Innovation for Prevention and Health

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Introduction
In 2003, the co-founder of Seattle’s Institute for Systems Biology (ISB), Leroy Hood, coined the term ‘P4 Medicine’, a systems approach to health and disease.\(^1\) It aims to make health care more \textit{Predictive, Preventive, Personalized} and \textit{Participatory}. Advances in genomics and molecular diagnostics have enabled the development and use of \textit{predictive} information to \textit{prevent} diseases. In case a patient is already subject to a disease, individual genetic information is then used to \textit{personalize} treatments.\(^2\) The \textit{participatory} nature of the approach is also important, involving individuals in managing their own health.\(^3\)

This Issue Brief takes a closer look at the element of \textit{prevention}.

1. The need for prevention in health care
The developed world will be facing growing health challenges in the near future. Today’s ongoing trends such as the obesity epidemic, the growing prevalence of certain chronic diseases or increasing fiscal pressures on our health-care systems are as many symptoms of a need to change the way we look at and take care of our health. One central element on this pathway to change is the concept of prevention.

In health care, prevention is an approach aiming at avoiding, but also moderating or disrupting major dysfunctions (e.g., diseases). Prevention is typically understood as an early intervention that occurs before the full manifestation of symptoms and through the identification and study of risk and protective factors. Prevention (of secondary effects, or of other diseases) is also relevant during disease remission. Prevention can be population-wide, or targeted at a high-risk group of patients. It is multi-faceted and multidisciplinary by nature. In health care, it targets social determinants such as social class, environmental influences such as geographical location, lifestyle influences such as smoking or nutrition, and physiological influences such as cholesterol.\(^4\)

Health-care services are often and traditionally oriented towards ‘sick care’ (treating acute diseases), rather than disease prevention and public health programs. The share of health-care expenditures allocated to prevention remains limited.\(^5\) In 2006, prevention represented only 3% of total health expenditures in OECD countries.\(^6,7\) However, it is increasingly gaining ground in the debate on the future of health and health care. For instance, it has become an important pillar of the US national health strategy in 2011.\(^8\) This section first provides a number of reasons behind the renaissance and emergence of prevention on health agendas and discussions. It also touches upon the various concepts defining prevention.
**A response to health challenges in Europe**

A number of trends and health challenges will likely lead to considerable losses both in terms of mortality and morbidity burden, and economically.

Chronic diseases remain and will continue to be Europe’s major health challenge. The number of deaths caused by some of them is projected to increase. For example, in terms of mortality, most cancers are expected to cause an increasing number of deaths through 2030 – in particular lung, colorectal, breast and prostate cancers. Chronic diseases being rarely cured and lasting longer, they require different treatments and patient management.

Such diseases are driven by the spread of unhealthy habits and behaviors in Western societies. Smoking, physical inactivity or the consumption of sugary foods and alcohol have a major influence on the development of chronic illnesses, including diabetes, cancers or heart diseases, and multimorbidity, i.e., when a patient suffers from a combination of such diseases. The human and economic burden of these risk factors is considerable, yet much of it is preventable. Currently, more than half of the WHO European Region does not get the recommended doses of physical activity, and according to the WHO, this share is increasing. In addition, overweight and obesity have been increasingly linked to typical Western high-calorie diets. The EU estimates that more than half of the adult population in the EU is obese (defined as a BMI $>30$) or overweight (defined as a BMI $>25$), and both these health problems are ranked fifth on the list of leading causes of death in Europe.

Future health challenges can also be explained by demographic trends that characterize the developed world. In particular, aging will lead to a greater incidence of diseases, including neurodegenerative disorders (e.g., Alzheimer’s), but also to more disabilities. For example, according to the European Commission, the Netherlands is expected to see the share of its population over 65 increase from 15.3% in 2010 to 26.8% in 2050. This will require additional investments such as daily assistance from health-care personnel. Increasing fiscal pressures are likely to weigh on health-care systems, as life expectancy and the health-care dependent share of the population will go up while the workforce and thus the share of tax payers will decrease. The current economic context facing the developed world is expected to render this situation more urgent.

