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Beyond the digital health tsunami: reaffirming biomedical and health informatics as the scientific foundation of digital healthcare transformation

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ABSTRACT

Digital health (DH) has emerged as the dominant terminology for technology-enabled healthcare, reshaping institutional discourse, educational programmes and policy agendas. DH is often portrayed as a novel discipline that could supersede Biomedical and Health Informatics (BMHI), creating conceptual ambiguity and the risk of weakening scientific rigour in the design, evaluation and governance of digital interventions. This paper clarifies BMHI's disciplinary identity, characterises DH as a practice-oriented and implementation-oriented domain, and establishes the epistemic relationship between the two in order to inform academic strategy, curricula and professional identity. A comparative conceptual analysis examined scope, theoretical foundations, methodological approaches, educational frameworks, professional structures and stakeholder ecosystems in both domains, informed by recent debates on degree programmes and workforce training. We found that BMHI is a mature scientific discipline with explicit theoretical foundations encompassing data representation, knowledge modelling, clinical reasoning, decision support, interoperability, sociotechnical analysis, evaluation science, safety, ethics and governance. DH, by contrast, represents an implementation-oriented translational domain that operationalises BMHI through products, services and organisational transformation (eg, telehealth, mobile applications, artificial intelligence-enabled clinical services). While DH has amplified visibility and accelerated adoption, it lacks autonomous theoretical foundations and depends on BMHI for scientific validity, safety and sustainability. Three evolutionary scenarios are examined: DH absorbing BMHI (epistemically incoherent), convergence as parallel disciplines (conceptually flawed), and reintegration of DH within BMHI as its applied layer (scientifically coherent and strategically sustainable) but requiring disciplinary communication, curricular alignment and institutional leadership explicitly positioning DH as a translational layer of BMHI.

INTRODUCTION

Biomedical and Health Informatics (BMHI) is the scientific discipline that studies how information and communication technologies can be used to advance biomedical research, healthcare delivery and population health. As defined by the US National Library of Medicine,[1] 'in the context of biomedicine and health, informatics is the study and practice of using computers, information technology and data to improve health outcomes and care'. Originating from the early developments in medical computing during the 1960s,[2 3] BMHI has progressively transformed medicine into a data-driven and knowledge-driven endeavour through innovations such as electronic health records, interoperability standards, clinical decision support systems, and artificial intelligence (AI) in healthcare. Over time, BMHI has evolved into a mature academic and professional discipline, grounded in computer science, data science, health sciences and social sciences. Supported by international organisations such as the International Medical Informatics Association (IMIA), it has shaped education, research and health policy worldwide.

In recent years, the rapid rise of Digital Health (DH) has reshaped the language and visibility of technology in health. Driven by technological acceleration, entrepreneurship, consumer devices and policy priorities,[4–6] DH commonly denotes the deployment of digital technologies—telemedicine, mobile apps, connected sensors, AI-enabled services, data platforms—aimed at improving health outcomes and care processes. This shift in terminology has increased the public and institutional visibility of technology in healthcare.[7] It has also produced a structural misunderstanding: by occupying the public space of 'digital science for health,' DH has come to be perceived as filling a conceptual and scientific void that, in reality, had long been occupied by BMHI. This situation did not arise because informatics was absent, but because it was largely invisible outside academic and professional circles. This perceived vacancy has generated a disciplinary identity crisis

within the informatics community, threatening to fragment a mature scientific field.[8]

At stake is not merely terminology, but the preservation of scientific rigour in an era of technology-driven healthcare transformation. Some have questioned whether DH represents a new paradigm requiring separate educational pathways and professional identities, while others argue that it corresponds to application-oriented dimensions long addressed within BMHI. This debate was crystallised in 2024 when Car and Topol proposed the creation of a Master of DH (MDH) degree, modelled after the Master of Public Health (MPH), to address what they perceived as a gap in existing informatics education.[9] They argued that DH innovation requires competencies in design, entrepreneurship, social determinants of health and large-scale implementation that are insufficiently covered in traditional informatics programmes.

