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Costs and benefits of diagnostic testing: four ways to improve patient care by purposive use of in vitro diagnostics

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Summary

Scientific advances and innovative targeted drugs, especially biologics, have revolutionised the treatment of many diseases. In oncology in particular, previously acute or lethal conditions have come to be considered chronic as new treatments have led to longer life expectancies and a lower rate of years lived with disability. These advances, however, come with rising costs in a resource-constrained environment. To achieve cost containment, reimbursement for *in-vitro* diagnostics (IVDs) is increasingly coming under pressure because they are perceived as a cost factor rather than as a tool to reduce expenditure in the long term. In this conceptual paper, we propose four possible interventions from an industry perspective that may contribute to increase effectiveness of IVD use to counteract increasing healthcare expenditures. These are: (1) fostering prevention, screening, early diagnosis and therapy; promoting (2) comprehensive and (3) stratified disease management; and (4) using targeted treatment alongside companion diagnostics. We conclude that the implementation of policies that promote a fee-for-outcome model rather than fee-for-service reimbursement can support sustainable healthcare.

Key words: *cost containment, healthcare resource use, IVD, personalised healthcare, early diagnosis, targeted treatment, value-based reimbursement, stratified treatment*

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Introduction and problem statement

Increasing healthcare costs

Healthcare expenditure as a proportion of gross domestic product (GDP) is on the rise. In the US, for example, healthcare spending is expected to grow 1.3 percentage points faster than GDP annually, rising to comprise 20.1% of GDP by 2025 [1]. Across all Organization for Economic Co-operation and Development member states, total public healthcare and long-term care expenditures are projected to double by 2060 (from 6.2 to 13.9% of GDP) if the pace of the last decade continues [2]. Even with concerted efforts at cost containment, expenditures are projected to grow by 50% (to 9.5% of GDP) [2]. Therefore, the importance of improvement to the ratio of healthcare resource utilisation to overall health outcomes is becoming increasingly clear [3].

Underutilisation of IVDs in clinical practice

In-vitro diagnostics (IVDs) play a critical role in driving clinical decision-making, and their true impact includes cost savings and increased efficiencies in downstream activities [4–6]. IVD testing can answer crucial questions about a patient's health status, including risk or predisposition for developing a certain condition; the stage of disease; the chances of therapy response; and the prognosis for progression/remission under therapy [7].

Evidence suggests that the potential of IVDs is currently underexploited and undervalued. Recent research indicates that IVDs account for 2.3% and 1.4% of total healthcare expenditure in the US and Germany respectively, while driving 66% of clinical decision-making [8]. Nonetheless, the reality surrounding the use of IVDs is different. A watershed analysis of the US healthcare system showed that physicians followed diagnostic best practices only 62% of the time [9], highlighting that ~38% of patients may not have received the best care. This lack of utilisation has a ripple effect. The US National Committee for Quality Assurance linked low compliance with diagnostics-based quality measures for diabetes, colorectal cancer, and breast cancer with 56 200 avoidable adverse health events, nearly 34 000 avoidable deaths, and $899 million in avoidable healthcare costs [10]. Adding insult to injury, a recent meta-analysis of 42 IVD utilisation studies worldwide (evaluating 1.6 million tests) found underuse to be a much bigger problem than overuse [11]. The overall mean rate of underutilisation (IVD tests indicated but not ordered) was 44.8%, more than double the 20.6% rate of overuse (IVD tests ordered but not indicated) [11]. This might be indica-

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tive of the fact that in budget-constrained healthcare systems, it seems to be more acceptable to reduce laboratory testing volumes than to ask clinicians to cut down on treatment [12].

Consequences for patient care

Cutting down on IVDs is often favoured as an *ad-hoc* solution to counteract increasing healthcare costs for payers, mainly because of the methodological inability to measure the cost of not doing something (e.g., not ordering a test). If a payer captures laboratory testing costs but not long-term savings, diagnostic testing will always appear as a net cost. The unpleasant side effect of focusing on this short-term solution is that it aggravates the fundamental problem, namely it further increases society's overall expenditure on healthcare resources as a result of a delay, inappropriate selection, or complete lack of therapy.

