relevance, it reduces unnecessary hospitalizations (Jenq et al., 2016; Mercer et al., 2015), treatment costs (Williams et al., 2018) and various wastes such as food (Leiblein-Züger & Honegger, 2014). Targeted to “complex” or high-utilization patients, it enables more appropriate and efficient organizational responses (Blumenthal et al., 2016; Hardin et al., 2017). Finally, when applied to many patients with similar clinical conditions, it can coexist with economies of scale stemming from common standards of care (Chaudhuri & Lillrank, 2013). However, evidence remains limited and warrants further research to demonstrate the value of this form of personalized management and to identify its most suitable configurations (Colldén et al., 2021).

CONCLUSION

Despite its limitations, our study advances a theoretical framework: Large-Scale Management of Uniqueness. In Blumer’s sense of a sensitizing concept (1986), it sharpens attention to the organization and functioning of communities of inquiry in situations characterized by substantial uncertainty. This framework departs from MC applications in healthcare by placing the individuality of each patient at the center of the personalization effort. By specifying practices and capacities in work organization, we show that knowledge, coordination, and agility are necessary conditions for such management. Meeting these needs in the digital era

requires human–machine collaboration (health professionals, notably nurses, working with digital tools). We hope our findings motivate managers and health professionals to reconfigure their organizations accordingly and prompt further research to elaborate this approach.

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TABLES AND FIGURES

Table 1: Clinical and non-clinical data sources used within MonitorSanté's digital platform

Category	Technology-Enabled Data Source	Examples of Data Collected and use	Frequency of Collection
Clinical Data	Body-worn sensors/ Wearables (bracelet, pulse oximeter, smartwatch)	Heart rate, oxygen saturation, respiratory rate, movement, fall detection	Continuous / Event-based
	IoT Medical Devices for clinical measurement	Blood glucose, blood pressure, weight, temperature	Periodic or on-demand
	Remote Diagnostic Tools	ECG, arrhythmia detection, digital stethoscope for teleconsultations (lung & heart sounds)	Spot / On-demand
	Geolocation & Safety Trackers (SOS button)	Real-time location for patient with dementia, Alzheimer's, SOS alerts for at-risk patients,	Real-time
	Platform Data	Patient-care team communication logs, teleconsultations, data aggregation, dashboard access (evaluation reports, alerts, scores)	Continuous
Non-Clinical Data	Smartphones /tablets for Health Questionnaires	Standardized self-reported assessments (e.g., symptom reported questionnaire, PROs, etc.)	Periodic
	Digital forms questionnaires for Cognitive & Functional Assessments	Cognitive tests, ADL/IADL, GIR	Baseline and periodic updates
	Socio-Economic Data	Living conditions, caregiver availability, income, insurance coverage	Periodic / at inclusion
Behavioral & Lifestyle Data	Self-Reported or Wearable-Derived	Physical activity, diet, medication adherence, sleep quality	Continuous + self-reported
Patient Preferences	Care & Communication Preferences	Care goals, preferred interventions, contact preferences, shared decision inputs	Updated at care-plan revisions

Table 2: Data collected and their role in analysis

Data collected	Role in analysis
Interviews – Wave 1 14 interviews (May–Sept 2024) Profile (Number) Navigator Nurse MonitorSanté (6) Geriatrician MonitorSanté (1) Operational Support Team (3) Development Team (4)	- Provided insights into the work processes of the MonitorSanté system in personalizing patient remote monitoring from referral/inclusion through the entire follow-up period. - Clarified how patients are assessed initially to identify needs and how personalized care and monitoring plans are created to prevent deterioration. - Documented what types of patient data are collected (e.g., questionnaires, clinical scores) and how; explored the use of data-driven technologies (bracelets, teleconsultation, connected devices). - Identified the stakeholders involved (Navigator Nurses, MonitorSanté geriatricians, operational support team, platform developers, and managers). - Analysed processes of data collection, analytics, anomaly detection, and alert management. - Examined how coordination occurs across the follow-up period (e.g., Navigator Nurses managing alerts, discussing cases with geriatricians, adjusting care plans with new thresholds or additional surveillance). - Highlighted emerging organizational practices for managing personalized patient pathways. - Built rapport with professionals ahead of observations and captured multiple perspectives. - Enabled triangulation with observations and documentation.
Interviews – Wave 2 9 interviews (Jan–May 2025) Profile (Number) Navigator Nurse MonitorSanté (2) Geriatrician MonitorSanté (2) Platform Supervisor (2) Medical Secretary (1) Partners: General Practitioner and Nurse (2)	- Deepened and refined understanding of emerging elements in patient monitoring, especially interactions between professionals and technology throughout inclusion and follow-up. - Added more clarifications about interviewees’ roles, routines, and daily practices as well as interaction with digital tools. - Allowed probing and follow-up questions to expand and refine Phase 1 insights. - Traced informants’ evolving experiences alongside the development and refinement of devices/platform