This position was challenged by the leaders of the American Medical Informatics Association and the members of the American College of Medical Informatics, who countered that BMHI programmes already encompass these competencies—data management, analytics, systems design, wearable biosensors, environmental exposures evaluation and ethical oversight[10]—raising concerns that the proposed MDH may fragment a mature discipline by detaching its applied components from their scientific foundations.

The exchange reflected a deeper tension: whether DH should be understood as already covered by BMHI, an extension of BMHI, or a transformative paradigm deserving its own academic identity. This question was explicitly addressed during an IMIA panel at MedInfo 2025 in Taipei,[11] provocatively asking: "*Is Digital Health the fancy term for Biomedical and Health Informatics, or do the two expressions cover different notions?*" The panel, composed of leading health informatics figures such as Patrice Degoulet, Ted Shortliffe, Christian Lovis, W. Ed Hammond, Heimar de Fátima Marin, Jack Li, Otto Rienhoff and Brigitte Séroussi discussed not only differences in culture, pace and institutional context, but also the strong conceptual and historical continuity between the two (Degoulet P *et al*. Clarifying the relationship between biomedical and health informatics and digital health: Expert perspectives. *BMJ Health & Care Informatics* (Submitted)). The panel's deliberations underscored the urgent need for conceptual clarity to guide educational strategy, professional identity formation and institutional positioning in an era of rapid digital transformation.

This paper builds on that debate to analyse whether the apparent distinction between BMHI and DH reflects a disciplinary separation or rather different levels of abstraction, orientation and maturity within the same informatics ecosystem. We argue that the technologies commonly grouped under DH already fall within established sub-domains of BMHI, though framed through different terminologies and modes of implementation. Clarifying this relationship is essential to preserve epistemic coherence, methodological rigour and ethical responsibility in the digital transformation of healthcare.

BMHI: DISCIPLINARY FOUNDATIONS AND EDUCATIONAL FRAMEWORK

Scope and scientific foundations

BMHI is a mature scientific discipline focused on the optimal use of biomedical data, information and knowledge to advance biomedical research, support clinical practice and improve the performance of health systems. Situated at the intersection of computer science, health sciences, cognitive sciences and social sciences, BMHI's defining contribution is not the promotion of specific technologies, but the development of principles, models and methods that make technology clinically meaningful, safe and useful.

Historically rooted in clinical computing and electronic data management, BMHI has expanded in response to the growing complexity and digitalisation of healthcare. Today, it covers a broad set of domains—clinical informatics, bioinformatics, public health informatics, imaging informatics, clinical research informatics, consumer and nursing informatics and health data science—spanning infrastructures (records, repositories, exchanges), standards (semantic and technical interoperability), clinical decision support and AI methods. Importantly, BMHI has developed explicit theoretical and methodological foundations: models of clinical reasoning and decision-making; knowledge representation through terminologies, ontologies and data models; human–computer interaction and cognitive approaches to system usability; and sociotechnical theories explaining how technologies interact with organisations, professional practices and patient behaviour.

This scientific core is inseparable from rigorous evaluation. BMHI has long advanced evidence-based approaches to assess usability, effectiveness, safety, equity and unintended consequences of health information systems. It incorporates methods ranging from qualitative usability studies and workflow analyses to quasi-experimental designs, simulation and implementation science. Ethics, governance, privacy and security are not peripheral constraints; they are constitutive components of the discipline because they condition the legitimacy and sustainability of information-driven healthcare.

From this perspective, domains frequently labelled as DH—telemedicine, patient-facing apps, connected devices and AI-enabled services—are not external to BMHI. They are contexts in which BMHI infrastructures, methods and governance frameworks are applied. DH, therefore, does not constitute a separate epistemic territory but rather manifests as the visible, implementation-focused expression of BMHI's foundational science—in the way clinical practice would express basic medical sciences, or engineering applications would express physics.