The following tangible examples might be considered: The World Health Organization (WHO) recently completed a longitudinal study of tuberculosis (TB) control using data from 21 European countries. Because of shrinking public health budgets during the 2008–2011 economic downturn, IVD testing rates decreased and rates of TB case detection fell by 5.22% across Europe [13]. Interestingly, at the same time, the WHO projected that the prevalence of TB and TB-attributable mortality would increase by as much as 3% for over a decade after the recession ended [13]. The number of TB-associated deaths was estimated to be approximately 1.5 million in 2014, although the WHO aims to reduce the TB-associated mortality rate to 2 per 100 000 population before 2030 [14]. However, providing sufficient financial means is still the bottleneck in fighting the global burden of TB. Approximately US$8 billion is required annually to cover the costs of detection and treatment on a global scale, but only approximately US$6.4 billion is available [15]. Without the funding to address these needs, TB incidence rates are falling by only 1.5% per year [15].

In oncology, reducing the number of molecular tests performed follows a similar logic. These tests, which cost US$100–3000 each, could help avoid the use of expensive anticancer drugs costing US$600–28 000 per patient [16], and would improve individualised patient care.

Conceptual interventions

To overcome this problem, we propose four conceptual interventions for clinical practice. These are: (1) fostering prevention, screening, early diagnosis, and therapy; promoting (2) comprehensive and (3) stratified disease management, as well as (4) the targeted delivery of treatment alongside companion diagnostics. Based on our argumentation, we conclude with the political actions that should be taken into consideration to pave the way towards more sustainable healthcare systems.

Fostering prevention, screening, early diagnosis, and therapy

A recent study by Cancer Research UK found that late diagnosis is a major driver of the UK's National Health Service (NHS) cancer treatment costs [17]. Treatment for stage 3 and 4 colon, rectal, lung, and ovarian cancer costs the NHS nearly 2.5 times the amount spent treating stage 1 and 2 cancers. The report estimated that the financial dividend of earlier diagnosis amounts to 5% of the total UK treatment budget for these four cancers. Extrapolated to a global scale, these data hint at the magnitude of savings that could be made through early detection. Although survival rates differ markedly between cancers, early-stage diagnosis is consistently associated with longer survival. Among patients diagnosed with stage 1 lung, ovarian, or colorectal cancer between 2002 and 2006, five-year survival rates in the east of England were 35, 90 and 95%, respectively; among those diagnosed at stage 4, five-year survival dropped to 1, 2 and 5%, respectively [17]. A recent US Food and Drug Administration (FDA) report estimated that the cost to society is US $775 278 when a patient with high-risk early-stage breast cancer does not receive timely life-saving therapy, and they lose three years of life as a result (fig. 1) [18]. Furthermore, early diagnosis has a downstream effect on the patient's quality of life during adjuvant chemotherapy, as treatment regimens for metastatic disease require further add-on agents that may increase the adverse-event burden.

Another example is cervical cancer, which has one major known causative factor – human papillomavirus (HPV). The global number of deaths due to cervical cancer was estimated to be approximately 266 000 in 2012 [19]; HPV is prevalent in 99.7% of cervical carcinomas [20]. In the US, the estimated annual cost of treatment of cervical carcinoma and its precursor condition is approximately $1.2 billion [21]. If cervical cancer is diagnosed early, the US National Cancer Institute estimates a five-year survival rate of 91.5%; if diagnosed late, the five-year survival rate drops to 16.5% [22]. Because there are no early-stage symptoms, screening is the primary mode of detection. Ultimately, primary prevention of cervical cancer through HPV vaccination should be encouraged. The cost-effectiveness ratio of vaccination in the US was estimated to be US $43 000 per quality-adjusted life-year compared with current screening practice, if performed at the age of 12 years in girls and if lifelong immunity is ensured [23].

Promoting comprehensive disease management

Comprehensive disease management refers to the rigour applied to best support diagnosis and treatment of a given disease during every stage of its lifecycle to help patients and physicians in their clinical decision-making. Again, the treatment of cervical cancer and associated HPV infection provides an example. Of all the high-risk HPV genotypes, HPV16 and HPV18 account for the largest numbers of cervical cancer cases [24], although their impact on disease-free survival and prognosis is still controversial [25]. After its introduction in the 1940s, the Pap smear quickly became the gold standard for cervical-cancer screening and prevention, dramatically decreasing mortality rates. However, a single Pap test has limited ability to detect cases of cervical cancer and cervical intra-epithelial neoplasia. Studies show that up to one-third of cervical cancers occur in women with normal results from a traditional Pap smear, which has a significant diagnostic false-negative rate [26]. To compensate, clinicians perform Pap smears annually, and set a low threshold for follow-up procedures, including colposcopy. The repeated testing and subsequent (often unnecessary) colposcopies are expensive.