Observations (field) 88 hours total field observation, including: - 34h shadowing of NNs and a geriatrician - 48 weekly leadership /platform meetings (60–90 min each) (May 2024–May 2025)	- Provided direct insight into daily practices of Navigator Nurses and MonitorSanté geriatricians. - Enabled longitudinal tracking of emerging processes in personalization. - Helped researchers familiarize with context and work routines in alert management, anomaly response, and personalized adjustments. - Documented real-time interactions with platforms, technologies, and analytics. - Strengthened trust with interviewees and facilitated recruitment. - Triangulated with interviews and documents. - Weekly meetings enriched insights into organizational work processes and platform development from managers' and developers' perspectives.
Documentation 15 internal documents ~200 pages Access to the developer platform access.	- Enabled triangulation with interviews and observations. - Provided contextual understanding of organizational work of MonitorSanté Navigator Nurses' daily work (e.g., how anomalies are analyzed relative to patients' context). - Deepened knowledge of the technical components of the system. - Offered institutional and scientific context (guidelines, protocols, platform documentation). - Gave concrete examples of platform use (e.g., dashboards enabling data visualization and alert management). - Strengthened the credibility of findings.

Figure 1: Navigator Nurses’s Dashboard (shared with other health professionals)

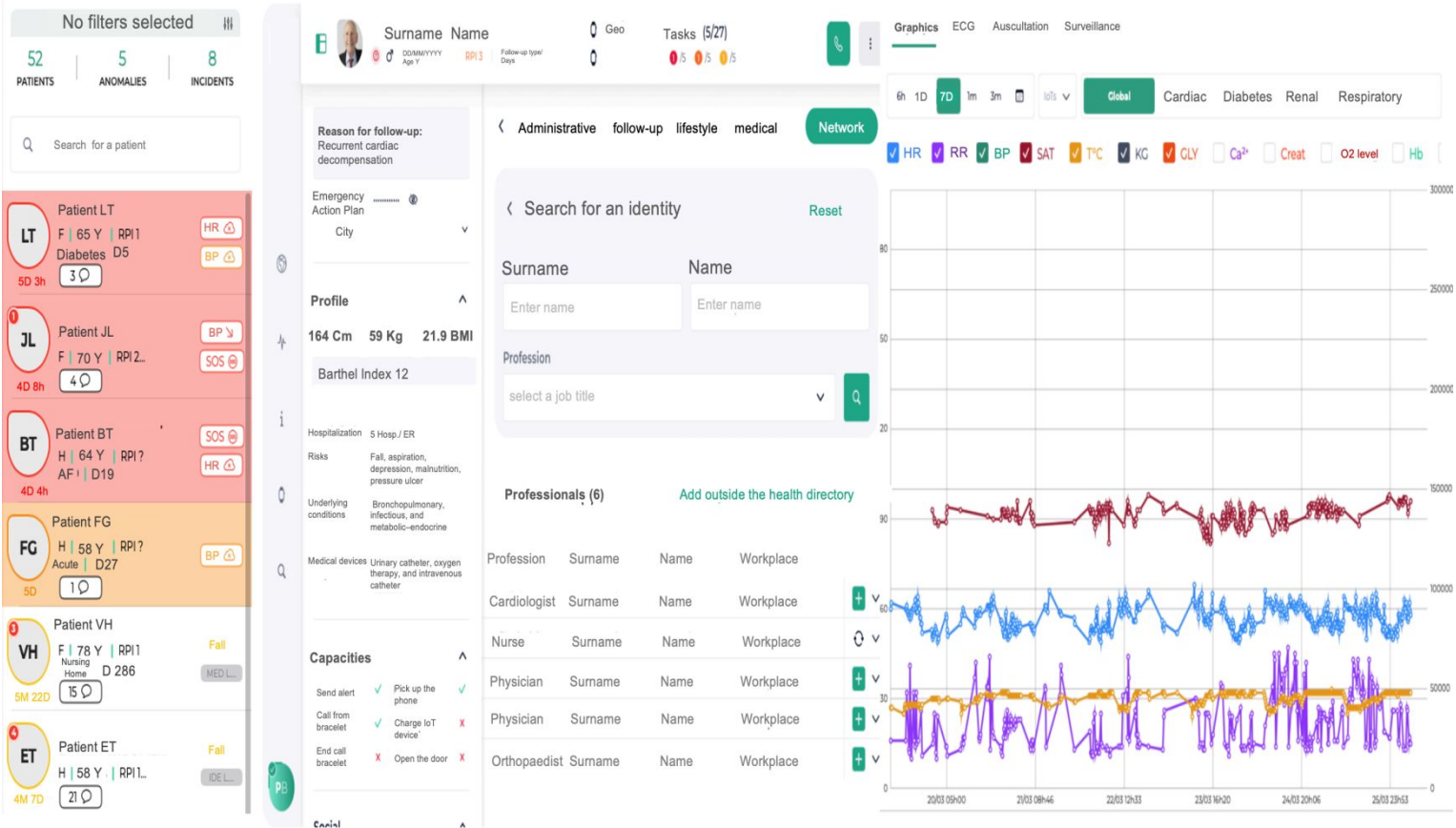
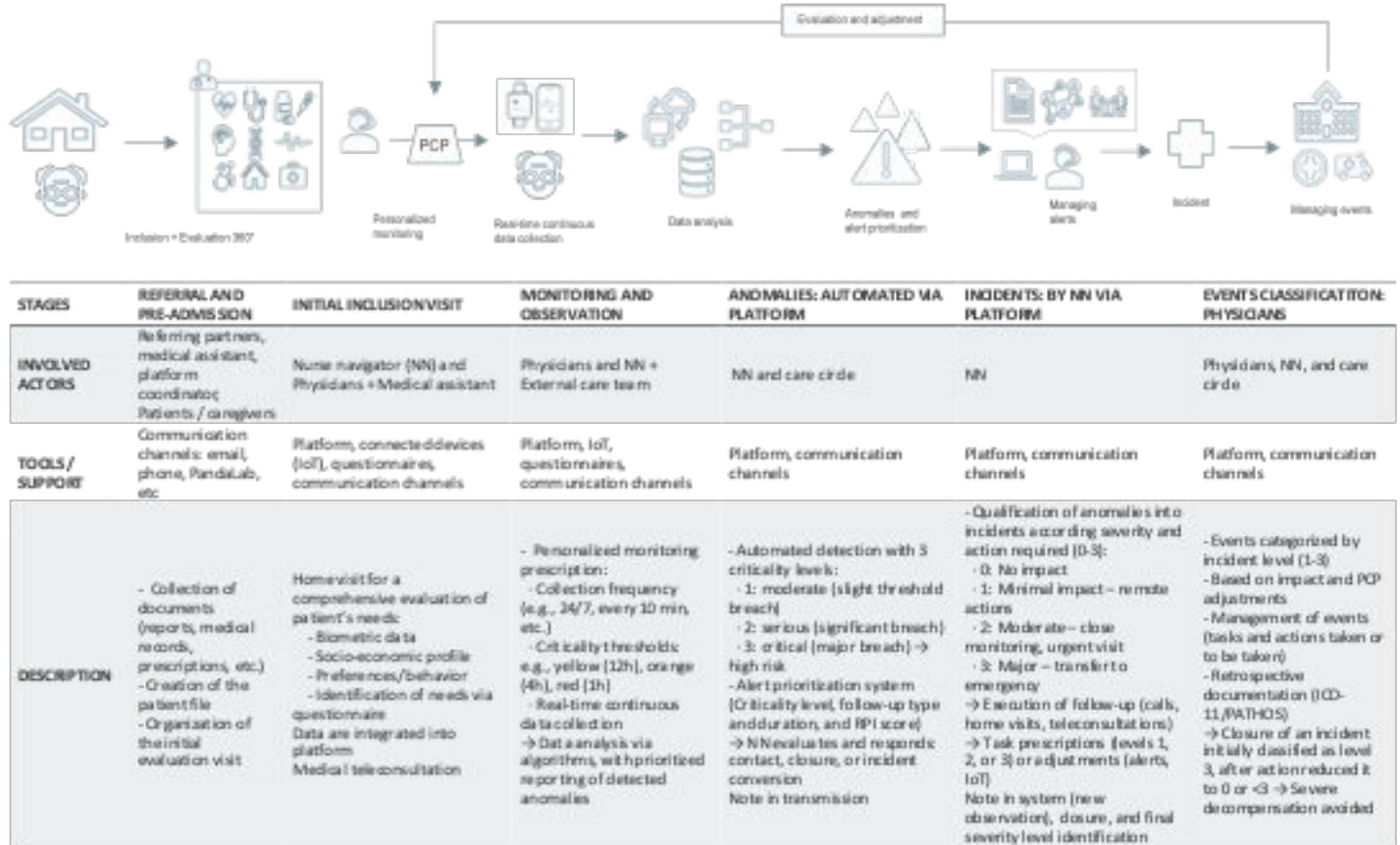


Figure 2: Personalized Patient Pathway Within MonitorSanté's digital platform**Figure 3: Illustration of the Large-Scale Management of Uniqueness framework**