Prevention can be based on the concepts of patient empowerment and self-management (the participatory element of the ‘P4 medicine’). They entail the increased participation and role of patients in the process from health to disease. This is expected to lead to a decline in health risk factors (e.g., smoking). Empowering communities and employers to promote wellness strategies and prevention programs are also recommended.
2. The role of innovation in prevention

Innovation is a major driver of preventive measures and strategies in health care. Different types emerge from various industries and sectors: they can be institutional, social, behavioral or cultural, or technological. In this section, a number of such initiatives supporting the concepts of prevention are surveyed. It is worth noting here that prevention can be associated with the transformation of the health-care market into a consumer health-care market, in which the buying initiative originates from the consumers’ demands. This shift is driven by the increasing use of mobile and web-based technologies, self-monitoring devices, health tourism, self-care drugs, or functional foods. These are as many solutions facilitating prevention as well.16

Strategies and policies of prevention

There are several ways through which prevention can be efficiently implemented: from prohibition, taxation, to nudging, and self-management. Grouping these approaches combines individual responsibility with an impetus for prevention by health-care organizations and the government.

Institutional innovations

Policies that save money and aim to prevent unhealthy habits may be more efficient than medical interventions and therapies.17 They include prohibitive regulations such as smoking bans in public places, raising the minimum age for alcohol consumption, or food advertising restrictions, as well as economic (dis)incentives such as the increased price of cigarettes, or fuel price escalator (i.e., increasing duties on fuel) to encourage physical activity.

In addition, using information technology architectures and developments in intervention and biomedical technology could accelerate the implementation of new processes by public authorities, such as moving care from hospitals into patient homes.

Behavioral innovations

There are a number of barriers to the successful implementation of disease prevention as a process. These barriers can be demographic (e.g., educational level), or institutional (e.g., access to care), but also behavioral, cultural. The latter include languages, social customs, values, norms, traditional health beliefs, dietary preferences and practices, and communication patterns.18

Prevention could therefore be implemented further by establishing a ‘culture of prevention’ effectively changing values with respect to health. Establishing such a culture would imply a change within society and transformations at the organizational level. So far, it remains mostly envisioned through safety and health in the workplace.19 It therefore needs to be expanded to general attitudes and daily behaviors and, at the organizational level, promoted within the processes of our health-care systems.

In particular, ‘nudging’, the empowerment of communities and self-management could progressively and definitively transforming behaviors among populations.

Preventative strategies are intrinsically based on the rationality of patients with respect to – for example – lifestyle choices. However, appealing to emotions (e.g., as shown in the second section, with computer games) can prove very efficient in raising awareness, but also in improving emotional health as part of the objective of prevention. Through the activation of this affective system, behaviors could be effectively transformed by ‘nudging’ populations, as suggested in a 2011 study.20
Combined with prohibitive regulations as suggested above, nudging could lead populations to internalize and adopt healthier behaviors, for example by promoting non-smoking attitudes and choices through mass media campaigns, by serving drinks in smaller glasses, or by encouraging physical activity through more visible, attractive and safer cycling lanes in urban areas.

Further, increasing the public understanding of medical science and communicate better on diseases would facilitate prevention as well as improve medical or health literacy. This implies a larger public access to more knowledge of the consequences of both their individual behaviors and their use of health-care systems. New educational tools can help patients make more informed choices of health-care products, services and options. As a result, healthier lifestyle choices and a more responsible use of health-care services are promoted. Prevention strategies mentioned above – such as nudging or patient empowerment – can also contribute to changing behaviors on a large scale.

According to a study, the perception of disease prevention remains characterized by traditional concepts of medical practice. Indeed, the responsibility of individual health would be delegated to the population, which would make individuals feel guilty and devalued, and “slip into passiveness”. Investments in research, infrastructure and human resources could be useful in order to modify attitudes towards prevention and promote it better. For example, research into the cost-effectiveness of preventive screening programs, which are not equally recommended or accessible across Europe, could lead to their increased integration into health-care delivery.

**Technological innovations**

Prevention is expected to be facilitated by a number of tools and devices developed in several sectors, which would make care more affordable and less intrusive. New imaging equipment, diagnostic devices, wireless devices and in-home care technologies are predicted to become widespread. This could help in coping with new health challenges such as aging, for example by developing new tools for in-home care, thereby increasing the independence of elderly.