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An IVD that more accurately identifies women at greatest risk of advanced disease, and thus qualifying for colposcopy, as opposed to those at intermediate risk, maximises the benefits of cervical cancer screening while minimising the potential harm (and cost) of overtreatment.

To better stratify patients by risk status, an HPV screening test with simultaneous genotyping for the high-risk HPV strains 16 and 18 has become available recently [27].

In a trial involving 34 254 patients, primary screening via the test plus triage of HPV-positive women based on HPV16/18 status and Pap smear provided a good balance between maximising sensitivity (benefit) and specificity by limiting the number of colposcopies (potential harm) [28]. Germany showed that using the new test could reduce the annual incidence of cervical cancers by 30% and annual mortality by 70% [4]. Furthermore, primary screening and triage reduced the total cost per patient screened per year by 7%, resulting in annualised payer budget savings of more than €9.5 million [4]. Figure 2 summarises the comprehensive management of HPV and cervical cancer.

Promoting stratified disease management

Stratified disease management refers to the allocation of patients to risk groups for either developing a certain disease or for progressing towards a predicted outcome.

In the case of preeclampsia, the use of a biomarker combination can facilitate the prediction of occurrence during pregnancy and ensure that high-risk patients are identified

Figure 1: Generic diagram of the consequences of early vs late diagnostic measures with regard to life expectancy and associated costs.

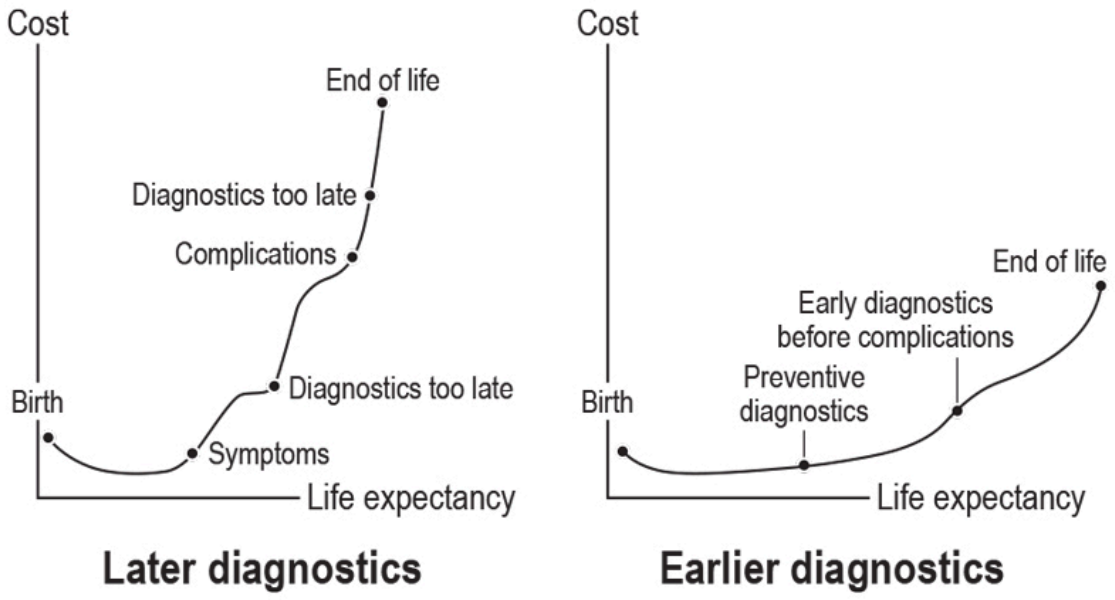
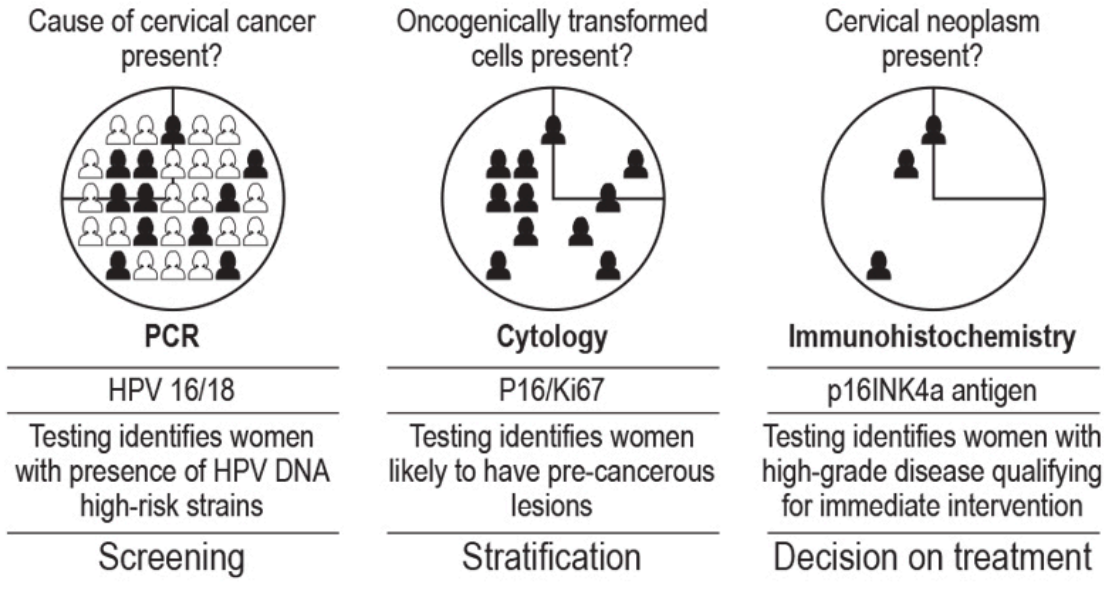


