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Contributors
Introduction

Leaders in policy, business and healthcare, while receptive to the potential of precision medicine applications, often struggle to find a consistent and standardized approach for evaluating their health system’s readiness for the practical implementation and integration of precision medicine. Stakeholders in emerging economies, in particular, have requested a guide that includes examples and access to partner communities as they think about how to strategically grow the precision medicine capabilities of their healthcare ecosystems.

Aligned with this need, the World Economic Forum Platform for Shaping the Future of Health and Healthcare launched the Precision Medicine Readiness Principles, a thought leadership project that will begin with developing a living document from which policy-makers and others looking to advance precision medicine in their countries can find benchmarks for readiness. Precision medicine offers a more personalized and targeted approach to preventing disease and screening, diagnosing, treating and curing patients by considering genetic and environmental factors as well as their lifestyles.

The Readiness Principles will be developed as a roadmap that identifies distinctive precision medicine capabilities denoting three tiers of readiness and five categories of criteria for progress. Informed by the US National Academy of Medicine’s discussion paper Realizing the Full Potential of Precision Medicine in Health and Health Care, the roadmap will provide a set of exemplary capabilities by which to evaluate a country’s health ecosystem, inform policy and investment, and guide sustainable health ecosystem development.

One of the five categories of criteria for progress is the precision medicine innovation loop. The innovation loop category describes the how of innovation: the key capabilities needed to systematically drive precision medicine innovation and its development process. Specifically, an innovation loop presents the functions of business producers, resource funders and regulatory governors in incentivizing, establishing and building a continuously growing marketplace for precision medicine technologies. These necessary capabilities of a country’s precision medicine innovation loop are organized into four categories for the purposes of this resource guide: (1) Innovation governance; (2) Innovation financing; (3) Community and partnerships; and (4) Workforce and infrastructure.

This guide offers an overview of current thought and practice on the development and financing of innovative ecosystems from leading institutions and secondary sources. Relevant terms are described in each section, offering the reader both an introduction to the fundamental components of this field and a primer for the analysis that will be delivered through a white paper on the same topic.

Neither exhaustive nor static, this guide is intended as a dynamic, living document to which contributions are welcome. Case studies from governments or organizations that represent effective or new techniques in the categories presented are particularly beneficial. Please send your contributions and thoughts to Elissa.Prichep@weforum.org.
Innovation governance

Regulatory processes and national guidelines to facilitate precision medicine marketplace development
1.1 Open science

Contrasted with the more proprietary, innovation ownership models based on trade secrecy and competition, open science as defined by the Organisation for Economic Co-operation and Development (OECD) Making Open Science a Reality paper is a movement enabled by information and communication technologies towards transparent data sharing, rapid knowledge dissemination and broad research accessibility. While open science manifests in various initiatives (e.g. open journals, centrally accessible databases and international scientific research consortiums), the Government of Canada’s Roadmap for Open Science outlines its five core principles: people, transparency, inclusiveness, collaboration and sustainability. The practice of open science principles can incentivize precision medicine innovation by: (1) changing how genomics-related research is conducted and disseminated; and (2) reducing the otherwise high costs and uncertainty of precision medicine if actors were to invest resources in genomics research and development (R&D) as standalone initiatives. Open science principles in action provide academics with accessible, more harmonized methods of retrieving, analysing and validating genomic data as shared knowledge to be distributed and benchmarked by other researchers. Similarly, these precompetitive models avoid duplicate work and instead facilitate the effective allocation of research and translation projects among the collaborating researchers, laboratories and funders.

While this resource guide does not discuss the contended nature of open science implementation, it emphasizes the use of the GO FAIR Guiding Principles. Developed by GO FAIR (Findability, Accessibility, Interoperability and Reuse of digital assets) founding members France, Germany and the Netherlands, the GO FAIR initiative created these data principles for scientific data management and stewardship. Designed with the intention of moving towards data-driven and machine-assisted open science, the FAIR principles ultimately aim to enable researchers to find, access, interoperate and reuse each other’s research objects. The Global Alliance for Genomics and Health (GA4GH) Framework for Responsible Sharing of Genomic and Health-Related Data discusses data access that includes data transfer or exchange between data users or where data is made available to secondary researchers, either openly or under specified access conditions. The framework is based on 10 core elements, which include transparency, accountability, engagement, data quality and security, risk-benefit analysis and sustainability.

1.2 Intellectual property ownership and protection

The Compendium of OECD Work on Intellectual Property addresses the role of intellectual property (IP) protections as a driver of innovation and competition. IP policy designed for innovation plays a significant role in knowledge-intensive industries such as biopharmaceutical products from genomics by functioning as a tool to provide temporary economic incentives for patentees to own exclusive rights to a discovery’s commercialization. As such, discovery ownership and protection manifested through secure, enforced IP protection laws incentivize precision medicine innovation for researchers in academic and industry settings alike. Importantly, IP policy implementation should also aim to de-risk its exploitation that may otherwise result in inaccessible high pricing or restrictive access (e.g. authors can refuse access to their works by others or impose burdensome licensing fees and conditions). Hence, while IP ownership can incentivize innovation, any such policy must also include exclusive right expires such that all knowledge associated with the invention thereafter forms part of the public domain for common use and further traction towards new innovations.

Its incentive effects, however, may be limited or non-existent in developing countries, particularly due to the low and uncertain market demand for precision medicine. The World Health Organization (WHO) Commission on Intellectual Property Rights, Innovation and Public Health report Public health innovation and intellectual property rights provides over 50 recommendations for governments, international organizations and other agencies, as well as private companies to improve health access for diseases primarily affecting low- and middle-income countries (LMICs), given current international and national rules on patent rights.
**1.3 Intellectual property benefit sharing**

The Organisation for Economic Co-operation and Development (OECD) Guidelines on Human Biobanks and Genetic Research Databases note that the benefit arising from research using a biobank or genetic research databases should be shared as broadly as possible. One such method specific to generating a precision medicine marketplace is the sharing of information and licensing benefits from IP. Such benefit sharing strategies aim to distribute the benefits of patented innovations along the value chain to those who participated in or contributed to a discovery. Benefits can be non-monetary or monetary in nature, and shared at each stage of research and development, prior to commercialization. In the case of precision medicine, new diagnostics and therapeutics may be discovered in part using the data from international open science genomics projects, originally sourced from populations of developing countries that contributed resources or expertise to the open science project. 

Approaches to sharing benefits from IP may take many forms, including knowledge sharing, technology transfer, or socially responsible licensing capabilities in which the IP owner can provide differential access or pricing for public health agencies to arrange country-specific equitable IP benefit sharing. 

