



Innovation for Health System Efficiency and Improvement

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Executive Summary

Many healthcare systems globally are under pressure as they emerge from the COVID-19 pandemic. Poor economic conditions and escalating costs are placing additional financial burdens on public and private payers alike. Furthermore, a considerable amount of waste and inefficiency exists within these systems. Wasteful spending and inefficiency result in limited patient access to the best treatments, hindered incentives for innovation, suboptimal health outcomes, and severe cost burdens.

Various approaches are available to healthcare systems to improve their efficiency by helping them successfully transform limited resources into valued outcomes. Innovation is one potential tool to implement such solutions. However, perspectives on the impact of innovation on efficiency vary widely across stakeholders, with some arguing that healthcare spending on innovation like pharmaceuticals should be contained to protect efficiency, others arguing that inefficiencies are in many cases the result of suboptimal innovation adoption. As a result, efficiency and innovation are all too often framed as irreconcilable and competing objectives.

In this report, we reconsider the contribution of innovation to efficiency in the context of growing healthcare cost pressures and limitations on health systems. Additionally, we seek to understand the obstacles that hinder realising more significant efficiency gains from innovation and consider how they can be overcome through stakeholder collaboration. We argue that introduction of innovation is consistent with the goal of efficient use of limited resources and leads to the long-term improvement of health systems' efficiency. A focus on cost of innovation and short-term savings of limited resources should be counterbalanced by considerations of access to innovation and long-term efficiency gains.

Revisiting the innovation-efficiency debate

Understanding whether innovation and health system efficiency are best conceptualised as complements or substitutes is complex. The answer may depend on the type of efficiency and innovations being considered. At a high level, efficiency is a comparison between the observed and optimal values of the outputs and inputs in the production of healthcare. Nonetheless, the production of healthcare can be decomposed into a series of transformations which convert resources into healthcare and, ultimately, health. Therefore, efficiency can be analysed separately for each transformation step or for the whole production process. Different approaches can be taken to analyse efficiency, including the extent of waste in the production process (technical efficiency) or whether inputs are allocated to the mix of outputs that maximises value (allocative efficiency). Similarly, innovation in healthcare encompasses multiple categories of inventions and developments, including new health technologies, healthcare delivery processes and organisational practices.

A common view on the relationship between these concepts emphasises a trade-off between 'static' and 'dynamic' efficiency. Static efficiency concerns a single period and focuses on the impact of innovation on healthcare expenditure. On the other hand, dynamic efficiency involves incentivising innovation to stimulate research and development (R&D) over time in the context of innovative pharmaceuticals and other health technologies.

Adoption of innovation for health system efficiency and improvement

The trade-off between static efficiency and innovation is less acute when considering the latter's effect on the overall healthcare production process rather than expenditure on innovation in isolation. The introduction and improved innovation uptake can generate cost savings to the healthcare

system via the 'offset effect' and lead to better patient outcomes. This is consistent with the goal of healthcare spending in a resource constrained environment, which should be improving the long-run efficiency of the entire health system.

Furthermore, health systems can harness efficiency gains by reducing wasteful duplications and ensuring that resources are spent on interventions providing the highest value for money. However, these enhancements are finite and may not be sufficient to keep up with the demographic and economic trends that will continue to amplify the demand for healthcare in the coming decades. To sustain access to high-quality healthcare in the long term and cope with demand pressure, health systems need to adopt innovation to increase their productivity over time. Further, ensuring a long-term health system's efficiency requires a full scope of innovation, including health technologies and 'complementary' processes and organisational practices that can improve their adoption and full realisation of efficiency gains.

Adoption of new health technologies can improve efficiency and provide value for money by reducing demand in other parts of the health system. The trade-off with static efficiency is not acute when we consider the effect of innovation on the overall healthcare production process and final impact on patients' health outcomes rather than expenditure on innovation in isolation. The goal of healthcare spending should be improving the long-run efficiency of the entire health system. An approach that emphasises system-wide efficiency will enhance value for money overall.

Barriers to the adoption of innovation

When considering the critical role of innovation in the healthcare production process, it is crucial to understand why innovation currently does not translate into more significant efficiency gains for the health system. In this context, we considered the case of health technologies as one type of innovation requiring 'complementary' innovation in terms of adapted healthcare delivery processes and organisational practices for implementation. We proposed a taxonomy of nine barriers that can prevent the adoption of innovative health technologies in health systems. They concern the complete innovation adoption pathway, including regulatory, HTA & pricing, procurement, and clinical implementation phases.

The barriers relate to

- a. intrinsic properties of the innovation that may impede the assessment and adoption of innovation (technology barriers)
- b. the lack of frameworks, regulations, and policies to incentivise, evaluate, and fund healthcare innovation (regulation and policy barriers, value assessment barriers, provider-level funding barriers, and procurement barriers)
- c. the ability of the healthcare system to effectively implement and adopt novel innovation (health system complexity barriers and implementation barriers)
- d. the knowledge and interest of patients and healthcare professionals to adopt novel innovation (readiness barriers and willingness barriers)

Solutions to barriers through stakeholder collaboration

Overcoming barriers to innovation adoption in health systems requires a breadth of solutions and the involvement of different stakeholder groups. We analysed the potential of stakeholder collaboration in overcoming the identified barriers to adopting health system innovation through case studies on



multistakeholder partnerships, including the advanced therapy treatment centres (ATTC) network, Fast-Track Cities London, and the PrEP Think Tank initiative.

Our analysis shows that multistakeholder partnerships can remove silos, enhance knowledge exchange, conduct additional research on technology and implementation, and influence policy. Hence, they should be considered as a solution to overcoming barriers that impede innovation adoption and efficiency improvements.

1. Introduction

Many countries around the world are experiencing strains on their healthcare systems. Even after COVID-19-related demands on health systems have subsided, a significant backlog persists for procedures and consultations (Warner and Zaranko, 2022). Simultaneously, poor economic conditions and rising costs are introducing additional financial strains to public and private payers alike.

Meanwhile, most healthcare systems are subject to significant 'waste' and are accused of inefficiency (Shrank, Rogstad and Parekh, 2019; Berwick and Hackbarth, 2012; Barroy et al., 2021). Around 10% of the European Gross Domestic Product (GDP) is spent on healthcare (OECD/EU, 2018), and estimates suggest that as much as one-fifth of this amount (2% of GDP) is spent on interventions that make no meaningful contribution to health outcomes (OECD, 2017).

Wasteful spending and inefficiencies imply suboptimal patient access to the best treatments, inadequate incentives for innovation, suboptimal health outcomes, and severe cost burdens. As an example of the associated impact, the European Union is estimated to miss out on an additional 1.8 years in life expectancy at birth due to the health system's inefficiencies (Medeiros and Schwierz, 2015).

Various approaches are available to improve healthcare system efficiency and to transform limited resources into valued outcomes such as improvements in health (Smith, 2009). These solutions may include policies to contain and minimise the cost of resources to provide healthcare, 'doing more with less' by maximising the quantity of healthcare delivered with minimum resources, or prioritising resource allocation to healthcare services that provide the highest health gains. This diversity of solutions indirectly points to the complex and multi-layered nature of healthcare system efficiency for which no simple or single solution exists.