Education, professional identity and career pathways in BMHI

The maturity of BMHI as an academic discipline is reflected in internationally recognised educational standards and well-defined career pathways. The IMIA 2023 Recommendations on Education in BMHI[12]—resulting from decades of international consensus-building—provide a comprehensive framework for academic programmes worldwide. They articulate six core knowledge domains spanning foundational informatics principles, health sciences, computer and data sciences, social and behavioural sciences, management science and specialised BMHI domains, thereby defining the intellectual scope of the field and ensuring that graduates acquire an integrated foundation encompassing theoretical concepts, healthcare context, technical expertise, human and organisational factors, leadership capabilities and specialised competencies (see figure 1 for the domains and table 1 for the details of domain contents).

This yields structured curricula—commonly at MSc level—combining core coursework, specialisation tracks and a capstone project or thesis to equip graduates with the competencies required to analyse clinical workflows, manage and interpret complex health data, and design, implement and rigorously evaluate information systems that improve the quality, safety and efficiency of care. Professional identity has also been formalised. Clinical informatics recognition and certification pathways illustrate the institutionalisation of informatics as a professional field with defined competencies, ethical responsibilities and leadership roles. Career trajectories are diverse—clinical informaticists, data scientists, system architects, interoperability and standards leaders, evaluation and implementation specialists and executive roles such as Chief Medical Information Officer/Chief Nursing Information Officer—spanning healthcare organisations, academia, government and industry.

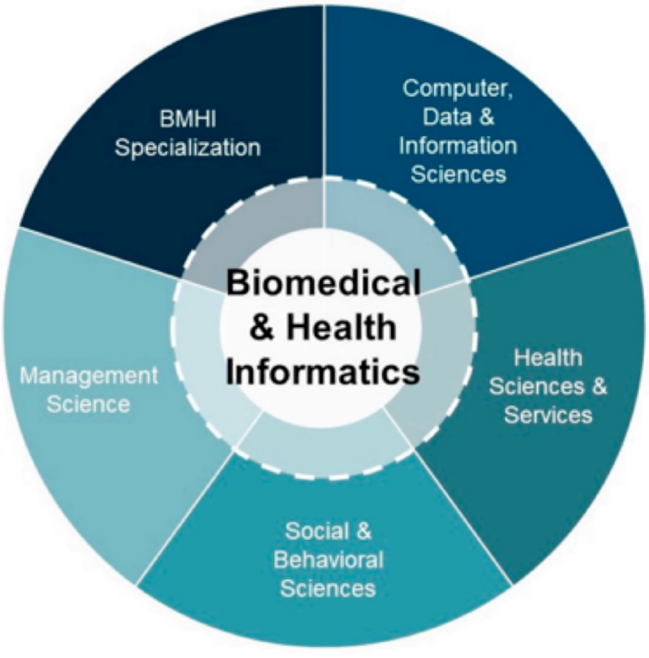

Figure 1 Representation of the six BMHI knowledge domains (from Bichel-Finlay *et al*[12]).

Taken together, these educational structures and career trajectories underscore BMHI's dual identity as a rigorous scientific discipline grounded in strong theoretical and methodological foundations, and as a practical driver of healthcare transformation through the effective use of information and technology.

DH: CHARACTERISTICS, FOUNDATIONS AND EDUCATION

Defining characteristics, scope and scientific foundations of DH

DH is commonly used as an umbrella term[13] to describe a wide range of digital technologies used in healthcare delivery, public health and health management. The term emerged primarily from industrial, policy and entrepreneurial contexts and has no single stable definition. The WHO defines DH as 'the field of knowledge and practice associated with the development and use of digital technologies to improve health,'[14] while regulatory bodies like the US Food and Drug Administration focus on its application such as mobile health, wearable devices, telehealth, telemedicine and personalised medicine.[15] DH is therefore best understood as an activity-oriented domain, shaped by innovation dynamics, implementation imperatives and policy agendas, that applies existing digital technologies in real-world healthcare scenarios. DH innovations are characteristically practice-oriented, solution-driven and user-centred. They aim to make healthcare more accessible, personalised and proactive, often directly involving the patient in their care through tools like apps, remote monitoring and teleconsultations,[8] thereby empowering patients, caregivers and frontline providers to actively participate in health management and care delivery.