Figure 2: Holistic disease management in the diagnosis of cervical cancer and its associated risk factor of HPV infection.HPV = human papillomavirus; PCR = polymerase chain reaction.



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for monitoring while others receive routine care. The ratio of soluble FMS-like tyrosine kinase-1 (sFlt-1) to placental growth factor (PlGF) has been proposed as an indicator of preeclampsia [29–35], as it is elevated in pregnant women 4–5 weeks before the clinical onset of preeclampsia [31]. The Prediction of Short-Term Outcome in Pregnant Women with Suspected Preeclampsia Study (PROGNOSIS) was a large, non-interventional, multi-centre trial that established and validated a threshold-based prediction model using the sFlt-1:PlGF ratio [36]. Managing patients with suspected preeclampsia using the sFlt-1:PlGF ratio could help prevent unnecessary hospitalisations, with concomitant economic benefits for healthcare providers [37].

A further example is found in cardiology, where healthcare expenditures are increasing. In the US alone, healthcare costs attributed to cardiovascular disease are expected to triple between 2010 and 2030 [38]. About 80% of heart-failure-related costs in Europe are attributable to recurrent hospitalisations. Each re-hospitalisation costs almost €7893 [39]. The ability to diagnose and prognosticate worsening heart failure could have great utility in preventing avoidable hospitalisations. By measuring and stratifying levels of N-terminal pro-brain natriuretic peptide (NT-proBNP), clinicians can confirm suspected heart failure more accurately, reduce the use of echocardiography by up to 58%, prevent 13% of initial hospitalisations, and reduce hospital stays by 12% [40]. Indeed, the UK's National Institute for Health and Clinical Excellence updated its guidelines in 2010 to adopt NT-proBNP biomarker IVDs as "rule-out" tests for suspected heart failure in order to limit unnecessary referrals to echocardiography [41].

Targeted delivery of treatment alongside companion diagnostics

Broadly, the concept of targeted delivery of treatment can be summarised as personalised healthcare (PHC) [42, 43], allowing patients to be stratified into responder and non-responder groups. In PHC, IVDs enable clinicians to identify and stratify patients who will benefit from or, possibly, be harmed by a particular therapy. This allows effective treatment of patients while safeguarding the sustainability of finite healthcare resources.