Innovation is one available tool to support the improvement of the health system's efficiency. In fact, innovation encompasses multiple inventions and developments that may improve the way healthcare systems operate. For example, in the context of industry, science and technology, innovation has been categorised into three main categories of product, processes and organisational innovation (OECD, 2005). Similarly, innovation in healthcare may include new health technologies, healthcare delivery processes and organisational practices. However, stakeholders' perspectives on the relationship between innovation and healthcare system efficiency vary widely. While some see innovation as a driver of healthcare expenditure growth, others argue that waste and inefficiencies result from the inability to adopt innovations effectively. There is truth to both sides. The complex nature of efficiency and the diversity of connotations assumed by the term innovation allows both synergies and trade-offs between these concepts. As a result of this complexity, efficiency and innovation are often framed as irreconcilable and competing objectives.

1.1. Objectives and methods of this report

In this report, we reconsider the contribution of innovation to efficiency in the context of increasing pressure and constraints of health systems and propose a more positive and collaborative approach to adopting innovation. This involves (1) addressing the misalignment of views that prevent the recognition of complementarities between these concepts, (2) understanding what barriers impede the realisation of greater efficiency gains from innovation, and (3) identifying solutions that may be needed to overcome these barriers.



We address the first objective in Section 2 of this report by reviewing the definitions of efficiency and innovation with their multiple dimensions. Understanding this complexity allows us to reframe the traditionally adversarial debate to an approach that recognises the compatibility of innovation with an efficient transformation of financial resources into health outcomes and with the growth in health system's productivity that is necessary to keep up with increasing healthcare demand over time. This approach emphasises a broader scope of the innovation that is needed to enable efficiency gains. It reaches beyond new health technologies to incorporate 'complementary' processes and organisational approaches required to enable optimal implementation, allocation, and adoption of innovation.

The second objective of this report is addressed in Section 3, where we present a taxonomy of barriers to the adoption and uptake of innovative health technologies. The taxonomy focuses on health technologies as one type of innovation requiring 'complementary' innovation in terms of adapted healthcare delivery processes and organisational practices for implementation. The taxonomy was developed through a targeted review of the published and grey literature – see the Appendix for a detailed description of the literature search strategy. Building on the broad scope of innovation from Section 2, the taxonomy helps to systematically categorise the 'complementary' methods needed to enable efficiency gains at each stage of a health technology adoption pathway.

The third objective of this report is addressed in Section 4, where we explore solutions to barriers to innovation uptake with a focus on stakeholder collaboration. We present case studies on real-world examples of partnerships to understand whether seeking solutions through stakeholder collaboration enhances access to innovation. For each case study, we collected information on the main challenges the partnership addresses, its outcomes, and its stakeholder composition to generate insights on the need for stakeholder collaboration and learnings on best practices.

2. Innovation for health system efficiency

2.1. Definitions and level-setting

Efficiency

Efficiency is a complex, multi-dimensional and multi-level concept. At a high level, a health system's efficiency is a comparison between the observed and optimal values of the output(s) and input(s) in the production of healthcare. Nonetheless, the production of healthcare can be decomposed into a series of transformations which convert resources into healthcare and, ultimately, health (Cylus, Papanicolas and Smith, 2016). Figure 1 provides a schematic of the healthcare production process and its underlying stages using a few (non-exhaustive) examples. This representation highlights the sequential relationship between production stages and suggests that the outputs of any stage may act as inputs for the following one.

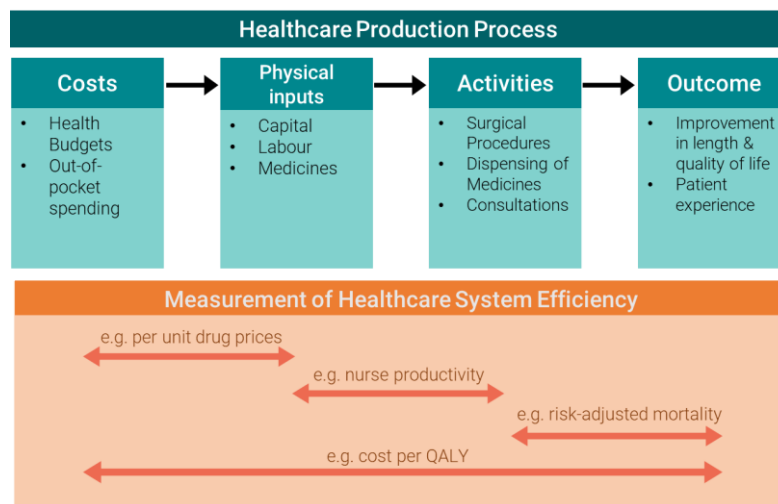


FIGURE 1 SCHEMATIC REPRESENTATION OF THE HEALTHCARE PRODUCTION PROCESS, ADAPTED FROM CYLUS, PAPANICOLAS AND SMITH (2016)

As suggested by the arrows at the bottom of Figure 1, the efficiency of each step of the production process can be analysed separately – such as in the conversion step from costs to physical inputs – or can be evaluated together – such as in the comparison of overall costs and patient outcomes – depending on the most relevant unit of analysis to the matter being addressed. Focusing on a single transformation stage only provides a partial view of the efficiency of the overall healthcare production process from costs to patients' outcomes, i.e. whether 'value for money' is achieved (Smith, 2009).

There are two different ways to analyse the efficiency of the individual stages or the production process as a whole. The first, known as 'technical efficiency', examines whether there is any waste in the production process. Waste may occur when inputs are not minimised to produce a certain output (or output is not maximised given certain inputs). For example, if medicines are not purchased at the

minimum cost, there will be a waste of the health budget; or if more consultants than needed participate in a surgical procedure, there will be a waste in labour inputs.

The second approach looks at the 'allocative efficiency' of production. It examines whether inputs are allocated to the mix of outputs that maximises value (or whether the right mix of inputs is chosen given their price). For example, a surgical procedure performed in a surgical theatre may be allocatively inefficient if it does not maximise patients' health outcomes relative to another use of the theatre's room. Allocative inefficiency could also take place if highly skilled workers (more costly) are employed in activities that could be done by less specialised workers (less costly) (Cylus, Papanicolas and Smith, 2016). Different from technical efficiency, allocative efficiency is concerned with the value of the output produced and the inputs employed.

Efficiency can also be evaluated considering the relationship with the complex external environment in which health systems operate. This environment is determined by contextual factors (e.g., population characteristics) and system constraints (e.g., policy, resource availability) that are in continuous change over time (Cylus, Papanicolas and Smith, 2016). The evolving landscape of the healthcare system means that approaches that maximise efficiency in one year may not be optimal. For example, a type of surgical procedure that requires multiple consultants may cease to be efficient if the demand for the procedure increases over time and capacity constraints do not allow for the expansion of the workforce.

In these circumstances, technical change may be needed to improve the optimal healthcare production process (i.e., its productivity) through the development and adoption of innovation. Technical change can be seen as enabling continued productivity growth in the long run, even after improvements in the other factors have been exhausted. Electronic health records (EHR) are a relevant example of such innovation (Bronson, Doyle and Van Reenen, 2022). EHRs are digitalised medical charts, allowing a more streamlined information gathering and access to patients' medical history. Replacing paper records, EHRs can improve healthcare productivity by reducing duplication in information recording, providing faster access to patient data and supporting better provider communication and coordination in medical decision-making. A recent systematic review found that health information and communication technology, including EHR, positively impacts healthcare productivity (Bronson, Doyle and Van Reenen, 2022).