**Pharmaceutical and medical industry**

In the pharmaceutical industry, innovation emerges in in-home care products or ‘low-cost’ medication. Generic medicine, self-medication (such as currently customary pregnancy home tests or drugs for urinary infections) are examples of drugs that would help patients monitor their health – and would be cheaper to manufacture than those they replace.

In the medical device (‘medtech’) industry, expectations for future technologies that could create preventive solutions through 2040 range from diagnostics (for example, blood stream sensors) to telemedicine (for example, robotic health-care assistants), or from biogerontology (for instance, anti-aging drugs) to regeneration (with artificial organs), enhanced metabolism and sensory augmentation.

Siemens is developing preventive solutions that include early screening for cardiovascular disease, or computed tomography improving patient experience. These processes form a framework for personalized medicine with integrating prevention and early detection, diagnostics in vitro and in vivo (e.g., mammography), and therapy and care (i.e., physical examination). Philips is engaged in wide-ranging R&D to develop new products that are applicable to older consumers, from specialized lighting options to a range of ‘tele-health’ or home-based care products that facilitate independence.
Wireless health

Other industries are contributing to technological breakthroughs in health care, including innovations that are not originally related to this sector. One of the most revealing examples is the development of initiatives that use ‘big data’ in health care. Information about customers of these initiatives can be collected, registered, and exchanged; users can measure their performance and evaluate their behaviors with their smartphone applications or other devices.28

Applications

In particular, familiar technologies such as tablets, mobile and web device applications provide solutions that are transforming the health-care industry. They increasingly support preventive care and patients in managing their health condition by aggregating data, sending medication reminders, healthy habit tips and medical bill reminders, tracking blood sugar, blood pressure, pain, counting calories, etc.29 As anticipated in one study, “Google-types of search engines for medical advice will emerge, as will software to manage medical expenses, and technology that enables instant home health-care access, or telemedicine”30.

Mobile Personal Health Records (mPHR) include the so-called apps that enable self-care through the monitoring of patients’ conditions and potential chronic illnesses. One of Nhumi.com’s innovations, a software company specialized in clinical data, comprehensively targets and defines diseases through a 3D-model of the human body.31 Heart diseases are one of the many chronic illnesses that remain major causes of death: developed by an eponymous Californian start-up,32 the Cardiio App calculates the user’s heart rate, and can help monitor one’s condition by targeting or preventing complications.

Diabetes is set to become an increasing issue in developed societies: a mobile phone app, mySugr, helps diabetics manage their level of blood sugar concentration. Another promising example in a context of increasing allergic diseases33 include 23andMe, or the ‘pollen app’ which identifies both allergy symptoms and types, the regions with likely pollen release, etc. Customers can adjust their activities and mobility on this basis. The conditions of an aging populations could become more efficiently examined by mPHR as well: Control4 by CloseBy Network, a developer of wireless communications products, combines “sensor technology embedded in the home to monitor the elderly and alert caregivers to changes in status” or behaviors via cell phones and alerts via email or text “when specific sensors are triggered”.34

Personalized devices

It is interesting to note the recent shift towards investments that aim to increase independence, such as equipment personalizing health-care solutions, empowering patients, and providing information control. These technological solutions support acute and chronic care and give rise to more patient-friendly innovations. They are also expected to play a role in providing a system for prevention by adapting treatments to patients’ profiles.35 They support daily health management for both health individuals or patients in the form of sensor-embedded consumer products such as glucometers or sleep manager devices aiming to prevent apnea, etc.36 Tools such as the Zeo are particularly relevant as people suffering from insufficient sleep are exposed to greater disease risks.37 The Zeo, a personal analysis device, consists of a “wireless headband, bedside display, and email based personalized coaching program and analytical tools. It identified periods of wake, REM, light, and deep sleep”. The Zeo produces a daily score relating to the individual’s sleep quantity and quality. Another example is the Fitbit Tracker, a coaching device clipped to clothing, tracking calories burned, steps taken, distance travel, sleep quality. It wirelessly synchronizes with a phone or a computer, which
automatically upload the tracked data to a fitness and nutrition website.\textsuperscript{38} Dexcom “uses a biosensor inserted into the skin to continuously monitor blood sugar levels and transmit that data to a mobile communication device”.\textsuperscript{39} If used by diabetics, this could help practitioners and caregivers to adjust insulin doses accordingly.