PHC has led to an increase in response rates over the past decade, particularly in cancer [44]. PHC IVDs do not necessarily need to be developed de novo, and evidence shows that a combination of existing biomarkers can be used to formulate algorithms that are sufficient to help the healthcare system safely direct healthcare costs and resources [45].

The human epidermal growth factor receptor 2 (*HER2*) gene, for example, is known to be linked to certain breast and ovarian cancers [46]. HER2 overexpression is associated with more aggressive disease, making standard chemotherapy less effective [47]. Trastuzumab, which is an effective treatment only for patients with tumours that overexpress HER2 (HER2-positive tumours), was first approved by the FDA in 1998 for use in HER2-positive metastatic breast cancer, and subsequently in 2006 for early-stage HER2-positive disease. Today, it is on the WHO's Model List of Essential Medicines, a formulary of the most important – and cost-effective – medications needed in a basic health system [48].

Despite its clear utility in selecting patients suitable for treatment with trastuzumab, the HER2 IVD test struggled to gain reimbursement across the European Union, mainly because of heterogeneous regulatory and reimbursement environments, further complicated by the fact that most drugs undergo national-level reviews [49]. In France, the HER2 test was approved in 2000, but reimbursement has only been available since 2007 [49].

The budgetary impact of inappropriate treatment is not the only consideration. The importance of avoiding treating a patient with an agent that will be ineffective is further highlighted when trastuzumab's side effects are considered, as they include cardiomyopathy, infusion reactions, embryo-fetal toxicity, pulmonary toxicity and exacerbation of chemotherapy-induced neutropenia [50].

Table 1 provides an overview of selected compounds and their companion diagnostics in oncology and beyond.

Consequences for policies: promoting a fee for outcomes

The majority of healthcare systems pay for running a diagnostic test but do not offer an incentive for choosing the right diagnostic test. A decision not to use a certain diagnostic test that could allow earlier diagnosis and treatment may lead to productivity losses and increased healthcare costs. To reduce the overall costs related to a specific disease, current legislation mandating fee-for-service delivery should be revised to emphasise the payer's need for more effective patient management. Catering for customer value is a concept that has been discussed for many decades in the business literature [51], and it is equally applicable in healthcare.

For example, Porter suggested value propositions to describe what outcome measures should be rewarded [52]. They produced a tiered system highlighting the domains of (1) survival, (2) time to recovery and return to routine, and (3) sustainability of health (table 2).

Unfortunately, unlike pharmaceuticals, the reimbursement of IVDs is still not guided by the value these tests generate [53]. The reimbursement of pharmaceuticals, on the other hand, follows strict guidance based on medical evidence. The UK has one of the oldest outcome-based systems; more recently, Germany introduced its Act on the Restructuring of the Pharmaceutical Market (Arzneimittelmarkt-Neuordnungsgesetz). This legislation was introduced in 2011 after a substantial increase in expenditure on healthcare drugs. The law aims to maintain a balance between innovation and affordable medicines by introducing a rigorous system that requires the manufacturer of an agent to submit evidence of added value from the patient's perspective [54]. This law is expected to generate cost savings of approximately €2 billion annually. The pharmaceutical industry has already reacted to this important trend in healthcare policies. For example, after the rejection of reimbursement for bortezomib (Velcade®) in the UK in 2007, Johnson and Johnson offered the Velcade Response Scheme to the NHS, which used response to treatment for multiple myeloma (based on serum M-protein levels) in the pricing algorithm. Under this plan, the full cost of treatment for multiple myeloma would be completely covered by the NHS if the patient's serum M-protein level reduced by

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Table 1: Overview of selected compounds and their companion diagnostics in and beyond the field of oncology.