Innovation

Innovation in healthcare is often associated with biomedical innovation, which describes the research and development which creates scientific knowledge to improve the delivery of human healthcare and the treatment of disease (Swan et al., 2007). This process starts with discoveries in basic science and progresses through stages of safety testing and efficacy trials before a new health technology is deemed ready for clinical use. This definition may include innovative health technologies like medicines, vaccines, diagnostics, digital tools, and medical devices (Swan et al., 2007).

However, the scope of innovation relevant to healthcare is wider than this, and the term can refer to any invention and development of new ideas, methods, and technologies that can improve the way a healthcare system operates (Dearing, 2008; Greenhalgh et al., 2004). Innovative ideas and methods may include improvements such as streamlined care delivery processes or improved management and organisational practices.

Furthermore, innovative processes and organisational practices can often have a 'complementary' role to innovative health technologies in enabling their optimal adoption and implementation in clinical practice. For example, the translation of biomedical innovation into clinical practice may require innovative practices to be adopted in other parts of the health system, such as changing how new medicines are transformed into clinical practice guidelines and then implemented in the

provision of healthcare. Alternatively, the co-development of diagnostic or digital tools alongside a new medicine can enhance their effectiveness and the likelihood of successful adoption.

2.2. The current state of the debate

Determining whether innovation is consistent with health system efficiency is a complex question. Because of the multi-dimensional nature of efficiency and the wide scope of innovation, the answer may depend on the type of efficiency and innovations being considered.

A common view on the relationship between innovation and health system efficacy is the traditional trade-off between 'static' and 'dynamic' efficiency (Tirole, 1988). Static efficiency refers to efficiency during a single period and focuses on the impact of innovation on healthcare expenditure (Camejo, Miraldo and Rutten, 2017). Dynamic efficiency refers to rewarding innovation to stimulate research and development (R&D) for innovation over time (ibid.). In this debate, the notion of innovation typically focuses on pharmaceuticals and other types of health technologies.

With limited resources, it is unavoidable that health systems face trade-offs between spending on providing existing health services and funding the innovation of new technologies. Health systems can be criticised for striking the wrong balance between these objectives (Woods et al., 2021, 2022). For example, a health system could implement a market exclusivity policy during the patent period, which increases efficiency in the long run by stimulating additional R&D but decreases efficiency in the short run by increasing drug prices and pharmaceutical spending.

The trade-off between static and dynamic efficiency is well-studied and has no easy answers (Danzon, Towse and Mestre-Ferrandiz, 2015). However, this theoretical trade-off risks being extrapolated to a view that presents efficiency and uptake of innovation as necessarily competing objectives.

2.3. Revisiting the debate

In this section, we provide two arguments supporting a more positive view about the role of innovation in the health system's efficiency improvements.

Consistently with the definitions provided in section 2.1, both arguments rely on a revised *scope* of innovation, which goes beyond health technologies (i.e., product innovation) and encompasses new ideas, methods, and technologies that improve the way a healthcare system operates. Such a view of innovation in health systems allows for a complementary relationship between types of innovations that may also improve the adoption rate of innovative health technologies. In fact, successful implementation of innovative health technologies in real life often requires additional investment in solutions that change the entire healthcare delivery system. As we further argue below, a lack of such 'complementary' innovations may result in a failure to reach optimal adoption and to realise efficiency improvements for the health system.

Impact of innovation on the healthcare production process

The trade-off between static efficiency and the adoption of innovative health technologies is not as acute when we consider the effect of the latter on the overall healthcare production process rather than expenditure on innovation in isolation. For example, reducing spending on innovative health technologies may increase the efficiency of the single transformation stage from costs to physical inputs. However, this may have knock-on effects on other areas of the production process and,

therefore, fail to maximise value for money in the overall transformation from costs to patients' health outcomes (i.e., via suboptimal allocative efficiency).

The introduction and improved innovation uptake can generate cost savings for the healthcare system as a whole via the 'offset effect' (Zozaya, Alcalá and Galindo, 2019). For example, in the context of pharmaceuticals, one study estimated that an additional dollar spent on medicines reduced spending on USS hospital care by \$3.65 due to lower utilisation of inpatient services (Schöffski, 2004). Similarly, a cost-benefit analysis by Cutler et al. (2007) found that the benefits of antihypertensive medicines in the USS outweighed costs by a ratio of 6:1 (Cutler et al., 2007). More recently, Bell et al. (2022) estimated that COVID-19 vaccine coverage produces significant cost savings, which more than offset the significant costs associated with manufacturing and distribution (Bell et al., 2022).

Zozaya, Alcalá and Galindo (2019) also find that these offset effects are present across several therapeutic areas and countries. For example, they point to Tsiachristas and collaborators, who found that "the use of ten innovative pharmaceuticals leads to a gross saving of 4,900 labour years (3.6%) in [Dutch] hospitals and 2,300 labour years in [Dutch] mental hospitals (7.4%)", most of which comprises of nurse and caregiver time (Tsiachristas et al., 2009). Importantly, Zozaya et al. note significant offset effects related to improved adherence to treatment, which strengthens the case that complementary innovations such as adherence-improving digital tools can help to enable optimal uptake.

The extent to which health systems can identify and capitalise on efficiency-improving innovations depends on the methods they use to evaluate the adoption of new technologies and allocate constrained health budgets, such as country-specific cost containment policies. Cost containment is often used as an umbrella term to refer to several methods to control costs, and it has become widespread in healthcare systems worldwide as a way for payers to manage price inflation and rising demand (Mossialos and Grand, 2019). Whether cost containment creates efficient levels of innovation uptake depends on the design of the policy (Mills and Kanavos, 2020).

Health Technology Assessment (HTA) is one such tool to contain spending on health technologies by evaluating new technologies based on their cost effectiveness if adopted by a health system. When properly applied, HTA can be consistent with efficiency improvements and uptake of efficiency-enhancing (cost-effective) innovations if it assesses system-wide costs and outcomes. Hence, it can identify efficiency-improving innovations that provide value for money across the entire healthcare transformation process, from costs to patient outcomes. While HTAs can be an effective tool to identify efficiency-improving innovation, they are not a complete solution to address all cases of inefficiency and waste. Whether HTA fully encompasses and recognises the efficiency gains of new technologies depends on the chosen methodology, and failing to do so can unduly restrict patient access to treatment. In addition, HTA typically has a limited purview to evaluate health technologies per se, not the complementary practices and processes that should be adopted system-wide to enable efficiency improvements from innovative health technologies. Their remit would not typically extend to spending on other physical inputs or activities like surgery. As a result, even when HTAs set the appropriate cost-effectiveness threshold for adopting new health technologies, HTA alone is insufficient for optimal adaptation of the healthcare system over time.

Technical change from innovation adoption over time

While the COVID-19 pandemic has put significant immediate strains on health systems, other factors are creating medium- and long-term headwinds. Slowing economic growth in many high-income countries has left less budgetary headroom to spend more on health (Hensher et al., 2020). At the same time, demographic and epidemiological trends in many countries, such as an ageing population, mean that demands on health systems will continue to grow into the foreseeable future (De Biase, Dougherty and Lorenzoni, 2022).