In a more playful domain, computer games are being developed for their therapeutic effects,\textsuperscript{40} and strengthen the relations between stakeholders. For example, ‘Re-mission’ has been developed by HopeLab (from the Omidyar philanthropic network) for young cancer patients.\textsuperscript{41} Research has shown that the game would be effective in supporting health outcomes and behaviors among patients.\textsuperscript{42} ‘Circus Challenge’ was created by neuroscientists from Newcastle University and Limbs Alive (a company specialized in the rehabilitation of arms and hands) for stroke victims. Halfbrick Studios also developed ‘Fruit Ninja’ which helps stroke victims through motion controls. Circus Challenge is available for iPad, PlayStation, Xbox, etc., and could soon include telemonitoring to allow practitioners watch and support their patients’ progress. Lastly, remote monitoring devices combined to computer games also aim to prevent people at risk from becoming diabetic. One example is the digital glucose monitor (DIDGET) that integrates with the Nintendo game console. It was commercialized by Bayer to ensure patient compliance in diabetes monitoring.\textsuperscript{43}

This further incorporation of technology into people’s lives – which some refer to as the ‘Quantified Self’ (QS) movement\textsuperscript{44} – can help in monitoring and improving one’s health daily through gaining self-knowledge and making better choices. Developers of QS initiatives advocate the democratization of health care and, as more data becomes available, the acceleration of medical research as additional positive implications. At the same time, challenges such as the increasing vulnerability to loss, theft and abuse of personal data, and the growing threat of cyber crime, cannot be underestimated.

**Organizational innovations**

In health care, organizational innovation can be associated with the development of new forms of networked cooperation between health-care organizations, professionals, and patients.\textsuperscript{45} It is also reflected within the corporate world, in the implementation of preventive health measures and alternative work processes, and in the creation of new financial arrangements (PPPs). These innovations provide solutions that aim to support prevention and could well increasingly provide an alternative to shrinking governmental health-care expenditure.

**New business models**

Communities That Care (CTC) is an example of organizational or social innovation implemented by the University of Washington. It develops a preventative strategy by encouraging communities to use prevention research and data to implement systems aiming at reducing risk factors such as drug and alcohol misuse or school age pregnancy. CTC provides manuals, training and tools, and technical assistance to identify risk factors and target needs.\textsuperscript{46}

New business models in health-care delivery increasingly rely on technologies. Examples include facilitated user networks for chronic disease prevention and management. Showing the evolution of established brands towards the integration of technologies, Weight Watchers has developed into an online coaching program that includes support and advice on helpful habits and smart eating. The network dLife aims to facilitate the exchange of advice and information among diabetics and their families.\textsuperscript{47} These models are expected to move simple procedures from hospitals to homes. Such innovations supporting preventative measures and self-management of health may render health
care more affordable, as they deliver care at lower costs and offer alternatives to hospital and physician practices.

**Prevention in the workplace**
Firms are increasingly implementing policies using technologies adapted to working environments. This could help reduce costs by mitigating the effects on aging on workers, thereby extending working lives with improved productivity.48

Wilkhahn is an example of a company with successful qualification measures, as it was able to “more than halve its sickness rate from formerly ten to then four percent by means of a systematic participation-oriented analysis of the stresses and strains of the workplaces and corresponding comprehensive measures of behavior prevention as well as the prevention of unsafe workplaces”.49

Continental AG had achieved a similar success through ergonomic improvements. BMW is also adapting to the future evolution of its labor pool, by implementing policies that aim to preserve the productivity of an aging workforce. Since 2007, BMW has initiated adjustments of limited cost such as wooden platforms for workers to work on, rather than cement floors, to reduce the impact on joints; chairs at several workstations, to let workers sit while performing some tasks; magnifying glasses to help workers see tasks more clearly, etc. As a result, the performance and productivity of workers increased. A broader plan for demographic change followed in 2011: ‘Today for tomorrow’ was designed “to set new standards in aging-appropriate workplaces” through better health management and training, as well as new retirement possibilities such as semi-retirement and more flexible working models.50

**Public-Private Partnerships**
Due to the increasing costs associated with non-communicable diseases or unhealthy habits and the diminished capacity of governments to address these, Public-Private Partnerships (PPPs) aiming to develop prevention are being increasingly created. Traditionally, PPPs seem to focus on preventing diseases (e.g., sexually transmitted infections and malaria), developing and facilitating access to vaccines and drugs, and improving health-care services in the developing world.