Drug name (trade name)	Producer	Swissmedic approval	Indication(s)	Biomarker	Companion IVD(s)
Trastuzumab (Herceptin®)	Roche	1999	Early and metastatic breast cancer Metastatic gastric cancer *ALK* rearrangements	HER2 overexpression	INFORM HER-2/NEU PathVysion HER-2 DNA probe kit PATHWAY ANTI-HER-2/NEU (4B5) rabbit Mab HercepTest™
Imatinib (Gleevec®)	Novartis	2001	Ph+ chronic myelogenous leukaemia with aggressive systemic mastocytosis	*KIT*^{D816V} mutation	*KIT*^{D816V} mutation detection DAKO C-KIT PharmDx
			Myelodysplastic syndrome/ myeloproliferative disease	*PDGFRB* gene rearrangement	PDGFRB FISH
Cetuximab (Erbitux®)	Roche	2003	Metastatic colorectal cancer	*KRAS* mutation	cobas® EGFR mutation test therascreen® KRAS RGQ PCR kit **EGFR pharmDx assay**
Gefitinib (Iressa®)	AstraZeneca	2004	Metastatic NSCLC	*EGFR* exon 19 deletions and exon 21 (L858R) substitution mutations	therascreen® EGFR RGQ PCR kit
Deferasirox (Exjade®)	Novartis	2005	Non-transfusion-dependent thalassaemia	Liver iron concentration	FerriScan® R2-MRI analysis system
Pertuzumab (Perjeta®)	Roche	2012	Metastatic breast cancer	HER2 overexpression	HercepTest™
Crizotinib (Xalkori®)	Pfizer	2012	Metastatic NSCLC	*ALK* rearrangements	Ventana ALK (D5F3) CDx assay Vysis ALK Break Apart FISH probe kit
Venetoclax (Venclexta®)	AbbVie and Roche	–	CLL	Deletion of LSI TP53 probe target (17p-)	Vysis CLL FISH probe kit
Pembrolizumab (Keytruda®)	Merck	2015	NSCLC; advanced melanoma	PD-L1 protein	PD-L1 IHC 22C3 pharmDx
Osimertinib (Tagrisso®)	AstraZeneca	2016	Locally advanced or metastatic *EGFR* T790 mutation-positive NSCLC	*EGFR* mutations (exon 19 deletion and L858R; T790M)	cobas® EGFR mutation test
Olaparib (Lynparza®)	AstraZeneca	2016	Ovarian cancer	*BRCA1/BRCA2* variants in protein coding regions and intron/ exon boundaries	BRACAnalysis CDx
Afatinib (Gilotrif®)	Boehringer Ingelheim	2016	NSCLC	*EGFR* exon 19 deletions and exon 21 (L858R) substitution mutations	therascreen® EGFR RGQ PCR kit

ALK = anaplastic lymphoma kinase gene; *BRCA1/2* = breast cancer 1/2 gene; CLL = chronic lymphocytic leukaemia; *EGFR* = epidermal growth factor receptor gene; FISH = fluorescence in situ hybridization; IHC = immunohistochemistry; HER2 = epidermal growth factor receptor 2; IVD = in vitro diagnostic; MAb, monoclonal antibody; NSCLC = non-small cell lung cancer; PCR = polymerase chain reaction *PDGFRB* = platelet-derived growth factor receptor-beta gene; PD-L1 = programmed cell death 1 ligand 1; Ph+ = Philadelphia chromosome-positive

Table 2: Application of the outcome measures hierarchical tier system described by Porter to reinforcement interventions proposed as solutions to the shifting the burden archetype in the *in-vitro* diagnostics arena [52].

Tiering	Tier 1	Tier 2	Tier 3
Criterion	Survival	Time to recovery and return to routine	Sustainability of health or recovery
Expression	Degree of health or recovery	Disutility of care and treatment process (diagnostic errors, ineffective care, treatment-related discomfort, complications, adverse effects, etc.)	Long-term consequences of therapy (induced illness)
Reinforcement through	Fostering screening, early diagnosis and therapy	Comprehensive and integrated disease management	Targeted delivery of treatment

≥25% within the first four cycles of therapy. If the patient did not respond, Johnson and Johnson agreed to cover the costs [55]. Other manufacturers quickly followed with similarly programs e.g., Merck Serono reimburses the costs of its metastatic colorectal cancer drug cetuximab (Erbitux®) if patients fail to respond to therapy at six weeks [56].

The principle of cost containment through value-based rewards is also followed by several non-governmental organisations, including accountable-care organisations (ACOs). According to the Centers for Medicare and Medicaid Services, an ACO is "an organisation of health care practitioners that agrees to be accountable for the quality, cost, and overall care of Medicare beneficiaries who are enrolled in the traditional fee-for-service program who are assigned to it" [57]. ACOs aim to ensure that patients receive the right care at the right time, while avoiding unnecessary duplication of services [58] by linking payments to quality metrics and the cost of care.