The scope of DH is broad and continuously evolving. Mobile health (mHealth) includes smartphone applications for health tracking, medication adherence monitoring, mental health support, chronic disease management and health education. In many resource-constrained settings, simple and widely accessible tools such as SMS-based health reminders, WhatsApp consultations and basic mobile applications for medication adherence play significant and effective roles in healthcare delivery, demonstrating that DH encompasses both sophisticated platforms and simple, scalable solutions. The sheer volume of consumer health apps highlights the scale of this field. Wearable devices and sensors, ranging from fitness trackers and smartwatches to continuous glucose monitors and cardiac rhythm monitors, generate vast amounts of physiological data outside traditional clinical settings. These tools contribute significantly to patient empowerment by enabling self-management of chronic conditions, improving health literacy through accessible information and facilitating patient-provider communication. DH platforms increasingly support

Table 1 Detailed topics of the six BMHI Knowledge Domains (adapted from Bichel-Findlay *et al*[12])

(1) BMHI core principles	(2) Health sciences and services
Clinical decision support	Biomedicine
Data governance	Care delivery models
Education support though informatics methods and tools	Clinical decision making
Evaluation and assessment of information systems	Determinants of health
Health informatics standards and interoperability	Epidemiology
Health record structure, design and analysis principles	Evidence informed practice
History of BMHI	Health policies and regulatory frameworks
Information literacy	Health promotion
Information processing in healthcare	Health sector roles
Literature retrieval and analysis	Health terminology
Nomenclatures, vocabularies, terminologies, ontologies and taxonomies	Health service organisation structure and function
Regional networking and shared care	Human anatomy and physiology
Research methods and paradigms	Participatory health
Telemedicine and telehealth	Patient empowerment
	Patient safety
	Person-centred care
	Public health
(3) Computer, data and information science	**(4) Social and behavioural sciences**
Artificial intelligence	Digital literacy and the digital divide
Blockchain technology	Ethics, security and privacy
Cloud and edge computing	Health literacy
Data and information analysis	Indigenous data sovereignty principles
Data and information attributes	Medical law
Data and information visualisation	Problem solving
Design and development principles	Sociotechnical aspects
Information science theories	Stakeholder education
Information structure and design	Stakeholder engagement
Internet of things	User experience
Network architectures and topologies	
Robotics	
System design	
System lifecycle	
System security	
Wireless technology, sensor-based systems	
(5) Management science	**(6) BMHI specialisation**
Business alignment	Biomedical imaging and signal processing
Change management	Biomedical modelling and simulation
Health economics	Chemoinformatics
Information culture	Clinical bioinformatics and computational biology
Leadership	Clinical research informatics
Interdisciplinary team management	Global health informatics
Process reengineering	Nanoinformatics
Project management	Participatory health informatics
Quality management	Personal health informatics
Resource management	Public health informatics
Risk management	Translational bioinformatics
System governance	
Value management and benefits realisation	

BMHI, Biomedical and Health Informatics.

patient autonomy, shared decision-making and activation in care processes, shifting the traditional care paradigm toward more collaborative and patient-centred models. Telemedicine and virtual care have become central, including video consultations, remote monitoring, asynchronous communication platforms and virtual hospital programmes, a trend accelerated by the COVID-19 pandemic. AI and machine learning increasingly support diagnostic algorithms, clinical decision-making, natural language processing for documentation, predictive analytics for patient deterioration and chatbots for patient triage. Digital therapeutics—software interventions for

conditions such as cognitive behavioural therapy for mental health or diabetes management programmes—are emerging as a regulated category akin to medical devices. Health data platforms aggregate information from clinical systems, consumer-controlled records, health information exchanges and research networks, enabling advanced analytics and population-level insights. Social media and online communities further enhance patient engagement, health information exchange, peer support and support digitally mediated behaviour change interventions.