One example is the MalariaGEN Genomic Epidemiology Network’s Data Release Policy for Genome-wide Association Data, an advantageous patent licensing policy that states how “the owner of the IP agrees to license it on a reasonable basis for use in the developing world and on a preferential basis to the countries whose citizens are the subject of the database.” Further types of IP benefit sharing exist for global health (e.g. patent pools) but do not yet include precision medicine. Ultimately, this capability aims to strike the balance between maintaining R&D incentives for Western companies using an internationally provided open database while ensuring access to populations who contributed to patented discoveries.

**1.4 Precision medicine review processes**

The market entry review process enables the successful commercialization of a precision medicine innovation. Innovative precision medicine diagnostics and therapeutics require regulatory approval that validates and provides vetted support for the efficacy, safety and relative economic value of the innovation. From the World Economic Forum Precision Medicine Vision Statement, these market inspection processes consider the speed of review (turnaround time to keep pace with innovation), quality of review (feedback coming from relevant medical experts), and transparency of review (value assessment frameworks followed by review committees). The capability of a country to uphold these review processes through a regulatory agency, either via an established domestic review body or an international partner agency, ensures that high-quality, safe and accessible discoveries enter the market.
**National strategic plan**

This capability highlights the role of the government stakeholder in establishing national backing of a formalized precision medicine implementation plan. Precision medicine approaches enter public and private health systems often due to, and in accordance with, national strategic backing on the use of novel products and best practices in care delivery. The implementation of a national strategic plan is different for every country, illustrated by a sampling of global single-country precision medicine efforts described in the World Innovation Summit for Health report *Precision Medicine: A Global Action Plan for Impact*, which at the time of publication (2016) included Australia, Belgium, Canada, Estonia, France, India, Israel, Japan, the Republic of Korea, Luxembourg, Qatar, Scotland, Singapore, Sri Lanka, Thailand, the United Kingdom and the United States. Although the country-specific objectives of the projects differ (e.g. piloting specific CDx tests, PGx card implementation, creating biobanks), common among all programmes is the declaration of national interest in precision medicine practices through creating targeted strategic implementation programmes. Policy leaders are invited to evaluate their positioning in relation to health systems nationwide, determining country-specific strategies to establish and maintain any novel precision medicine product, practice or policy. The national strategic plan acts as both the commitment to and blueprint towards precision medicine innovation growth and accountability.

**Monitoring and evaluation**

The WHO and International Health Partnership *Monitoring, Evaluation and Review of National Health Strategies* report presents 10 key attributes and guidelines for countries and partners to strengthen monitoring and evaluation (M&E), and the review of national health strategies. The report refers to M&E as “a comprehensive framework that addresses indicator selection, related data sources, and analysis and synthesis practices, including quality assessment, performance review, communication and use.” M&E acts as an adaptive process for determining the status of an innovation based on measured outcomes; its methods seek to evaluate, adapt and modify or terminate interventions as needed. Such measurement of a set of standardized outcomes, if based on well-defined methods for collection and risk adjustment, paves the way for value-based reimbursement and a value-driven marketplace.

While most countries have some form of an M&E mechanism in place (unique to each country), this resource guide refers specifically to the ability to assess, improve and/or develop the M&E component of a national health strategy of precision medicine programmes. In the context of enabling precision medicine implementation, M&E results must be actionable and include formal processes to influence decision-making, including resource allocation and financial disbursement to precision medicine-specific programmes. A precision medicine M&E plan must be aligned with the comprehensive national M&E plan, regularly reviewed throughout implementation and linked with overall health systems surveillance for subnational, national and global reporting. Examples and use cases of the M&E framework for country programmes in immunization and HIV/AIDS can be found in the annexes of the WHO paper *Monitoring and evaluation of health systems strengthening: An operational framework*.

**Health technology assessment**

While various definitions of health technology assessment (HTA) exist, WHO definition EB (134/30) defines HTA as “the systematic evaluation of properties, effects and/or impacts of health technologies and interventions. It covers both the direct, intended consequences of technologies and interventions and their indirect, unintended consequences.” HTAs use a multistakeholder approach spanning patient, social, economic, organizational and ethical considerations of a health technology to inform policy and decision-making.

HTA processes vary globally and are subject to the maturity and cultural context of each country. However, given the increased recognition of evidence-based decision-making through HTA, the *International Society for Pharmacoeconomics and Outcomes Research (ISPOR) HTA Council*. 
In literature on policy innovation diffusion, policy entrepreneurship refers to how ideas for innovation gain prominence on government agendas, alter incumbent policy and regulatory frameworks, and create such frameworks in a greenfield policy space. Policy entrepreneurs mobilize constituencies on a novel agenda that may otherwise have already benefitted from previously established legislation, catalyse policy change and drive political process towards new legislation. In the policy entrepreneurship context, success in the policy-making process has been associated with the convergence of four factors: behavioural traits, institutional factors, network position and political capital.

Individual policy entrepreneurs within a country’s ministry of health or finance can begin to articulate a health innovation agenda and craft policy interventions that aim to promote both economic development and public health. This highlights the influence of the public sector’s risk tolerance for innovation – the high level of risk and uncertainty involved with precision medicine innovation projects may deter adopters. Consequently, government leaders must evaluate the support of their leadership teams for novel innovations such as precision medicine approaches, and find solutions to de-risk accordingly.

Working Group has synthesized good practices from literature and global perspectives to support consistency in approaches to HTA-informed decision-making. A summary of HTA components is illustrated in Figure 1 from the working group.

More recently, the inclusion of precision medicine in clinical practice has been recognized to “impact each stage of the HTA process, from scoping and modelling through to decision-making and review”. Some countries have had limited experience with precision medicine companion diagnostic testing and have accommodated the additional complexities into their HTA process, notably the Diagnostic Assessment Programme at the National Institute for Health and Care Excellence (NICE) in England or the Health Technology Assessment Access Point in Australia. However, as the pace and types of precision medicine innovation grow, refinement to various HTA components are required to keep pace with the influx of precision medicine algorithms, digital health applications and “omics”-based tests.
FIGURE 1 Components of the health technology assessment within the healthcare decision-making process