In the short- to medium-term, health systems can harness efficiency gains to meet growing demand by reducing wasteful duplications and ensuring that resources are spent on interventions that provide the best value for money in terms of transforming overall health system spending into improvements in patients' health outcomes. While waste is widespread in healthcare systems (OECD/EU, 2018), potential gains from eliminating waste are finite and may not be sufficient to cope with increasing demand pressures, given constraints on existing resources and capacity expansion.

In order to sustainably maintain healthcare access and quality in the long term, health systems need to consider the role of innovation in increasing their production capacity and overcoming increasing demand pressure and resource constraints. While innovation in health technologies may be necessary to respond to broader trends in a sustainable way over time, it may not be sufficient on its own. As explained in the previous section, innovation that improves the healthcare production process occurs in many other forms, including healthcare delivery processes and organisational approaches. Many of these innovations can also have a 'complementary' role to innovative health technologies, thus enabling their optimal use and the realisation of efficiency gains.

3. Barriers to the adoption of innovation

When considering the critical role of innovation in the healthcare production process, it is crucial to understand why innovation currently does not translate into more significant efficiency gains for the health system. Following a targeted review of the published and grey literature – see the Appendix for a detailed description of the literature search strategy), we identified nine barriers that can prevent innovation adoption in health systems (see Table 1).

TABLE 1: DEFINITION OF NINE BARRIERS AND POTENTIAL SOLUTIONS

Barriers	Definitions	Potential solutions
Technology barriers	Barriers concerning intrinsic aspects of the technology/innovation that can impact regulatory assessment and clinical implementation.	<ul style="list-style-type: none"> → Additional research on innovation → New clinical approaches for novel technologies → Adequate up-to-date regulations for informed consent, privacy protection, data sharing, and intellectual property
Regulation and policy barriers	Barriers concerning the existence or lack of national and international regulations and policies that impede evaluation and clinical implementation	<ul style="list-style-type: none"> → Regulations and policies that can incentivise, evaluate, and fund healthcare innovation
Value assessment barriers	Barriers concerning the appropriate demonstration and recognition of the value of innovation that can impede HTA/pricing evaluation	<ul style="list-style-type: none"> → Additional research on innovation → Frameworks that evaluate and capture the complete value of innovation to the healthcare system and society
Provider-level funding barriers	Barriers concerning the lack of financing or appropriate financing models that can impede procurement and clinical implementation	<ul style="list-style-type: none"> → Models and frameworks that are able to capture value and provide funding for all types of innovation
Procurement barriers	Barriers concerning inadequate procurement practices that disadvantage funding of certain innovative health technologies can impede procurement and clinical implementation	<ul style="list-style-type: none"> → Models and frameworks that are able to capture value and procure all types of innovation.
Health system complexity barriers	Barriers concerning organisational infrastructure, workflow and processes in local and national health systems that do not allow innovative health technologies to be implemented.	<ul style="list-style-type: none"> → Implementation strategy at a national and organisational level → Innovation champions → Initiatives for stakeholder collaboration and knowledge sharing
Implementation barriers	Barriers concerning the lack of tools, staff roles, or infrastructure in health systems for the practical implementation and optimal diffusion of innovative health technologies	<ul style="list-style-type: none"> → Implementation strategy at a national and organisational level → Creation of additional health system capacity → Initiatives for stakeholder collaboration and knowledge sharing
Readiness barriers	Barriers concerning the ability of patients and healthcare professionals to engage with the innovation can impede clinical implementation.	<ul style="list-style-type: none"> → Initiatives for stakeholder collaboration and knowledge sharing
Willingness barriers	Barriers concerning the pursuit of patients and healthcare professionals to engage with the innovation that can impede clinical implementation	<ul style="list-style-type: none"> → Initiatives for stakeholder collaboration and knowledge sharing

The barriers concern the complete innovation adoption pathway, including regulatory, HTA & pricing, procurement, and clinical implementation phases. Figure 2 shows a mapping of the barriers against the sequential phases of the innovation adoption pathway where they occur. Many of the barriers are indeed relevant to multiple phases. For example, regulatory and policy barriers are wide in scope and can affect the assessment of the innovation in both the regulatory and HTA & pricing phases, as well as disincentivise its use in clinical activity. Similarly, funding barriers can impact the innovation procurement at the provider organisation level and individual providers in clinical settings.

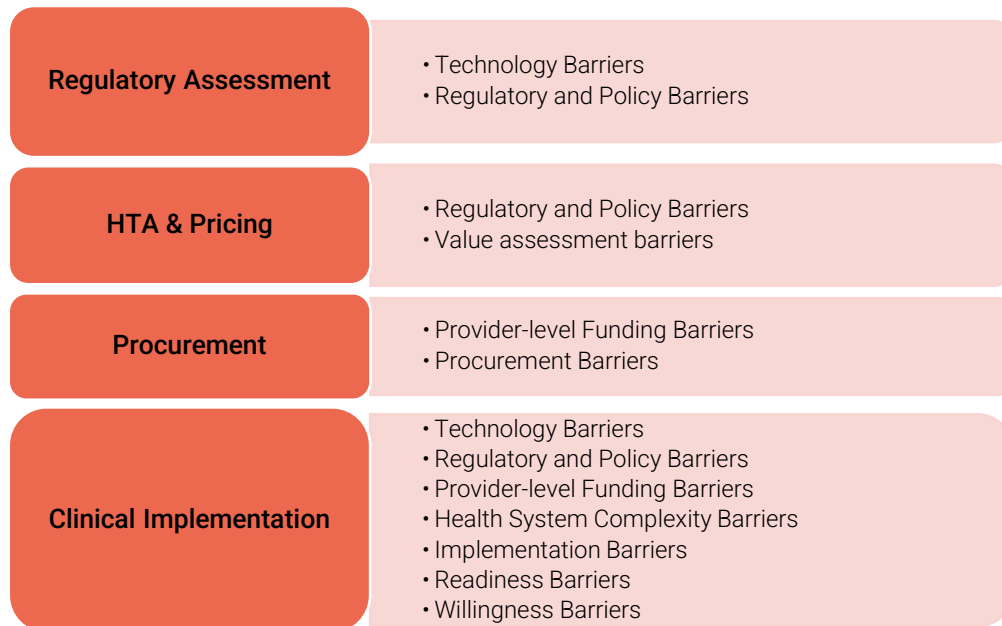


FIGURE 2: THE INNOVATION ADOPTION PATHWAY FROM REGULATORY ASSESSMENT TO CLINICAL IMPLEMENTATION.

Technology barriers

Technology barriers concern intrinsic technological aspects of the innovation that can impact regulatory assessment and clinical implementation. For example, the evidence base that should support the use and adoption of the innovation can be insufficient to resolve concerns regarding safety and efficacy (Kelly et al., 2019; Zakerabasali et al., 2021). Furthermore, concerns about the intervention's usability can also be challenging for clinical adoption (Palacholla et al., 2019; Makin D. and Pacheco L., 2019). Finally, novel technologies like artificial intelligence, genomics, or personalised medicine have evoked ethical concerns and issues regarding intellectual property, data ownership, and privacy, which can also ultimately have an impact on implementation (Ormond K.E. and Cho M.K., 2014; Palacholla et al., 2019). Potential solutions to overcome technology barriers include additional research on innovation, developing new clinical approaches for novel technologies, and regulations for informed consent, privacy protection, data sharing, and intellectual property.