From a disciplinary perspective, DH is characterised less by the novelty of its technologies than by its focus on rapid implementation, user adoption and transformation at scale. It mobilises heterogeneous actors such as clinicians but also engineers, designers, entrepreneurs, payers and policymakers, with the overarching goal of creating digital ecosystems that enhance accessibility, engagement and health outcomes. It is shaped by market dynamics and policy imperatives, its development culture often emphasises agile iteration, rapid prototyping and deployment.

Yet the evaluation and governance requirements that determine whether DH improves care—data quality, interoperability, usability, safety, bias, explainability, accountability, privacy and equity—are not intrinsic inventions of DH. They are long-standing objects of BMHI. DH depends on BMHI to ensure that innovation is evidence-driven rather than technology-driven. DH thus operates as a translational interface—neither scientifically autonomous nor methodologically independent—that mobilises BMHI's infrastructures, standards and evaluation frameworks to deliver market-ready solutions. This dependency structure reveals DH not as BMHI's successor, but as its most visible application domain.

The educational landscape of DH

DH education has expanded rapidly over the past decade, largely in response to workforce demands, policy priorities and the acceleration of digital transformation in healthcare systems. Programmes are diverse, ranging from short courses and online micro-credentials to full dedicated master's degrees housed in schools of public health, engineering, business or interdisciplinary innovation centres. This diversity signals responsiveness to workforce needs, but it also reflects an ongoing search for coherence. Curricula often highlight applied and innovation-oriented competencies: product development, user-centred design, agile methods, regulatory pathways, cybersecurity and innovation management, frequently delivered through project-based learning with industry partners, hackathons and pitch competitions. However, the core content of effective DH training consistently draws on BMHI including health data standards, interoperability, information system architecture, clinical workflow modelling, human factors and usability, data analytics, AI and evaluation methodologies.

From a professional perspective, DH is characterised by heterogeneous roles and career pathways rather than a consolidated professional identity. DH professionals come from diverse backgrounds, including clinical practice, engineering, data science, business and design, bringing interdisciplinary skill sets to the development and implementation of DH solutions. Unlike BMHI, DH lacks standardised career trajectories, formal credentialing and a clearly defined professional category. The term 'digital health' most often appears as a modifier in job titles of established professions (eg, 'digital health product manager'), rather than a stand-alone profession. Many DH professionals gravitate toward startups, technology companies, innovation hubs, consultancies or venture capital ecosystems rather than traditional healthcare organisations or academic institutions. In these settings, they frequently act as intermediaries between technology developers and healthcare systems, combining business acumen, clinical insight and technical expertise. Their work centres on integrating digital technologies into care delivery, designing user-centred and market-ready products, navigating regulatory and ethical constraints and responding to rapidly evolving organisational and market environments. Educationally and professionally, DH is strongest when explicitly anchored in BMHI rather than positioned as a parallel discipline.

COMPARATIVE ANALYSIS: CONTINUITIES, DIFFERENCES AND HIERARCHICAL RELATIONSHIP

BMHI and DH share the same underlying objective: improving health through better use of data, information and knowledge. They also share the same constraints: safety, usability, clinical validity, privacy and equity, all within sociotechnical healthcare environments. However, BMHI and DH present a structural asymmetry: the former acts as the foundational layer, while the latter builds on these foundations to focus on implementation.

BMHI is the foundational discipline: it produces theories, methods, infrastructures and evaluation frameworks that define scientific standards for health information systems and data-driven interventions. DH is the applied arena: it translates those capabilities into scalable solutions, emphasising deployment, adoption and service transformation. While BMHI defines what is possible and why it works, DH demonstrates how these possibilities can be implemented and scaled to improve accessibility, engagement and health outcomes. In this sense, DH is nested within BMHI, serving as the applied, implementation-focused expression of the discipline rather than a separate field. This asymmetry matters. Treating DH as an autonomous discipline obscures the source of its epistemic and methodological legitimacy[16] whereas positioning DH as an applied layer of BMHI preserves clarity: the same scientific foundations support both research and implementation, while allowing DH to retain its agility and societal resonance.