<table>
<thead>
<tr>
<th>Decision-making steps</th>
<th>Questions</th>
<th>HTA process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Request for HTA support</td>
<td>What level of support does the decision maker need?</td>
<td>Defining the HTA process</td>
</tr>
<tr>
<td>Healthcare technology decision problem</td>
<td>What is the problem and what research is needed?</td>
<td>Structure and governance / organizational aspects (e.g. government/health insurance based)</td>
</tr>
<tr>
<td>Policy analysis</td>
<td>How should research be conducted?</td>
<td>– Underlying principles (e.g. accountability for reasonableness; formal agreement with decision maker)</td>
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<tr>
<td></td>
<td>What does the research say? What do we know? What can we infer? What don’t we know?</td>
<td>– Priority setting process (e.g. application process for new medicines)</td>
</tr>
<tr>
<td>Assessment</td>
<td>How should research be identified and interpreted?</td>
<td>Framing and scoping</td>
</tr>
<tr>
<td>– Guidance for identification and interpretation of research</td>
<td>– What is the role of this HTA?</td>
<td>– What is the key questions to answer?</td>
</tr>
<tr>
<td>– Standards/checklists for researchers</td>
<td>– What output from HTA is required?</td>
<td>– What do we know?</td>
</tr>
<tr>
<td>– Peer review of HTA research</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Use of experts or expert panels</td>
<td></td>
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<tr>
<td>– Reporting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contextualization</td>
<td>What considerations should be made explicit?</td>
<td>How can HTA from other jurisdictions be adapted?</td>
</tr>
<tr>
<td>– Deliberative processes; committee work</td>
<td>How should stakeholders and social values be considered?</td>
<td>How should budget impact be considered?</td>
</tr>
<tr>
<td>– Stakeholder engagement; value frameworks</td>
<td>– Voting rules; weighted/nominal group techniques</td>
<td></td>
</tr>
<tr>
<td>– Qualitative research; thresholds</td>
<td>How should the results of the research be put into context?</td>
<td></td>
</tr>
<tr>
<td>Implementation and monitoring</td>
<td>How should the decision be?</td>
<td>– Communicating the output of HTA (e.g. recommendation)</td>
</tr>
<tr>
<td>– Defining involvement of HTA process with decision (e.g. arms length); transparency; evaluating impact of HTA</td>
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2 Innovation financing

Emerging methods for funding and purchasing precision medicine technologies
2.1 Fiscal space

Here, too, multiple definitions and metrics for the term fiscal space exist. The WHO web page “Health financing for universal coverage” defines fiscal space as “the budgetary room that allows a government to provide resources for public purposes without undermining fiscal sustainability”. Public healthcare spend is proposed and decided alongside other priorities for public spend (e.g. infrastructure, education, socio-economic relief programmes, etc.) by the ministry of finance and other public authorities. As such, creating fiscal space for public spend in health initiatives requires a government to carefully assess its financial sustainability across current and future programmes.

Within the fiscal space for healthcare spend, thorough examination of the existing programme portfolio is necessary to determine the viability of precision medicine investments. Fiscal space analyses are critical at all levels of health system development. In high-income countries, increasing health spend relative to GDP and recent economic crises have led federal agencies to re-evaluate their fiscal space for novel health innovations, including precision medicine products and approaches, given their long-term return on investment potential. In low-income countries, however, fiscal space for precision medicine may be further limited by resource constraints and the need to focus on other health priorities. Investment allocation depends on how effectively a country can: (1) maximize the use of actual resources; and (2) mobilize new resources for health fiscal spend. Notably, as indicated in WHO Health Financing Working Paper No. 3, Assessing Fiscal Space for Health Expansion in Low- and Middle-Income Countries: A review of the evidence, conventional earmarked funds and development assistance for health (DAH) have proven marginally successful in increasing fiscal space for health in the long term. Instead, the document suggests that macroeconomic growth, budget reprioritization and efficiency improvements are key drivers to expanding fiscal space for health.

Macroeconomic growth, budget reprioritization and efficiency improvements are key drivers to expanding fiscal space for health.

2.2 Development assistance for health

The adopted terminology across literature of development assistance for health (DAH) is defined by the US Institute of Health Metrics and Evaluation (IHME) as: “Financial and in-kind resources that are transferred through major international development agencies (such as UNICEF, the United Kingdom’s Department for International Development, or the Gates Foundation) to low- and middle-income countries with the primary purpose of maintaining or improving health”. From the public angle, the WHO decennial report, From Whom to Whom? Official Development Assistance for Health, 2000-2010 covering 119 countries captures both the commitment and disbursement of public funds for recipient LMICs. Other overall trends include a growth of DAH ($21.8 billion in 2007 to $41 billion in 2019), an increased share of funding from non-governmental and private-sector contributions (e.g. NGOs, philanthropy groups, corporate donors), and a changing investment mix of health focus areas reflecting: (1) acute funding for HIV/AIDS, malaria and tuberculosis; and (2) rapid growth in DAH for newborn and child health, and infectious diseases. These trends and others are illustrated in Figure 2, capturing changes in DAH disbursements from 1990 to 2018. The most recent and other holistic DAH financing trends are available on the IHME Financing Global Health database.

DAH allocated specifically to precision medicine investment is currently not well documented and falls under broader non-communicable disease (NCD) funding, which has remained at 1-2% of the total DAH share since 2000. Innovative financing mechanisms focused on NCDs are currently lacking and there are no innovative financing programmes for precision medicine.
FIGURE 2 | Changes in development assistance for health disbursements, 1990-2018

Development assistance for health by channel of assistance, 1990-2018

Annualised rate of change of development assistance for health disbursed by health focus area


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Push funding is one category of financing offered upfront by a donor or investor; it is most critical for basic R&D funding as compared to pull funding mechanisms, which are often more experimental (see Figure 3). The Brookings Institution Global Health Financing document, Improving the Financing of Health R&D for Developing Countries: A Menu of Innovative Policy Options, describes these direct disbursements by the public or private sector, often at different stages of the R&D process reducing financial burden for innovators of often high initial fixed costs. The mix of public and private funds depends on the stage of country development and on how the grantee is sourcing funding. In the global health context, push mechanisms most commonly come in the form of: (1) grants for product development partnerships (PDPs) and SMEs; (2) subsidized loans; and (3) investment tax credits. Experts caveat a common risk of push funding as paying for inputs (research projects, clinical trials), not outcomes (new diagnostics, therapies), which is considered choosing “winners” ex-ante. Donors may rely on peer reviewed panels (not exempt of bias) and/or PDPs to manage risk within an investment portfolio.

Figure 3: “Push” and “Pull” mechanisms for health research and development

Push mechanisms:
- Innovation funding/grants
- Subsidies for research
- Tax credits on R&D
- Product development partnerships
- Expedited regulatory review
- Facilitation mechanisms
- Liability protection

Pull mechanisms:
- Market guarantees
- Purchase funds
- Prizes for successful research
- Improved market information
- Tax credits on sales
- Intellectual property incentives
- Patent buyouts