Discussion

In this conceptual paper, we argue that the problem of IVD underutilisation is partly linked to the inability of healthcare systems to track patients longitudinally, and as a result, evidence of the direct health-economic effects of IVDs on patient outcomes is scarce [8, 59, 60]. To overcome this problem, policy-makers need to develop a deep understanding of the underlying problem and make follow-ups and outcomes more measurable. We also described, from a diagnostic perspective, four possible interventions with relevance for clinical practice and cost containment. In particular, we argued that an emphasis on prevention, screening, early diagnosis, and therapy is the means to limit rising healthcare expenditure and to improve patient management. Failure to detect diseases early can result

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in expensive, late-stage treatments, overuse of procedures and therapies, poor disease management, and possibly the onset of additional complications.

In light of this, it is important to encourage patients and payers to actively engage in screening programmes and to incentivise positive behaviour [61]. Patient education plays a large role in encouraging engagement. Incentives might include reductions in annual premiums or enrolment on loyalty programmes linked to screening, with a downstream effect on patients' medication costs in the scenario of a positive diagnosis. In South Africa, for example, a private health plan has introduced a voluntary incentive programme in which participants earn points when they receive preventive care. These points can be traded for discounts or goods. This programme led to a significantly higher likelihood of receiving preventive care [62].

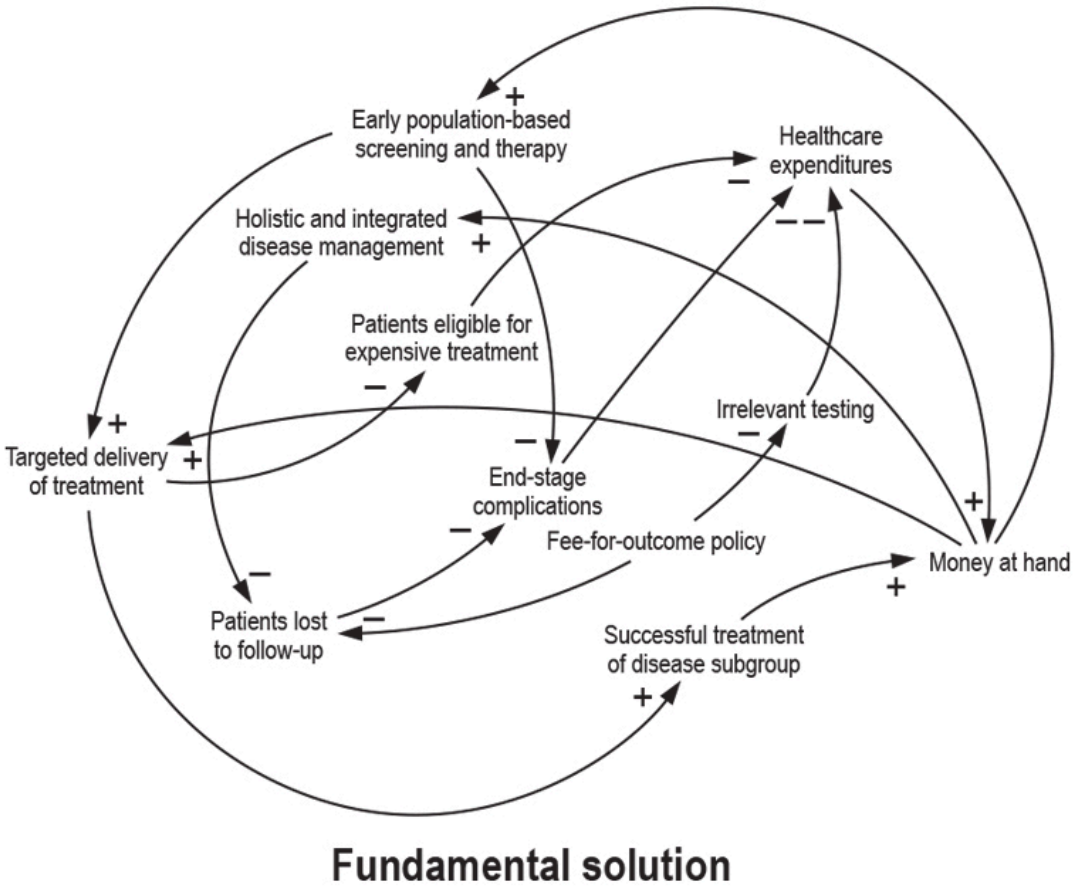
In Switzerland, voluntary screening programmes for breast cancer have been introduced in some cantons, where women age 50–74 years receive an invitation for mammography covered by their insurance every other year [63]. Furthermore, the health insurance covers stool testing every two years and colonoscopy every 10 years for people age 50–69 years to screen for colon cancer [64]. Another incentive for higher screening rates could be to facilitate enrolment on clinical trials, which will have a downstream effect on patients' medication costs.