Educational paradigms do reflect these differences. BMHI programmes are structured, disciplinary and research-oriented. They confer well-recognised

credentials and support clear career pathways. DH education, by contrast, is heterogeneous and interdisciplinary, offering breadth across technologies and applications but often less theoretical depth. Curricula emphasise practical projects, entrepreneurship and innovation, targeting professionals from diverse backgrounds, including clinicians, engineers, business specialists, designers and data scientists.

Finally, the stakeholder ecosystems and regulatory contexts diverge. BMHI operates within stable healthcare institutions, established professional societies, government agencies and regulated health IT environments, emphasising compliance, incremental improvement and standards adoption. DH thrives in dynamic, disruptive ecosystems involving startups, accelerators, consumer technology firms and venture capital, navigating ambiguous regulatory frameworks that allow rapid innovation but entail regulatory and safety risks.

Asymmetry between BMHI and DH is not a value judgement about importance or impact—DH's contributions to accessibility, engagement and rapid deployment are substantial—but rather a clarification of epistemic structure: one domain produces scientific knowledge (BMHI), the other applies it (DH).[17]

Table 2 summarises the comparison between BMHI and DH across key disciplinary dimensions, showing that while DH emphasises implementation, innovation and deployment of digital technologies in healthcare, its scope, theoretical foundations, methodologies and educational underpinnings are structurally derived from BMHI. This comparison clarifies the disciplinary relationship between the two domains and highlights that BMHI serves as the scientific 'engine room,' while DH operates as the 'interface' through which innovations are translated into market delivery and user adoption.[18]

THREE SCENARIOS FOR THE EVOLUTION OF BMHI

The rise of DH presents the BMHI community with a strategic choice: how should the discipline position itself relative to this highly visible but scientifically derivative domain? Is DH a new scientific field? Does it supersede BMHI? Or is it simply an application-oriented expression of informatics, amplified by technological acceleration and societal demand? These questions are no longer terminological; they concern the intellectual structure, legitimacy and future trajectory of BMHI. Against this background, three plausible scenarios can be envisioned.

In the first scenario, DH absorbs BMHI, and DH becomes the dominant paradigm, relegating BMHI to a supporting role. Research priorities shift towards deployment, scalability and market relevance, potentially enhancing visibility and funding opportunities. However, this scenario is fundamentally flawed. By placing foundational science behind its applications, it represents an epistemic inversion analogous to positioning 'evidence-based medicine' as the parent discipline of epidemiology and biostatistics, or treating 'biotechnology' as the foundation of molecular biology. The success or failure of digital interventions—interoperability, validity, safety, evaluation and governance—depends on the scientific methods developed within BMHI. Without this foundation, the community's ability to critically assess innovations, anticipate unintended consequences and ensure long-term sustainability would be compromised. While potentially attractive in the short term, this scenario erodes scientific integrity and must be rejected. DH cannot exist independently of the rigorous scientific backbone provided by BMHI.

A second scenario assumes a convergence between BMHI and DH, treating them as distinct but equal domains that progressively merge through collaboration and mutual influence. At first glance, this scenario appears balanced and conciliatory, but it rests on a flawed symmetry. Convergence presupposes that the two entities have a comparable epistemic status. Yet DH is not a parallel discipline to BMHI; it is derived from it. Conceptually, it is incoherent to argue for the convergence of a field with one of its own application domains—much as one would not claim that clinical trials should 'converge' with statistics, or that engineering should 'converge' with physics. Framing the relationship in terms of convergence risks obscuring the hierarchical structure of the field and blurring responsibility for scientific standards and governance. While interaction and translation are essential, convergence as a framing device ultimately weakens the clarity of the scientific narrative.