According to the Brooking’s Global Health Financing Initiative, pull financing methods aim to act indirectly on R&D processes by raising potential rewards for final output. For example, they can come in the form of guaranteed markets (e.g. price and/or volume buy-in under an Advanced Market Commitment) or incentives attracting, or “pulling” in investment in a particular space (e.g. IP protections or priority review processes). This class of financing methods resolves the issue of choosing “winners”, as described under push funding, by paying for outputs rather than inputs. It does so, however, by risking ambiguity from a financial reward (over- or under-paying R&D organizations at non-optimal incentive levels) and target product profile (TPP) specification (too niche or too broad TPPs either overlook potentially valuable innovations or result in products that may not serve the intended purpose). Importantly, while push and pull options offer many financing methods for global health, these methods were not designed specifically for precision medicine programmes. Such instruments may not be suitable for financing precision medicine projects, the funding of which remains inadequate.
The World Bank Venture Capital and Entrepreneurial Development working paper defines venture capital (VC) as “a temporary-equity or quasi-equity investment in a growth-oriented, usually small or medium-size business managed by a highly motivated entrepreneur. Management assistance often comes with the investment”. Often, VC financing acts as a form of equity funding targeting early-stage, young companies that are in the emerging stages of their development. Notably, VCs offer significant funding (scale of investment), technical and operating expertise, and other in-kind advisory resources for invested companies. The 2019 PitchBook Healthtech report illustrates how the volume of global VC-backed deals in “omics” and precision medicine has steadily remained in the mid-20s count on average since 2014. Overall growth is driven by mega deals in the United States (e.g. GRAIL, Helix, Guardant Health) in specific applications for genomics.

The Brookings Private Sector Global Health R&D Project Private Sector Investment in Global Health R&D report analyses private investment funding for global health and illustrates the lack of VC investment in overall global health R&D targeting the developing world. This also applies to the dearth of VC precision medicine investments in LMICs. Various explanations for this can be ascribed to the: (1) uncertain risk profile of precision medicine investments; (2) lack of necessary, complex upfront precision medicine infrastructure; and (3) lack of exit opportunities for investors; or a combination of the above. The International Finance Corporation report Private Equity and Venture Capital’s Role in Catalyzing Sustainable Investment discusses such sustainability barriers, and provides best practices and lessons learned for countries to voluntarily adopt in creating sustainable equity financing market development and deployment.

**FIGURE 4** Omics and personalized medicine VC deal activity, 2009-2019

<table>
<thead>
<tr>
<th>Year</th>
<th>Deal value ($M)</th>
<th>Deal count</th>
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<tbody>
<tr>
<td>2009</td>
<td>6</td>
<td>5</td>
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<tr>
<td>2010</td>
<td>5</td>
<td>8</td>
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<td>2011</td>
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<td>2018</td>
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<td></td>
</tr>
<tr>
<td>2019</td>
<td>14</td>
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</tbody>
</table>

Source: PitchBook, Healthtech, 2019

**2.6 Private equity financing**

PitchBook defines private equity (PE) as a form of financing in which capital is invested into a typically mature company in exchange for major equity stake, often over 50% ownership. PE investors may invest in ailing or potentially distressed companies with strong potential for turnaround such that long-term profitability can be achieved for an exit. In the most common PE deal type, a leveraged buyout, PE investors purchase a large controlling stake in a company with a significant amount of debt financing. This debt is to be eventually repaid by the company, but the investors work in the interim to restructure the company (e.g. upskilling teams, changing operating strategies, budgeting) for future growth.

As PE funds typically invest in later-stage companies, their role in an innovation ecosystem is more likely to sustain the progress of established players. The Emerging Market Private Equity...
Association Special Report on Private Equity and Health Care in Emerging Markets notes that PE financing in emerging markets has focused investments on building infrastructure (hospitals, laboratories, pharmacies, etc.), increasingly turning to diagnostics and treatment of NCDs. This PE trend towards NCDs can be explained by: (1) limited competition due to the focus of NGOs and similar donors aiding infectious disease; and (2) the chronic nature of NCDs resulting in recurrent treatment cycles and hence sustainable revenue flows. As such, the landscape is fairly premature for precision medicine-specific PE investment mandates, but the trend towards NCDs in LMICs indicates potential future opportunities.

2.7 Impact investing financing

The Global Impact Investing Network (GIIN) Impact Investing Guide defines impact investing as funding made with the intention of generating positive, measurable social and environmental impact alongside a financial return. Impact investments are defined by the characteristics of: (1) intentionality; (2) investing with various return expectations (e.g. at minimum, return of capital); (3) investing with a range of return expectations in various possible asset classes; and (4) commitment to measuring impact. Similar to blended finance, impact investing is a financing tool that aims to attract private-sector engagement; various impact investor types exist and may include banks, family foundations, specific impact funds, development finance institutions, high net worth individuals, and more. Impact measurement differs according to industry; the GIIN report, Impact Measurement in the Healthcare Sector, describes the various KPIs used by impact investors in healthcare. Examples of healthcare impact investment funds include the Global Health Investment Fund, UNICEF, USA’s Bridge Fund and TEAMFund. Notably, precision medicine has not yet emerged as a main investment sector for many healthcare impact funds; beyond one-off examples of precision medicine investments by impact investors, there are no specific mandates or investment theses that actively specify particular goals in precision medicine projects.

FIGURE 5 Impact investing asset class/return rate spectrum


2.8 Blended finance

Blended finance models remain a novel instrument for innovative financing of development goals, which can include opportunities in precision medicine. Blended Finance Vol. 1: A Primer for Development Finance and Philanthropic Funders from the joint ReDesigning Development Finance Initiative (RDFI) of the World Economic Forum and the OECD discusses “the strategic use of development finance and philanthropic funds to mobilize private capital flows to emerging and frontier markets”. The Blended Finance Toolkit, a product of the RDFI, is designed to provide an overview of the Blended Finance ecosystem and its benefits as well as recommendations for adopting this approach to finance and investment in emerging and frontier markets. The toolkit includes: (1) the “Primer” mentioned above; (2) a “How-To Guide”; and (3) an “Insight Survey” on blended finance. Significantly, while blended finance and impact investing have similar objectives (an intentional approach to create societal and financial impacts), blended finance...
specifically uses various risk-adjusting structures to mobilize private capital alongside development and philanthropic funding towards development objectives. For blended finance to support the advancement of precision medicine adoption in LMICs, blended capital funding should be tied to economic development objectives (e.g., general goals such as job creation and infrastructure growth, and specific health system strengthening agendas) that over time pave opportunities for precision medicine projects.

2.9 Innovative financing instruments

Innovative financing instruments refer to non-traditional approaches to raising donor funding and stimulating development aid for health (compared to traditional DAH). The World Bank working paper, *Innovating Development Finance – from financing sources to financial solutions*, defines innovative financing as “… nontraditional applications of solidarity, public-private partnerships, and catalytic mechanisms that (i) support fund-raising by tapping new sources and engaging investors beyond the financial dimension of transactions, as partners and stakeholders in development; or (ii) deliver financial solutions to development problems on the ground”. Previous 2009 publications from the high-level, international Taskforce on Innovative International Financing for Health Systems reviewed over 100 innovative financing initiatives and identified solidarity levies (airline and tobacco tax), immunization bonds (International Finance Facility for Immunization, IFFIm), advance market commitments and debt swaps as the most promising sources for new and additional financing, given their past implementation performance. Only three such mechanisms, however, have reached global scale: Gavi, the Global Fund and UNITAID. Importantly, the two key points of value-add in innovative financing instruments used by these mechanisms are: (1) the integration of steps in the value chain to efficiently mobilize, pool, channel, allocate and disburse financial resources to LMICs; and (2) the use of this new organizational body to create implementation and performance incentives.