Regulation and policy barriers

Regulation and policy barriers concern the absence of policies and regulations that may impede clinical implementation, regulatory assessment, and HTA/pricing assessment. For example, the lack of a national policy agenda on healthcare goals and incentivising the development and adoption of innovation can be considered a barrier (Zakerabasali et al., 2021). Furthermore, some technological areas can lack an adequate regulatory framework to assess the safety and effectiveness of innovation, which will ultimately affect the evidence-based uptake of innovation (Kelly et al., 2019; Zakerabasali et al., 2021). Additionally, cost-containment policies such as global budget setting and

focus on cost-saving over innovation can affect adoption (Mills and Kanavos, 2020). Finally, the absence of statutory guidance (e.g., on patient data sharing) could disincentivise the use of certain innovations (Zakerabasali et al., 2021; Schito M. et al., 2012). Developing regulations and policies that can incentivise, evaluate, and fund healthcare innovation are potential solutions to overcome regulation and policy barriers.

Value assessment barriers

Value assessment barriers concern the lack of appropriate value assessment of innovative health technologies, which may impact the HTA/pricing evaluation and subsequent uptake of innovation. For example, there can be an absence of adequate methods or frameworks for value assessment in certain technological specialities (Makin D. and Pacheco L., 2019; Schito M. et al., 2012). It can be complex to identify, measure, and quantify the “true” value to society in a number of technologies like antibacterials (Brassel, Al Taie and Steuten, 2023), vaccines (Luyten et al., 2020), or gene-therapies (Coyle et al., 2020). Even when there exist appropriate methodology, there can also be issues around the availability of data from randomised controlled trials (RCTs) or real-world evidence (RWE) to validate the value of the innovation, especially for those innovations with non-traditional forms of value (e.g., with significant public health impact) (Palacholla et al., 2019). The development of frameworks that can evaluate and capture the complete value of innovation to the healthcare system and society is a potential solution to overcome value assessment barriers.

Provider-level funding barriers

Provider-level funding barriers concern the lack of financing models, which may discourage the funding and uptake of efficiency-improving innovation at the stage of procurement and translation to clinical activity. For example, budget siloes within healthcare systems and provider organisations can hamper investment in innovation (Sachs, 2020). Furthermore, budgets may be set according to historical spending on healthcare inputs while ignoring the impact on efficiency (Barroy et al., 2021). For certain innovative health technologies, such as digital therapeutics or advanced therapies, a lack of provider-level funding for activities complementary to adoption (e.g. education) may also be a problem (Williams et al., 2020; Gardner, Webster and Barry, 2018). Developing better models and frameworks to fund innovation are potential solutions to overcome provider-level funding barriers. For example, financing models could better align incentives or pool budgets to ensure that funding follows the patient in the health production cycle or rewards efficiency gains through financial incentives.

Procurement barriers

Procurement barriers concern policies and contracts that do not accommodate innovative technologies with more long-term benefits and can impact procurement and clinical adoption of innovation. These policies are often based on market competition and short-term cost containment. For example, bulk contracts between manufacturers and providers at competitive rates effectively price out smaller manufacturers and their innovations (Liu, Kao Yang and Hsieh, 2011; MacNeil et al., 2019). Furthermore, there can also be a lack of formulary (e.g., for non-therapeutics or digital products), which may prevent providers from being able to justify the extra budget required if no national-level reimbursement is available (Williams et al., 2020). Developing better models or frameworks to fund innovation are potential solutions to overcome procurement barriers. For example, procurement practices could be amended to consider risk-sharing, negotiation, and value-based pricing.

Health system complexity barrier

Health system complexity barriers concern organisational infrastructure, workflow, and processes in local and national health systems that can impact the clinical implementation of innovative health technologies. For example, the complex nature of novel innovations may not fit into existing health

system workflow (Zakerabasali et al., 2021; Palacholla et al., 2019). Additionally, provider organisational infrastructure may not be optimal for adopting innovation, i.e., due to organisational silos (MacNeil et al., 2019; Greenhalgh et al., 2017). Health system complexity barriers can be further exacerbated by the lack of a comprehensive implementation plan outlining roles and responsibilities assigned to providers and healthcare professionals for the successful diffusion of innovation (Williams et al., 2020; Palacholla et al., 2019; Desveaux L. et al., 2019). Furthermore, it is not always clear how to champion healthcare technologies in a complex healthcare system without clear leadership and ownership over innovation (Palacholla et al., 2019; Chaudoir, Dugan and Barr, 2013). Developing an implementation strategy at the organisational level is a potential solution to overcome health system complexity barriers. Such implementation strategy could include an integration plan that states how innovations can be optimally adopted and integrated, the embracing of innovation champions, and initiatives for senior clinicians and organisational leadership to collaborate and share knowledge.

Implementation barriers

Implementation barriers concern the lack of tools, staff roles, staff expertise, or infrastructure in health systems for the clinical implementation of innovative health technologies (MacNeil et al., 2019). Developing an integration/implementation plan and creating additional health system capacity is a potential solution to overcome implementation barriers.

Readiness barriers

Readiness barriers can impede the clinical implementation and uptake of innovation because of the ability of patients and healthcare professionals to engage with the innovation. Patient-specific factors include demographic factors such as age, learning difficulties, language, or socioeconomic background (Makin D. and Pacheco L., 2019). Healthcare professionals may lack the expertise required to promote innovation to patients or require training that they are too time-poor to undertake to feel comfortable enough to prescribe the new technology to patients (Canedo et al., 2020). Stakeholder collaboration or engagement are potential solutions to overcome readiness barriers, e.g., scientifically-backed patient education and training for healthcare professionals on relevant skills to enable them to appraise, adopt and use the innovations safely within their practice.

Willingness barriers

Willingness barriers can impede the clinical implementation and uptake of innovation because of the pursuit of patients and healthcare providers to engage with the innovation. Patients may opt not to use the novel technology due to anxiety over perceived safety issues (e.g., vaccines) or the social stigma associated with a disease (e.g., HIV) (Medlinskiene K. et al., 2021; Grigolon and Lasio, 2021). Healthcare professionals can also be reluctant to adopt new technologies due to fears that specific jobs will become obsolete, their beliefs about the innovation, their age and clinical expertise, and 'innovation fatigue' (Keating et al., 2020). 'Innovation fatigue' can arise due to the high amount of innovation clinicians are asked to incorporate into clinical practice, leading to lower engagement levels. Furthermore, healthcare professionals may be reluctant to adopt new technologies without significant testing for fear of clinical malpractice by inadvertently bringing greater harm to patients (Anderson T.S. et al., 2018; Croff et al., 2019). Stakeholder collaboration or engagement are potential solutions to overcome willingness barriers, e.g., education for patients or pilot schemes to build up trust with patients and clinicians.

4. Solutions to barriers through stakeholder collaboration

Overcoming barriers that impede innovation adoption and efficiency gains may require a breadth of solutions and expertise. The involvement of different stakeholder groups may provide the necessary diversity of perspectives, expertise, and solutions. We analysed the potential of stakeholder collaboration in overcoming barriers to innovation adoption through three case studies, which included literature reviews and interviews with experts from the partnerships – see the Appendix for a description of the search and review methodology.