The third scenario is both scientifically coherent and strategically sustainable: DH is explicitly integrated as an applied domain within the broader scope of BMHI. This arrangement reflects an essential asymmetry: DH cannot exist independently of the scientific and methodological foundations provided by BMHI. This does not marginalise DH; on the contrary, it strengthens DH by ensuring that innovation is grounded in established principles of validation, evaluation, safety and governance, thereby protecting patients, professionals and health systems from the risks of under or incorrectly-evaluated or purely technology-driven solutions. It also guarantees continuity: whatever the next wave of technologies or buzz-words may be, they remain anchored in the enduring science of health information. Realising this scenario requires an active transformation of the informatics community. BMHI must assert its scientific identity, clearly define its problem space and demonstrate its indispensable role across the entire lifecycle of DH innovation. This includes leading the definition of quality and evidence, reclaiming ethics and governance as core responsibilities, and positioning DH explicitly as an applied, translational layer within the discipline. Concrete implementation strategies include: (1) Curricular integration: designing DH certificates and specialisations explicitly within BMHI master's programmes; (2) Terminological precision: systematically framing DH initiatives as 'BMHI-enabled' or 'informatics-grounded' in institutional communications; (3) Conference architecture: structuring scientific meetings with DH as an application track alongside clinical informatics, bioinformatics and data science; (4) Journal positioning: establishing DH sections

Table 2 Comparison between BMHI and DH

Dimension	BMHI	DH
Nature and status	Mature academic and scientific discipline; established theoretical foundations, research tradition and scholarly governance (IMIA).	Not an independent scientific discipline; an application-oriented and innovation-focused domain; shaped by policy, market trends and implementation contexts.
Core objective	To generate, structure, analyse and govern health data, information and knowledge to optimise clinical processes and health systems.	Deliver scalable, user-centred technological solutions that improve care delivery, organisational performance and patient engagement.
Conceptual scope	Broad and foundational, encompassing clinical informatics, public health informatics, bioinformatics, consumer health informatics, imaging informatics, AI and data science, telehealth, human factors, ethics and governance.	Selective and use-case driven, emphasising telemedicine, mHealth, wearables, apps and AI-enabled services already addressed within BMHI.
Methodology	Scientific and evidence-based: formal methods for system design, interoperability, usability, evaluation, bias detection and sociotechnical analysis, and rigorous validation.	Agile and iterative; relies on BMHI methodologies; rapid prototyping, market adaptation and quick deployment cycles.
Theoretical foundations	Explicit and cumulative, including theories of information, cognition, decision-making, interoperability, sociotechnical systems and learning health systems.	Lacks autonomous theoretical frameworks; applies theories developed within BMHI, management and behavioural sciences.
Epistemological role	Knowledge-producing discipline defining scientific standards and evidence in health information systems.	Knowledge-applying domain translating informatics knowledge into operational solutions.
Technical focus	Foundational: data structures, interoperability, AI models, imaging and sociotechnical system design.	Applied: devices, mHealth apps, wearables and smart environments focused on user experience.
Temporal orientation	Long-term systems optimisation, rigorous evaluation.	Rapid iteration, market adaptation, real-world implementation.
Telemedicine and mHealth	Long-standing research and practice domains within BMHI, formally institutionalised (eg, IMIA Telehealth Working Group).	Frequently presented as central components of DH, but historically and conceptually grounded in BMHI.
Artificial intelligence and data analytics	Core subdomains of BMHI with well-established models for clinical decision support, validation, bias analysis and evaluation.	Applied as enabling technologies, relying on BMHI methods for safety, validity and integration.
Wearables, apps and smart environments	Studied within consumer health informatics, smart homes and ambient assisted living (eg, IMIA Smart Homes and Ambient Assisted Working Group).	Highlighted as emblematic DH technologies, dependent on informatics infrastructures and standards.
Regulatory and ethics	Established: HIPAA/GDPR compliance, data privacy, safety, equity and formal ethical standards.	Evolving: ambiguous regulations; innovation-driven with ongoing debates on standards and patient data protection.
Education and identity	Structured academic programmes, standardised curricula and strong integration of research and theory (eg, IMIA educational recommendations); well-defined career pathways and professional certifications.	Heterogeneous and practice-oriented educational offerings focused on implementation, innovation, transformation and leadership, often drawing implicitly on BMHI foundations.
Key actors	Researchers, clinicians, informaticians and data scientists.	Entrepreneurs, engineers, consultants, venture capitalists and policy innovators.
Stakeholder ecosystem	Academic institutions, healthcare organisations, government agencies, standards bodies.	Startups, venture capital, accelerators, consumer technology firms (Big Tech) and private investors.