At the time of writing, no innovative financing instruments exist specifically for precision medicine. The attention to NCDs is also scarce. Most innovative finance disbursements address vaccine-preventable childhood diseases, HIV/AIDS, tuberculosis and malaria. Moving forward, global leaders and donors should explore how current innovative financing mechanisms can use diagonal approaches (in which targeted interventions drive the necessary improvements into the overall healthcare system) to build synergies to address under-resourced areas of health such as NCDs and precision medicine approaches. The upfront costs and competencies of creating novel innovative financing instruments are not to be underestimated and may be better served by critically strengthening existing integrated innovative financing mechanisms which in turn will support under-resourced precision medicine approaches. This complements how policy-makers must also mobilize greater support around a global agenda and financial commitment for precision medicine and NCDs. Analogous to the recent decade of growth in maternal health funding by GAVI and the Global Fund, promoting traction and international attention to the promise of precision medicine will be critical to achieving long-term financing flows for precision medicine.

![Diagram: Innovative financing instrument value chain conceptualization](image)

2.10 Development impact bonds

The Center for Global Development defines development impact bonds (DIBs) as performance-based financing instruments intended to fund development projects in LMICs. They are modelled on social impact bonds (SIBs) and work similarly. In the OECD working paper Understanding Social Impact Bonds, SIBs are presented as an outcomes-based financing method in which public entities (e.g. government) enter into contracts with service providers (e.g. hospital systems) and private investors to pay for the delivery of pre-defined social outcomes. Similarly in a DIB, investors provide upfront capital to service providers for a specific developmental purpose, results are assessed against projected key performance indicators, and where results meet KPIs, an outcome payer (usually a third-party donor or aid agency) agrees to pay the investors a return on investment. DIBs and SIBs exemplify the growing outcomes-based principle of impact investing and have the potential to spur innovation given the clear incentives to perform against impact targets. The DIB mechanism to pay for rigorous evaluation of outputs ties closely with the evidence generation and evaluation essential to precision medicine projects. Accurate context is crucial as the methodology may be complex and costly to structure and implement.

2.11 Coverage and purchasing

Key areas driving the coverage for precision medicine innovations include: (1) tying real-world evidence of measured outcomes to reimbursement value; and (2) experimenting with and adopting novel value-based payment strategies.

One common means of financing healthcare services is to pool financing across a defined population through an insurance mechanism. Financed by public and/or private funding, depending on the choice of insurance scheme, the insurance pool is designed to cover the enrolled beneficiaries who effectively share treatment costs. When health financing occurs through insurance, the insurance scheme is responsible for designing reimbursement methods for providers servicing their beneficiaries. Multiple payment methods exist by which the healthcare services delivered by providers are purchased. Information from the WHO “Health financing for universal coverage” web page on Provider payment mechanisms offers pertinent descriptions of the most commonly used payment methods (e.g. fee-for-service, capitation, per diem).

The WHO asks four key questions about purchasing: (1) Who purchases health services? (2) Which health services are covered by purchasers? (3) How are health services purchased (by means of what mechanisms)? and (4) From which providers are health services purchased? These questions have been raised globally by policy-makers with regard to precision medicine and no conclusive answers have been recorded as yet. Standards for evidence of efficacy and effectiveness are still in development. However, key areas driving the coverage for precision medicine innovations include: (1) tying real-world evidence of measured outcomes to reimbursement value; and (2) experimenting with and adopting novel value-based payment strategies described in the following sections.

2.12 Alternative payment models

Traditional fee-for-service (FFS) models are often cited as the root cause of misaligned incentives that reward volume over value of services; FFS does not incentivize coordination of care towards efficiency, quality or outcomes. Growing demand for new purchasing methods has spiked interest in alternative payment models (APMs) that represent a class of experimental methods used by government health programmes and private insurers to deliver value-based care in the United States. The most prominent APMs in the white paper on Paying for Personalized Medicine: How Alternative Payment Models Could Help or Hinder the Field published by the Personalized Medicine Coalition include: (1) accountable care organizations that enable shared governance between stakeholders for a specific population leading to “shared savings”; (2) bundled payments (also known as “episode-based payments”) that pay for a set of services for a specific treatment or condition; and (3) patient-centred medical homes, that focus on individual care coordination, usually through primary-care practices. At the time of writing this guide, the impact of APMs on the development and access to precision medicine has yet to fully be explored. Nonetheless, the conversation around value-based care continues to drive APM experimentation, in turn affecting decisions to use precision medicine-based solutions in care delivery.
Managed entry agreements (MEA) refer to a class of innovative reimbursement approaches that payers are exploring internationally to cover new products while managing financial and performance uncertainty. The most notable referenced definition of MEAs comes from Health Technology Assessment International (HTAi) Policy Forum literature What principles should govern the use of managed entry agreements?: “an arrangement between a [pharmaceutical] manufacturer and payer/provider that enables access to (coverage or reimbursement of) a health technology subject to specific conditions. These arrangements can use a variety of mechanisms to address uncertainty about the performance of technologies or to manage the adoption of technologies in order to maximise their effective use, or limit their budget impact”. MEAs can be summarized as conditional coverage – a “yes, but” decision. The taxonomy below distinguishes the different types of MEAs.

The potential of MEAs in precision medicine approaches can be summarized in their novel methods to reimburse health technologies that may not fall under traditional coverage paradigms. However, these financial agreements are more common in the Western countries, with their use in at least two-thirds of OECD countries and EU member states. MEAs may provide patient access to precision medicine technologies while managing optimal use in the current complexities surrounding precision medicine reimbursement. For instance, precision medicine diagnostics may or may not alter the patient care pathway, creating uncertainty about how HTA bodies will obtain material assessments of budget impact and overall outcomes for market entry and coverage agreements. While few countries have formally evaluated their performance of MEAs due to confidentiality agreement barriers, there is growing discussion by payers globally about the use of more innovative reimbursement instruments such as MEAs. Their application as a policy tool capable of managing uncertainty and enabling early patient access continues to be explored.