The selected partnership programmes for the case studies were the Advanced Therapy Treatment Centres (ATTC) network, Fast-Track Cities London, and the PrEP Think Tank initiative. The case studies focused on the area of advanced therapies, which encompass relatively novel pharmaceutical innovations that require special considerations for health system adoption due to their technological properties, value assessment and funding, and challenges for healthcare systems to integrate into available structures (Marsden et al., 2017; Mikhael, Fowler and Shah, 2022; Kamal-Bahl et al., 2022; Jommi et al., 2022). Additionally, we explored the area of HIV, which is characterised by challenges for the adoption of diagnostic, preventative, and treatment innovations amid the fragmentation of healthcare (and social care) systems for procurement and clinical implementation and the difficulty of awareness and readiness of the public, patients, and healthcare professionals, especially regarding novel innovations in testing and pre-exposure prophylaxis (PrEP) (ECDC, 2023; Zablotska and O'Connor, 2017; Nichols and van der Valk, 2021; Cooper, Rosenblatt and Gulick, 2022).

4.1. Case study 1: Advanced therapy treatment centres network

Settings and structure: The advanced therapy treatment centres (ATTC) network is a publicly funded multistakeholder partnership in the UK established in 2018. ATTC is led by three clinical NHS networks, and the partnership involves academia, NHS, and industry (Whitaker, 2022; Advanced Therapy Treatment Centres, March 22). The work was supported by an “Industry Advisory Board”, which included advanced therapy manufacturers, clinical research organisations, logistics providers, digital solution developers, NHS trusts, and government bodies, including regulators. They receive support from the Cell and Gene Therapy Catapult for coordination and driving the UK policy agenda. A “distributed leadership” structure meant all partners could lead on work packages.

Aims and reason for partnership: ATTC was initiated to foster the adoption of advanced therapies by the NHS. While the relationship between pharmaceutical manufacturers and health systems is generally transactional, the funder and stakeholder partnership identified a need for this relationship to be more collaborative for advanced therapeutics to co-develop novel approaches for logistics and distribution, procurement, manufacturing, and implementation (Whitaker, 2022; Advanced Therapy Treatment Centres, March 22).

TABLE 2: SUMMARY OF ADVANCED THERAPY TREATMENT CENTRES NETWORK

Advanced Therapy Treatment Centres									
Geography	UK								
Settings	Advanced therapies				Disease agnostic				
Stakeholder composition	1. Academia 2. NHS 3. Industry								
Stage of progress	Set-Up ●	Milestones ●			Outcomes ●		Finalised ○		
Aim	Adoption of advanced therapies in the National Health Service								
Challenge	Novel characteristics of the technology require new approaches to health system adoption.								
Barriers targeted *	1 ✓	2 ✓	3 ✓	4 ✓	5 ✓	6 ✓	7 ✓	8 ✓	9 ✓
Reasons for partnership	Partnership enables the co-creation of new approaches								
Activities	<ul style="list-style-type: none"> Regional pilot projects to address challenges and inform nationwide adoption. Production and dissemination of guidance, toolkits, and educational programmes Influencing of national policy agenda 								

* 1: technology barriers, 2: regulation and policy barriers, 3: value assessment barriers, 4: provider-level funding barriers, 5: procurement barriers, 6: health system complexity barriers, 7: implementation barriers, 8: willingness barriers, 9: readiness barriers;

Targeted barriers and partnership activities:

- Technology, regulatory and policy, procurement practices, and implementation barriers: gene and cell therapies differ from more traditional medicines in that they require special considerations for transport, storage and delivery of the medicine. In addition, they are often manufactured from patient material, which introduces complexity regarding manufacturing and logistics. The partnership conducted various projects focussing on solving the problems of shipping, logistics, supply chain traceability, and procurement of advanced therapies in the NHS (Advanced Therapy Treatment Centres, 2023a). ATTC has also facilitated industry standards harmonisation regarding the harvesting of patient material that is used to produce personalised advanced medicines. They have compiled all their experiences and advice into a Manufacturing and Preparation Toolkit (Advanced Therapy Treatment Centres, 2023f).
- Value assessment, provider-level funding, procurement practice, and health system complexity barriers: Advanced therapies can be expensive, it can be challenging to assess their value, and the NHS is fragmented when it comes to procurement and adoption of advanced therapies. ATTC has developed an HTA assessment guide (Advanced Therapy Treatment Centres, 2023e) and an NHS readiness guide (Advanced Therapy Treatment Centres, 2023g) and has also worked on unified procurement systems (Advanced Therapy Treatment Centres, 2023d).
- Health system complexity, implementation, willingness, and readiness barriers: Advanced therapies require institutional readiness, healthcare professional training and patient awareness and engagement for successful adoption. ATTC has created and disseminated guidance documents, toolkits, and educational programmes for healthcare professionals and patients (Whitaker, 2022; Wotherspoon et al., 2021; Advanced Therapy Treatment Centres, 2022; Pillai, Davies and Thistlethwaite, 2020; Advanced Therapy Treatment Centres, 2023b, h; c).

Overall, ATTC designed and conducted regional pilot projects to address challenges and inform nationwide adoption. It also produced and disseminated guidance, toolkits, and educational programmes to support the policy agenda. As a result of the initiatives undertaken by the partnership, ATTC grew into a recognised and neutral party of expertise that allows for collaboration between industry partners and public sector stakeholders, which has attracted international recognition. They have successfully supported the commercialisation and clinical adoption of advanced therapies in the UK and increased the attractiveness for manufacturers to set up in the UK (Advanced Therapy Treatment Centres, 2022). In addition, the partnership contributed to knowledge sharing amongst industry partners, creating a pre-competitive forum for industrial cooperation (Whitaker, 2022; Advanced Therapy Treatment Centres, 2022; Medcalf, 2021).

4.2. Case study 2: Fast-Track Cities London

Settings and structure: Fast-Track Cities London (FTCL) is a publicly funded multistakeholder partnership in the UK established in 2018. FTCL involves the London Mayor, London Councils, the UK Health Security Agency, NHS England, clinical experts, people living with HIV, community organisations, and experts from the voluntary sector. FTCL brings together all the key actors to overcome health and social care system fragmentation and involve the community to improve health and quality of life of people living with HIV. FTCL has dedicated staff that acts as infrastructure and links between the different partners. Ensuring the engagement and involvement of all stakeholders and putting people living with HIV at the centre of the initiative within the partnership is essential for fulfilling the partnership’s goals (Fast-Track Cities London, 2023a; Office of Health Economics, 2023).

Aims and reason for partnership: FTCL operates in the therapeutic area of HIV as a member of the global Fast-Track Cities program (Duncombe, Ravishankar and Zuniga, 2019). It aims for zero new HIV infections, zero deaths, and zero stigma before 2030 (Fast-Track Cities London, 2023a). FTCL is technology agnostic, i.e., the focus is not on adopting a specific technology. Their focus is on optimising the prevention and treatment environment around HIV. The health and social care system in London are fragmented and the stakeholder partnership identified a specific need to overcome these structural barriers to achieve the zero target goals. The objective is to take an outcomes-based approach using data and intelligence in the widest sense. They aim to be greater than the sum of the parts and avoid duplication of work.