AI, artificial intelligence; BMHI, Biomedical and Health Informatics; DH, digital health; GDPR, General Data Protection Regulation; HIPAA, Health Insurance Portability and Accountability Act; IMIA, International Medical Informatics Association.

within informatics journals rather than endorsing separate publication ecosystems and (5) Certification pathways: developing professional credentials that recognise DH competencies within unified informatics frameworks.

The central challenge is therefore not to resist to DH, nor to treat it as an equal or separate domain, but to explain the scope, principles and value of BMHI more effectively. This requires active efforts to increase visibility, clarity and

accessibility for policymakers, stakeholders and the public. When the discipline is clearly presented, the inclusion of DH becomes self-evident: it is the visible and practical layer through which informatics principles are translated into real-world health solutions. By asserting this leadership and visibility, the informatics community ensures that future waves of innovation—whatever their name, technological configuration or societal framing—remain anchored in a science capable of transforming data into knowledge and knowledge into better health. For organisations such as IMIA, the strategic imperative is clear: reaffirm BMHI as the intellectual backbone of digital transformation, while explicitly embracing DH as a prominent application domain.

CONCLUSIONS

DH and BMHI are not competing paradigms requiring reconciliation, but hierarchically related components of a single scientific ecosystem. DH represents the contemporary, large-scale, consumer-facing expression of informatics—enabled by unprecedented computational power, wide-scale deployment and enhanced user engagement—while BMHI provides the enduring scientific foundations that ensure these innovations are safe, effective and sustainable. The growing prominence of DH has nevertheless generated persistent confusion. Because informatics remains poorly understood outside academic and professional communities—and because industry, policy and media narratives privilege speed, visibility and novelty— DH is sometimes perceived as an autonomous discipline, even to the point of justifying separate curricula or institutional identities. This misunderstanding reflects not a weakness of BMHI, but a failure to make its foundational role sufficiently explicit to non-specialists.

The strategic imperative is therefore clear: the informatics community must clarify this relationship. This requires neither renaming the discipline nor diminishing DH's contributions, but rather asserting scientific leadership through clearer communication, stronger institutional positioning and explicit educational frameworks that present DH as an applied, translational layer of BMHI. The alternative—allowing DH to be framed as an autonomous discipline—carries substantial risks: fragmentation of scientific standards, erosion of methodological rigour, disconnection between innovation and evaluation and, ultimately, compromising patient safety and care quality. By contrast, successful reintegration strengthens both domains. DH gains scientific legitimacy and long-term sustainability through explicit connection to BMHI's theoretical and methodological foundations, while BMHI enhances its societal relevance and visibility by embracing DH as its most prominent translational application. For organisations such as IMIA, the mission is not defensive but constructive: to guide technological acceleration rather than resist it, ensuring that whatever emerging technologies or terminology dominate future discourse, they remain anchored in the enduring science of health information. This requires active leadership in defining quality standards, reclaiming governance as a core responsibility and demonstrating that sustainable digital transformation depends fundamentally on informatics science.

The future of health in a digital world will be shaped not by the loudest voices or most visible technologies, but by the discipline capable of transforming data into knowledge and knowledge into better health. That discipline is, and must remain, BMHI—with DH as its most visible and impactful expression.

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