Performance-based risk-sharing agreements

Also known as outcomes-based agreements, performance-based risk-sharing agreements (PBRSAs) are a class of MEAs that reimburse a product or service on condition of performance. In these payment schemes, an intervention’s health and/or cost outcomes in a defined patient population are closely tracked for subsequent reimbursement based on those metrics. In PBRSAs, payers and producers are able to better align on financial incentives that reward strong evidence collection while reducing investment risk in cases where a health intervention performance does not meet health-gain and/or cost-saving expectations. An OECD Health Working Paper on Performance-based managed entry agreements for new medicines in OECD countries and EU member states evokes the lack of global evidence around these payment schemes and provides four good practices: (1) define a strategy to guide usage only when benefit of additional evidence on product performance outweighs the administrative costs of setup and execution; (2) identify uncertainties in each coverage decision such that a PBRSA’s data sources and research designs address those uncertainties; (3) implement a governance framework for transparency of process and guidelines for how payers may act upon the additional evidence generated from the PBRSA; and (4) limit confidentiality to parts of a PBRSA that may be commercially sensitive (e.g. prices) such that a minimum level of content transparency is achieved.

As precision medicine approaches are considered to deliver value-based care, outcomes-based contracts (PBRSAs) provide payers with low-risk opportunities to actualize precision medicine approaches in which their outcomes performance (“value”) is tied to payment.

Coverage with evidence development

Coverage with evidence development (CED) is an approach for the early adoption of medical innovations (pharmaceuticals, medical devices, diagnostics, or procedures) for a limited period of time under the explicit requirement of having to generate further evidence. As one type of PBRSA, CED is the taxonomy adopted by the US Centers for Medicare and Medicaid Services but is referred to by other names in different countries: “interim funding” (Australia), “conditionally funded field evaluation” (Ontario, Canada), “conditional reimbursement” (Netherlands), “still in research” (France) or “monitored use” (Spain). The unifying approach, however, is the ability to have funded the medical technology by the healthcare system for early access to promising innovations while conducting ongoing data collection and assessment when an evidence gap may exist. This is particularly important when an innovation has significant promise, yet key uncertainties about benefits, risks and/or costs may cause reluctance to funding for public and private groups. CED seeks three main purposes in policy-making: “(1) to generate evidence for a promising technology; (2) to monitor use or control volume; and (3) to help innovations enter the market”.

CED is particularly important for precision medicine innovations owing to the lack of robust data available due to trials not having been conducted or having been conducted only in a small number of patients and where a randomized control trial is not quite applicable. Given the ongoing complexity and questions around HTA processes for precision medicine innovations, CED offers a mechanism for providing early access to precision medicine approaches with promising health potential not yet sufficiently demonstrated to be cost effective under a HTA.
Community and partnerships

Formalizing collaboration models and innovation incentives for precision medicine approaches
3.1 Genomics partnership models

Precision medicine innovation has been largely achieved through a variety of multistakeholder partnerships. There being no universal partnership model for precision medicine implementation, an increasing variety of healthcare stakeholders have entered into genomics-based partnerships in the past decade. US-based full-service seed fund Rock Health illustrates this growth in partnership model variety in its genomic company database through four categories: (1) private multi-partner collaborators supported by public government projects; (2) biopharma producers sharing data with genomics companies; (3) provider systems using the services of genomics companies; and (4) genomic companies partnering with vendor products. While these partnership models are observed specifically in the US context, such examples act as analogues for maturing activity in precision medicine collaboration.

Most recently in PitchBook’s 2019 Healthtech report, precision medicine activity in more mature innovation landscapes has seen a greater number of partnership models based on employer and provider involvement: (1) providers are increasingly piloting genetic testing programmes with genomic sequencing companies alongside annual patient check-up exams; (2) employers are incentivized to reduce overall health spend by offering genetic testing, where appropriate, within health benefit packages. The multiple pilot and development methods that do exist should be considered when critically evaluating how novel partnerships may be created for natural marketplace growth.

Shift driven by partnerships

A look at four transformation partnerships out of 200+ that were struck in 2015 and 2016

- 44% - A genomics company selling a product has partnered with another vendor
- 31% - A genomics company has teamed up with a hospital, health system, or clinical research institution
- 16% - Big Pharma has gotten on board
- 10% - Government is involved in the partnership


![Diagram showing 200+ partnerships in 2015-2016]}

- 23andMe will integrate data into Apple’s ResearchKit App to enable researchers to discover correlations between genetic, behavioral, and wellness data.
- Columbia University Medical Center staff will use IBM’s Watson to translate DNA into actionable information so oncologists can deliver better personalized care.
- HLI will sequence genomes from AstraZeneca’s patients currently enrolled in clinical trials. AstraZeneca will use this data to identify new drug targets.
- The White House-funded Precision Medicine Initiative brings together 40+ companies to study, expand, and centralize individualized care. Initial goal is 1M participants.
The WHO Priority Medicines for Europe and the World 2013 update of Background Paper 8.1 on Public Private Partnerships relates the promising growth and potential of public-private partnerships (PPPs) for addressing challenges in biopharmaceutical innovation. Fundamentally, PPPs can be formal or informal and include at least one public and one private stakeholder in which the project’s risk is shared between parties. Various types of PPPs exist (e.g. PDPs, research partnerships, overall “system innovation” reform partnerships) that all aim to mobilize in-kind and financial resources from the various partner organizations. The World Bank PPP Reference Guide 3.0 establishes the rationale, design, formation and implementation of multiple types of PPPs. Finally, the United Nations Economic Commission for Europe Guidebook on Promoting Good Governance in Public-Private Partnerships describes good governance as encompassing the following six core principles: efficiency, accountability, transparency, decency, fairness and participation. Metrics can be used to measure the value of PPPs, as illustrated in Figure 9 for pharmaceutical PPPs.

With regard to precision medicine approaches, PPPs have been established for various oncology and neglected tropical disease (NTD) diagnostics programmes globally (e.g. Foundation for Innovative New Diagnostics (FIND), African Network for Drugs and Diagnostics Innovation (ANDI), PPPs for cancer control plans). Precision medicine PPPs cover multiple steps along the healthcare value chain (e.g. product R&D, collaboration with regulators, public engagement and care delivery) in which public-sector involvement occurs in order to: (1) resolve market failures; and (2) capture broader social and economic benefits. While the diversity of public-private collaborative models has resulted in a very limited evidence base for evaluation, best practices for PPPs vary across countries. Hence, although PPPs offer a promising route towards enabling and sustaining precision medicine innovation, their formation must capture the local context of stakeholder composition and roles.