Targeted barriers and partnership activities:

- Procurement practice, health system complexity, and implementation barriers: There is no single seamless HIV patient pathway due to a fragmentation of health and social care in England regarding responsibilities, funding, and procurement for HIV prevention, treatment, and care. FTCL supports novel and pilot initiatives that foster a more integrated HIV care pathway across the systems, like “Consultant Connect,” which connects general practitioners with HIV consultants to provide improved patient care. Additionally, a pilot for HIV primary care champions across London has recently been initiated (Fast-Track Cities London, 2023b).
- Procurement practice, health system complexity, implementation, willingness, and readiness barriers: HIV remains a stigmatising condition that disproportionately affects already marginalised communities, making health equity a key driver. There are ongoing challenges in ensuring that diagnostic testing and long term treatment for HIV are available and accessible to ensure people living with HIV can access optimal treatment and care. FTCL has supported novel initiatives aimed to increase HIV testing e.g., opt-out testing in hospitals, testing initiative to put testing within the reach of high-risk minority populations, and through the support of the voluntary sector working in the community (Fast-Track Cities London, 2023b). In this context, the partnership used the COVID-19 housing initiatives that were put in place in London during the first

wave of the pandemic to implement the offer of HIV testing to without homes who were housed in hotels during the pandemic.

- **Willingness and readiness barriers:** London has the highest prevalence and burden in relation to HIV in the UK. FTCL have created city-specific long-term improvement programmes to tackle stigma and improve the quality of life of HIV patients by involving a wide range of providers across the voluntary and charitable sector (Fast-Track Cities London, 2023b).

Overall, FTCL created a unique forum that brings everyone working and living with HIV together to work on challenges and solutions within London’s overall HIV response. FTCL led an asset and gap analysis of the HIV sector in London and engaged various organisations to co-design city-specific improvement programmes involving both statutory and voluntary sectors. They were able to secure an investment of £6 million between 2020 and 2023 to deliver their objectives.

TABLE 3 SUMMARY OF FAST-TRACK CITIES LONDON

Fast-Track Cities London									
Geography	London (UK.)								
Setting	Technology agnostic					HIV			
Stakeholder composition	<ol style="list-style-type: none"> 1. NHS (England/London) 2. Public health bodies 3. The Mayor of London & local authorities 4. Clinicians 5. People living with HIV 6. Voluntary sector organisations 								
Stage of progress	Set-Up ●	Milestones ●			Outcomes ○		Finalised ○		
Aim	Zero new HIV infections, zero preventable HIV related deaths, zero HIV associated stigma, and best quality of life for Londoners living with HIV by 2030								
Challenge	Fragmented care and procurement models impede health system adoption								
Barriers targeted *	1	2	3	4	5 ✓	6 ✓	7 ✓	8 ✓	9 ✓
Reasons for partnership	Partnership brings together all actors to overcome health system fragmentation and involve the community								
Activities	<ul style="list-style-type: none"> • Leading across boundaries to engage leaders and key stakeholders • Advocating for London • Creation of city-specific programmes to address HIV related stigma and quality of life • Communication about HIV in London and the sharing of best practices and guidance 								

* 1: technology barriers, 2: regulation and policy barriers, 3: value assessment barriers, 4: provider-level funding barriers, 5: procurement barriers, 6: health system complexity barriers, 7: implementation barriers, 8: willingness barriers, 9: readiness barriers;

4.3. Case study 3: PrEP Think Tank

Settings and structure: PrEP Think Tank (PTT) was a charity-funded multistakeholder partnership in Spain established in 2018. PTT involved experts from non-governmental organisations and representatives of scientific societies in the field of HIV with funding from the Spanish Interdisciplinary AIDS Society (SEISIDA). Additionally, the pharmaceutical industry supported some studies by the partnership. PTT was formed as an "ethical lobby" group to identify barriers to PrEP implementation, like health system fragmentation and financing, and propose advocacy measures (HIV Outcomes Initiative, 2023; Garcia Sousa, 2019).

Aims and reason for partnership: PTT was created as an "ethical lobby group" to foster the implementation and adoption of PrEP in Spain (HIV Outcomes Initiative, 2023). They co-created evidence on the barriers to implementation and proposed advocacy measures. After the Ministry of Health approved public funding for pre-exposure prophylaxis within the health system in 2019, PTT continued to promote and monitor PrEP implementation in Spain.

TABLE 4 SUMMARY OF PReP THINK TANK

PrEP Think Tank									
Geography	Spain								
Setting	PrEP				HIV				
Stakeholder composition	1. HIV Charities 2. HIV Clinical Experts 3. Public Health Experts								
Stage of progress	Set-Up	Milestones			Outcomes		Finalised		
	●	●			●		●		
Aim	Adoption of PrEP in Spain								
Challenge	No national funding and fragmented healthcare system impede health system adoption								
Barriers targeted *	1	2	3	4	5	6	7	8	9
			✓	✓	✓	✓	✓	✓	✓
Reasons for partnership	"Ethical lobby" group to identify barriers to PrEP implementation and propose advocacy measures.								
Activities	<ul style="list-style-type: none"> Analysis of the situation and creating evidence on barriers Advocating for and supporting PrEP implementation Creating visibility and awareness 								

* 1: technology barriers, 2: regulation and policy barriers, 3: value assessment barriers, 4: provider-level funding barriers, 5: procurement barriers, 6: health system complexity barriers, 7: implementation barriers, 8: willingness barriers, 9: readiness barriers;

Targeted barriers and partnership activities:

- Value assessment, provider-level funding, and procurement practice barriers: PrEP was not funded by the National Health Service. PTT published a resolution asking for the implementation of PrEP in Spain, which was supported by all political groups and led to public funding for pre-exposure prophylaxis within the Spanish health system in 2019 (HIV Outcomes Initiative, 2023).
- Procurement practice, health system complexity, implementation, willingness, and readiness barriers: PrEP was only available via hospital pharmacies and no other health system settings.

Furthermore, implementation is hampered amid the fragmentation of the healthcare system across autonomous regions in Spain. PPT fostered the cooperation between scientists to provide and publish analyses on the awareness of patients, analyses on the barriers to the implementation of PrEP in Spain, and guides for PrEP implementation (Iniesta et al., 2021, 2018; Mir, Mazarío and Coll, 2020).

4.4. Learnings on best practice and partnerships' benefits

Based on the evidence from the case studies and interviews, multistakeholder partnerships should be considered as a solution to overcoming barriers that impede optimal innovation adoption and efficiency improvements. Their role is key when there are divergences in objectives/ incentives among different stakeholders or when there is a need for coordination and pooling of knowledge amongst stakeholders. For example, partnerships can be instrumental in planning, coordinating, and funding additional research on the technology and its barriers to implementation. They are also successful at removing silos and sharing knowledge between stakeholders who might otherwise not cooperate. Additionally, when it comes to policy and decision-making, multistakeholder partnerships may have a higher authority and ability to influence policy than individual stakeholder groups. Partnerships require hard work and adequate funding and ideally should encompass a wide range of stakeholders to be most effective.

For best practice, partnerships should involve multiple stakeholders with diverse backgrounds who strongly believe in the technology. A similar partnership composition can help foster a shared understanding of different perspectives while creating common goals. It was also suggested that members create additional capacity on top of their day jobs and commit to work in a "true" partnership.

For a successful partnership's implementation, all partners should align on principles, deliverables, timelines and boundaries and police them together. Most importantly, all partners should benefit from the collaboration. In our case studies, some partnerships implemented expertise-driven leadership, allowing different members to lead specific activities or initiatives. This model was found to improve ownership and engagement. Partnerships are not always needed, but sometimes joint-up working outside a partnership can be useful.