In order to demonstrate the cost-effectiveness of screening and early diagnosis, and given the increasing quality and availability of electronic health-record data [65], more longitudinal and comprehensive real-world patient data are needed [66].

We further proposed that both comprehensive and stratified patient management have the potential to reduce costs and improve medical outcomes by enabling earlier, individualised interventions that can diminish subsequent health problems [6], avert adverse outcomes [67, 68], reduce or prevent hospitalisations [64], and avoid the cost of late-stage or unnecessary treatment [16]. Figure 3 summarises the potential consequences of all interventions on the current use of IVDs.

Finally, we favour a move towards individualised treatment (PHC). Individualised treatment allows patients to receive exactly the medication that is needed and avoids inappropriate therapies with consequent high healthcare expenditures, and prevents undesired outcomes [6, 69, 70]. In order to implement these interventions, we argued that shifting healthcare incentives from a service-based to a value-based approach is a *conditio sine qua non*, as it not only underscores the importance of regulating IVDs, but also serves as an incentive for developers to continue to innovate [49]. Validation of assays should follow quality parameters, such as clear definition of the intended use, thresholds, optimisation, standardisation, repeatability, an-

Figure 3: How interventions affect the current use of in vitro diagnostics.+ = amplifying feedback; – = attenuating feedback.



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alytical/diagnostic sensitivity, and specificity [71]. Full validation is required when there is no suitable performance specification available, and should be performed in comparison with the currently available "gold standard" [72]. For IVDs, value-based reimbursement criteria could be potentially based on the following conditions:

- Clear evidence of improved patient outcomes, derived through algorithms validated in clinical utility studies addressing an unmet medical need
- Delivery of actionable and medically relevant information enabling support and guidance in decision-making.

In a scenario with transparent and meaningful reimbursement policies for assays with a clearly defined intended use and proven clinical utility, more innovation and investment will happen on the industry side, paired with meaningful patient outcomes, and better resource utilisation [73–76].
In 2012, the American Board of Internal Medicine launched the "Choosing Wisely" initiative to avoid unnecessary medical tests, treatments, and procedures [77]. In 2014, the Swiss Society of Internal Medicine launched a similar campaign called "Smarter Medicine" [78]. These initiatives, indicative of a move towards value-based reimbursement for pharmaceutical agents, have not yet been implemented in the diagnostics field.

Conclusion

Implementing changes to the current utilisation of IVDs will be necessary to provide broad, cost-efficient, state-of-the-art healthcare in the future. It is key to creating awareness that IVDs are often misunderstood as being part of the problem. Those in charge of managing the limited resources available for healthcare are called on to take into account the possible consequences of removing the tools that could help overcome the vicious circle of ever-increasing healthcare costs, and should act accordingly. Considering recent developments in the pharmaceutical sector, we believe that there is an unmet need for politicians to create policies for the use of IVD that reward outcome instead of service. Conversely, those developing and providing IVDs are challenged to focus on medically relevant, innovative and validated diagnostics. Other than that, diagnostics companies should continuously work on innovative reimbursement solutions for their products. This way, the promise of living a longer, healthier life can be kept for generations to come.

Disclosure statement
In addition to their clinical work, MS and HHS are employees of Roche Diagnostics, Medical and Scientific Affairs; CB was an employee of Roche Diagnostics at the time of preparing the manuscript. The opinion expressed in this article does not reflect the opinion of F. Hoffmann-La Roche Ltd.

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