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**Public-private partnerships**

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**Figure 9 Proposed framework for evaluating PPPs in the pharmaceutical sciences**

<table>
<thead>
<tr>
<th>Networks</th>
<th>Process</th>
<th>Output</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number and diversity of partners</td>
<td>Exchange of information between partners</td>
<td>Number of projects continued after PPP funding</td>
<td>Number and size of new partnerships inspired by PPPs</td>
</tr>
<tr>
<td>Know-how</td>
<td>Formal knowledge sharing; for example, background IP in consortia</td>
<td>Knowledge sharing through percentage of personnel exchanged and number of consortia meetings</td>
<td>Number and citation score for joint publications</td>
</tr>
<tr>
<td>Human capital</td>
<td>Number of experts involved, number of highly cited researchers</td>
<td>Percentage of researchers trained via PPP-specific courses</td>
<td>Number of completed PhDs and postdoctoral positions</td>
</tr>
<tr>
<td>Financials and operations</td>
<td>Total research funding available in partnership</td>
<td>Percentage of researchers and staff using intranet on a regular basis</td>
<td>Percentage of milestones achieved in consortia</td>
</tr>
</tbody>
</table>

Biotechnology clusters

In the context of innovation and competition, the World Bank’s 2013 Clusters of Competitiveness report states that “a cluster is a system of interconnection between private and public sector entities. It usually comprises a group of companies, suppliers, service providers, and associated institutions in a particular field, linked by externalities and complementarities”. Clusters are often industry-specific, as in the case of biotechnology clusters, in which biotechnology companies are located near research and care delivery centres (e.g. universities and hospitals) and extensively associated with external R&D services, equity investors and other large multinational corporations. Often, these sector-specific clusters can be formed both spontaneously, through the organic presence of key biotech stakeholders/resources, and policy-driven, catalysed by strong government commitment to establish conditions for their creation (or a combination of both methods). The characteristics of policy-driven cluster initiatives (CI) backed by government and private-sector entities are specified in Figure 10.

Such environments have emerged in cities around the world, ranging from the US Research Triangle Park to Singapore’s Biopolis to Brazil’s biotechnology hub in São Paulo. Biotechnology clusters act as hubs that foster activity within a marketplace by acting as a: (1) collaborative knowledge-generating environment linked closely to entrepreneurial activity; and (2) connected ecosystem that bridges burgeoning projects with financial and in-kind resources to achieve market access and scale.

FIGURE 10 Comparison of cluster initiatives by level of economic development

<table>
<thead>
<tr>
<th>Measure</th>
<th>Developing</th>
<th>Transition</th>
<th>Advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives</td>
<td>CIs focus on supply chain development, export promotion</td>
<td>Donor-initiated CIs have a narrower range – export promotion and increasing value-added</td>
<td>CIs focus on innovation and business environment improvement</td>
</tr>
<tr>
<td></td>
<td>Increasing value-added, improving business environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activities</td>
<td>Upgrading human resources, developing supply chain, and working out joint logistics</td>
<td>Lobbying for changes in business environment; management training; supply chain development</td>
<td>Firm formation; high importance of joint R&amp;D</td>
</tr>
<tr>
<td>Membership and resources</td>
<td>71% of CIs have an office; 37% have a website; median of 3 staff members</td>
<td>Fewer companies participating in CIs – median number is 18 with just 40% of CIs having more than 20 companies</td>
<td>CIs are larger, 51% have more than 20 firms participating and median is 25 companies</td>
</tr>
<tr>
<td></td>
<td>62% of CIs have an office; 41% have a website; median of 2 staff members</td>
<td></td>
<td>75% of CIs have an office; 79% have a website; median of 2 staff members</td>
</tr>
<tr>
<td>Cluster focus</td>
<td>Focus on “basic” industries</td>
<td>More of a mix of industry types; but donor initiators focus on “basic” industries and agriculture</td>
<td>Sometimes a tendency to favor “high-tech” industries</td>
</tr>
<tr>
<td>Role of government and financing</td>
<td>CIs often have an international initiator; government initiatives are also frequent; those initiated by business are less frequent</td>
<td>Largest share of funding comes from business sector</td>
<td>Dominating role of government that leaves business on the sidelines of CIs is a concern</td>
</tr>
<tr>
<td></td>
<td>International funding is usually the main source of income for CIs</td>
<td></td>
<td>Most of financing for CIs is provided by government</td>
</tr>
<tr>
<td>Performance</td>
<td>Developing economies score best in acquiring funds and improving the business environment, followed by export promotion</td>
<td>CIs in transition economies report their best results in acquiring funds from government and international organizations, improving business environment and increasing innovativeness</td>
<td>CIs in advanced economies score best in increasing innovativeness</td>
</tr>
</tbody>
</table>

3.4 Incubators and accelerators

The World Bank Group 2017 *Innovation Paradox* report defines incubators and accelerators as hosting “innovative companies, sometimes linked to universities, to support the commercialization of knowledge”. Such hubs create a physical environment in which founders are able to develop an invention while benefiting from the networking opportunities and spillover effects of co-location, such as the cross-pollination of ideas, for instance. These support programmes aim to foster business creation, particularly in their early stage, and local entrepreneurship, which has been regularly documented to correlate with economic growth.

According to the World Bank’s 2018 report *Supporting Entrepreneurs at the Local Level*, incubator support is more often expressed in terms of office space and administrative support services provided while accelerators tend to manifest as fixed-term, cohort-based programmes providing mentorship, education and funding to participating entrepreneurs. Incubators or accelerators can specify their support to host only precision medicine-driven start-ups (e.g. Barclays and UK’s first precision medicine accelerator, the P4 precision medicine programme) or they may include broader mandates that support a variety of healthcare (or other industry) start-ups that may include precision medicine-focused companies. In low- and middle-income countries, the entrepreneurial ecosystem is often underdeveloped and scarce to operate any incubators or accelerators, further limited in the healthcare space. While there is minor activity of social entrepreneurship incubators and accelerators aiming to provide innovations in this context (e.g. Unreasonable East Africa from the Uncharted social impact accelerator), more inclusive entrepreneurship environments are needed.

3.5 Technology transfer

Technology transfer (TT) is typically differentiated between two contexts, which the OECD describes as: (1) university-industry technology transfer; and (2) international technology transfer (ITT) for development assistance. University-industry TT is used to translate R&D activities, common in university projects, to clinical pilots and other implemented use cases. This is currently the most frequent form of TT employed in precision medicine.

To bridge connection between academic research and industry, research institutions will establish a university technology-transfer office (TTO) to facilitate all operations surrounding the commercialization of a viable research discovery. In the context of precision medicine innovations, TTOs establish the link between types of precision medicine research (e.g. biomarker discovery, early stage PGx clinical testing, CDx alongside drug discovery) and strategies for product or service market entry. A variety of approaches towards commercialization can be adopted by a TTO, with the end result enabling the effective handoff from novel research results to financially sustainable precision medicine innovations.