Sufficient long-term funding is needed to have a stable fundament for the partnership's work. In fact, partnerships might require dedicated management and resources. Hence, having an organisational structure with dedicated staff may be helpful to organise, monitor, and coordinate the partnership's work. If it is challenging to pull sufficient resources, joint-up working outside of a partnership could be considered without the need to establish a partnership.

5. Conclusions & Recommendations

In this report, we have reconsidered the contribution of innovation to health system efficiency in the context of increasing pressures and constraints. We have proposed a new paradigm that recognises innovation and efficiency as complex, multi-dimensional, and often complementary concepts. This has allowed us to make a case that the diffusion of innovation, in terms of innovative health technologies and practices for healthcare delivery and organisation, is compatible with and, often, necessary for improved health system efficiency. As such, the two concepts do not have to be competing objectives as more traditionally framed. We also developed a taxonomy of barriers to adopting and using innovative health technologies. The taxonomy can be seen as an attempt to categorise the missing 'complementary' methods for implementing, allocating, and adopting new health technologies to enable optimised innovation uptake and unlock efficiency gains. Finally, we explored whether seeking solutions to these barriers through approaches based on multistakeholder collaboration effectively enhances access to innovation.

Below, we outline the key messages of the report and accompanying recommendations.

Any analysis of the efficiency of a production process in healthcare should consider the impact of innovation on the efficiency of the health system as a whole as well as the broader societal and temporal environment in which it operates.

Innovation of new health technologies can improve efficiency and provide value for money by reducing demand for activities in other parts of the health system. The trade-off with static efficiency is not as acute when we consider the effect of innovation on the overall healthcare production process (i.e. the final impact on patients' health outcomes) rather than expenditure on innovation in isolation. The goal of healthcare spending should be improving the long-run efficiency of the entire health system. An approach that emphasises system-wide efficiency will enhance value for money overall.

Furthermore, health systems can harness efficiency gains by reducing wasteful duplications and ensuring that resources are spent on high-value interventions. However, these gains are finite and may not be sufficient to cope with demographic and economic trends, which will continue to increase demand for healthcare in the coming decades. To maintain healthcare access, quality and sustainability in the long term, health systems must adopt innovation to increase their productivity over time.

Recognising these complementarities between innovation and efficiency can help focus attention on the impact of innovation uptake on the value for money provided by health systems overall. Stakeholders must collectively realise that no one wins when efficiency-enhancing technologies are not adopted and made accessible to patients.

To ensure that new technologies are adopted and translated into clinical practice, complementary innovations, improvements in healthcare system processes, financing models, and delivery should be in place.

The 'scope' of necessary innovation to improve health system efficiency must reach beyond developing new pharmaceuticals to incorporate innovative practices for implementation, allocation, and adoption. A lack of such 'complementary' innovations may imply a failure to reach optimal adoption and to realise efficiency improvements for the health system.

We can reconcile this idea with the taxonomy of barriers to innovation uptake, which shows how innovative health technologies are insufficient to drive efficiency improvements.

Barriers to the optimal uptake of innovation are spread across different stages of the innovation adoption pathway, suggesting a role for many healthcare system stakeholders in overcoming them.

We identified nine barriers that affect the innovation adoption pathway, including regulatory, HTA & pricing, procurement, and clinical implementation phases. The barriers relate to 1) intrinsic properties of the innovation (e.g., technology barriers), 2) the health system's ability to fund or integrate the innovation, and 3) the clinicians' and patients' readiness and willingness to engage with the innovation. The widespread range of barriers implies that optimal uptake of new health technologies requires a broader approach to health system innovation – which is consistent with our recommendation on the need for a broad understanding of innovation that is necessary for efficiency improvements. Consequently, overcoming barriers to innovation adoption will require the contribution, and ideally collaboration, from a wide spectrum of healthcare system stakeholders who can influence change.

A collaborative approach to health system innovation can create an innovation-friendly environment and increase the uptake of new health technologies for health system productivity and improvement.

Several multistakeholder partnerships have been implemented in the real world to address barriers to innovation adoption. Our analysis of multistakeholder collaborations was limited to three partnerships in advanced therapies and HIV. While these conclusions are not fully generalisable, we observed that partnerships can:

- Help overcome barriers to innovation uptake by removing silos and sharing knowledge between stakeholders, funding and conducting additional research on the technology and its barriers to implementation, informing the implementation/adoption pathway through their activities, and influencing policy.
- Be considered when solutions require the pooling of knowledge across different stakeholders, when bringing innovation to patients safely and effectively requires coordination among different stakeholders, or when helping to overcome divergences in objectives/incentives among various stakeholders.
- Be successfully created and implemented by involving partners with belief and commitment to the programme's objectives, receiving sufficient operational capacity and funding, and operating on a straightforward programme of collaboration and objectives, ultimately benefitting all partners.

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7. Appendix

7.1. Methodology for identification of barriers

We undertook a literature review to inform the development of a taxonomy of barriers that prevent innovation adoption in health systems. A targeted literature review was conducted in EMBASE and complemented with targeted searches in Google Scholar. The EMBASE search (Table 5, search terms restricted to the title fields) yielded 56 records, and the Google Scholar search an additional 25. The abstracts of the records were screened to include publications relevant to high-income settings. We excluded publications on lifestyle interventions (e.g. exercise, smoking cessation) which were considered beyond the relevant definition of health technology and whose implementation is sometimes beyond the sole remit of healthcare systems (e.g. education delivered through online accessible communication channels). A cutoff date of 2010 was used to capture the most recent publications and relevant debate concerning the adoption of innovative health technologies in health systems. A total of 23 publications were selected for full-text review and inclusion in the targeted literature review.

TABLE 4 EMBASE SERACH TERMS FOR LITERATURE ON BARRIERS

Category	Search Terms
Intervention ('technology')	Digital health OR digital health technolog* OR digital therapeutics OR ehealth OR electronic health OR pharmaceuticals OR devices OR digital therapeutics OR diagnostics OR drugs OR drug OR medical solutions OR intervention* OR medicine* OR medical technolog* OR medical therapy OR healthcare technology OR Health tech OR personalised medicine OR telemedicine OR Telehealth OR pharmaceutical*
Innovative	Cutting edge OR innovation OR innovative OR AI OR technological advance* OR new OR innovate* OR novel OR advance OR inventive
Stage of drug development	Implementation OR adoption OR uptake OR clinical practice OR acceptance OR utilisation OR diffusion OR utilisation
Barriers	Challenge* OR barrier* OR blocker* OR prevent* OR inhibit* OR Obstacle* OR problem* OR issue* OR impeded* OR limit* OR hinder* OR restrict* OR obstruct*

7.2. Methodology for case studies on partnerships

We conducted three case studies based on a comprehensive literature search and interviews with partnerships in May 2023.

Case studies were identified through the internet and grey literature search. They were selected based on 1) relevance to the barriers addressed, 2) stage of progress, 3) availability of contact point for interviews, and 4) availability of published information.



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- The costs of treating, or failing to treat, specific diseases and conditions
- Drivers of, and incentives for, the uptake of pharmaceuticals and prescription medicines
- Competition and incentives for improving the quality and efficiency of health care
- Incentives, disincentives, regulation and the costs of R&D for pharmaceuticals and innovation in medicine
- Capturing preferences using patient-reported outcomes measures (PROMs) and time trade-off (TTO) methodology
- Roles of the private and charity sectors in health care and research
- Health and health care statistics