**FIGURE 11** Contextualizing the drug discovery pipeline with the broader TT pipeline

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**Source:** Horgan, D. and J.A. Lal, “Making the Most of Innovation in Personalised Medicine: An EU Strategy for a Faster Bench to Bedside and Beyond Process”, Public Health Genomics, 2018
The OECD defines a consortium as an “association of business enterprises, whether individuals, partnerships or companies, operating together on a temporary basis for some specific venture”. In the context of precision medicine advancement, consortia tend to be driven by open science principles; participating institutions are able to benefit from one another’s genomics research and data generation while contributing to a common objective. One of the earliest recognized pioneers of a consortium for precision medicine is the Structural Genomics Consortium (SGC), which aims to identify the 3D structure of human proteins and parasite proteins on a large, cost-effective scale for research and drug development. Current SGC collaborators include 17 international research, biopharmaceutical and funding organizations. Consortia can range from international open science projects, as with SGC, to pure academic research partnerships or industry-driven projects. US-based genomics assay company Foundation Medicine Inc. (FMI), for instance, launched the Precision Medicine Exchange Consortium (PMEC) in 2015, uniting 10 academic medical centres. The PMEC has facilitated data sharing and oncology discovery efforts by harmonizing FMI’s genomic profiling data for data mining research proposals, with execution at all sites when approved.
Workforce and infrastructure

Health systems strengthening and other foundational elements
4.1 Physician champions

According to one source, the primary change agent for establishing precision medicine approaches within a health system is often the care provider, specifically, physician champions who may advocate precision medicine adoption within the local care context. In management literature, the term boundary spanner describes the individual(s) within an innovation system as those who link “the organization’s internal network to external sources of information”. In more developed health systems, precision medicine adoption is driven by communities of practice, specifically practice leaders in large specialty departments who act as boundary spanners of precision medicine knowledge between the institution and the community at large. This has historically been the case primarily in oncology but has been extending into other practice areas, such as cardiology. At lower levels of health system development, physician champions may be standalone practitioners driving “grassroots-style” local recognition of precision medicine insofar as developed aid or government partners can act on such needs.

4.2 Precision medicine training programmes

The American Medical Association web page on precision medicine and notably in Education and resources in genetics and personalized medicine provides multiple precision medicine education guides for healthcare professionals, emphasizing the importance of such programmes for promoting the adoption and use of precision medicine approaches. These programmes are targeted for both practising physicians and the pipeline of medical students covering topics including common genomic profiling tools, genomic data ethics and precision medicine delivery approaches. The content and delivery of these programmes should be tailored to the specific healthcare needs of the country and local patient population. For instance, in a resource-constrained setting, precision medicine training programmes may include more content on basic best practices for screening and cancer awareness rather than novel technology use cases that may not be relevant in equipment-scarce care settings. Precision medicine training programmes come in various forms: workshops, e-modules, conferences and genetic experts-led education programmes.

4.3 Learning healthcare system

In a 2013 publication, the Institute of Medicine at the National Academies of Sciences, Engineering and Medicine presents a learning healthcare system as one “in which science, informatics, incentives, and culture are aligned for continuous improvement and innovation, with best practices seamlessly embedded in the care process, patients and families active participants in all elements, and new knowledge captured as an integral by-product of the care experience”. This concept was developed as a means of averting the traditional model consisting of intervention development, then efficacy and effectiveness studies, followed lastly by health technology implementation. The learning healthcare system instead aims to provide more efficient and lower-cost means of healthcare delivery improvement via a method that gathers knowledge from every care delivery experience and is engineered to promote continuous improvement.

The focus on continuous system improvement allows for novel findings to be incorporated into standard clinical care insofar as such advances are adapted to the local context of diverse practice settings. Implementation science supports this system by providing evidence-based strategies (e.g. system-change interventions, training, supervision, quality monitoring tools) for the purpose of integrating genomics and other precision medicine interventions into system practice. The three concepts of (1) precision medicine; (2) implementation science; and (3) learning healthcare systems tie ultimately into the ongoing learning and evidence generation essential to the fruition of precision medicine implementation and innovation in health systems.
Contributions of implementation science, the learning healthcare system and precision medicine

**Implementation science**
- Optimal integration of effective diagnosis, prevention, and treatment
- Understanding of multilevel context
- Theories and strategies to drive health care improvement

**Precision medicine**
- Optimal use of genomics and behavioral data to drive clinical and patient decision making
- Ongoing development of genomics evidence base
- Personalized and population impact

**Learning health care systems**
- Use of ongoing data to drive health system improvement
- Focus on interactive and ongoing learning
- All stakeholders participate

**Key areas of synergy**
1. Evolution of evidence base for precision medicine and implementation science
   - Recognition of underuse and overuse of interventions
   - Management of abundance of data
2. Refresh cycle of evidence base
   - Determination of degree of achievable personalization of care
3. Support for implementation of effective practices
   - Contextually sensitive improvement of practices

**Source:** Adapted from data provided in Chambers, D.A., et al., “Convergence of Implementation Science, Precision Medicine, and the Learning Health Care System”, *Journal of the American Medical Association*, 2016
References

Australian Government Department of Health
Applying through the HTA Access Point

Brookings Institution
Snapshot Series from the Global Health Financing Initiative (2016)
Private Sector Investment in Global Health R&D: Spending Levels, Barriers, and Opportunities (2017)

CB Insights

Emerging Market Private Equity Association (EMPEA)
Private Equity and Health Care in Emerging Markets (2016)

Global Alliance for Genomics and Health (GA4GH)
Framework for Responsible Sharing of Genomic and Health-related Data (2014)

Global Impact Investing Network (GIIN)

GO FAIR
Findability, Accessibility, Interoperability and Reuse of digital assets (FAIR) Principles (2016)

Government of Canada
Roadmap for Open Science

Institute for Clinical and Economic Review (ICER)

Institute for Health Metrics and Evaluation (IHME)
Financing Global Health

International Finance Corporation (IFC)
Private Equity and Venture Capital’s Role in Catalyzing Sustainable Investment (2018)

International Society for Pharmacoeconomics and Outcomes Research (ISPOR)
Health Technology Assessment Good Practices Recommendation (2019)

Organisation for Economic Co-operation and Development (OECD)
Making Open Science a Reality (2015)
Understanding Social Impact Bonds (2016)
Performance-based managed entry agreements for new medicines in OECD countries and EU member states (2019)

Personalized Medicine Coalition (PMC)
Paying for Personalized Medicine (2015)

PitchBook
Q4 2019 Emerging Tech Research Healthtech (2019)

Rock Health
The Genomics Inflection Point: Implications for Healthcare (2016)

UHC2030
High Level Taskforce on Innovative International Financing for Health Systems (2009)

United Nations Economic Commission for Europe (UNECE)
Guidebook on Promoting Good Governance in Public-Private Partnerships (2008)
Secondary sources

Innovation governance

Innovation financing


Community and partnerships


**Workforce and infrastructure**


- Sammut, S. (2020), Organizational antecedents to the implementation of precision medicine: Overcoming resistance to change, A dissertation submitted to the Temple University Graduate Board in partial fulfillment of the requirements for the degree Executive Doctorate in Business Administration.

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