A number of European PPPs promote initiatives to prevent childhood obesity. For example, the Directorate General Health and Consumers of the European Commission, several nonprofit organizations from the public sector have collaborated with Nestlé or Kraft Foods to facilitate community-based prevention interventions.52 Next to obesity, diabetes are a mounting concern in the developed world. In the US, the National Diabetes Prevention Program aims to reduce of delay type 2 diabetes through lifestyle programs (offering coaching services, encouraging physical activity, etc.).52 It is led by the Centers for Disease control and Prevention (US Department of Health), in cooperation with partners such as the UnitedHealth Group, a leading health-care company.

PPPs also set up projects in the field of neurodegenerative diseases. The Alzheimer’s Public-Private Partnership, ‘Solutions Project Office’, was implemented in 2010 within the US Federal Government. It is based on active collaboration with stakeholders outside the government and provides prevention and care improvement initiatives.53 In the Netherlands, ParkinsonNet54 was created by the Radboud University Nijmegen Medical Centre and the Dutch society for Neurology55 to enable the proximity of care for patients with Parkinson. The initiative is supported by the Dutch national
Parkinson’s organization\textsuperscript{56} and different professional groups of caregivers (e.g., physiotherapists, speech or occupational therapists, in cooperation with nurses and neurologists).

PPPs also focus on cardiovascular diseases, as these remain the biggest killer in the developed world. The National Salt Reduction Initiative in the US is coordinated by the New York City Health Department and 85 state and local health departments, as well as national health organizations such as the Consumers Union or the American Medical Association.\textsuperscript{57}

Other PPPs finance initiatives for cancer research and prevention. New York City programs aiming to prevent colorectal cancer through screening for vulnerable populations are funded by the New York Community Trust Cancer. The foundation particularly collaborates with the New York City Department of Health.\textsuperscript{58}

Health PPPs face implementation challenges, as all PPPs do (e.g., unpredicted increases in demand). But these projects may have a fiscal impact on governmental budgets. Other key challenges that can be expected include unclear regulations, inadequate technical capacity, maintaining the access to and quality of care, and accountability issues.\textsuperscript{59}
3. Assessing the costs and benefits of prevention in health care

In the face of the challenges previously mentioned, it appears that there is a case for disease prevention becoming a public health priority. But a number of studies have shown that the potential of prevention for controlling health-care costs should be carefully evaluated. Some measures are very efficient. Investing in prevention may save money in some cases, but it may increase medical spending in others. Much depends on the type of population and intervention. Investing in prevention is likely to be economically beneficial when intervention costs are low, or when getting sick is expected to be and remain costly (as it is the case for dementia care). Some studies indicate that prevention may positively affect productivity levels and lower mortality and morbidity, thereby reducing demands or cost pressures on health-care systems: healthier people are more productive than ill ones. And productivity losses associated with the effects of chronic diseases, such as disability, unplanned absences and increased accidents, are estimated to cost as much as four times more than the cost of treatment.

More generally, good health contributes in major ways to people’s wellbeing, which can also significantly contribute to high economic returns. Therefore, health improvement through prevention should be increasingly perceived as a value of investment with wider benefits rather than just an economic return on investment. Focusing on the latter may be the wrong way to think about prevention. Instead of simply taking into account financial indicators and the sole argument of cost-effectiveness, the value of good health could be measured through – for instance – participation indicators, preventive screening and health risk indicators.

Based on this perspective, Van Ewijk et al. present a number of health benefits. First, individual health benefits include an increased life expectancy (‘quantity’), a better quality of life and improved labor participation. Health is an important means for people to earn an income and to effectively participate in society. A healthy population is also a precondition for a functioning civil society – for instance, through voluntary work and informal care. In addition to individual benefits, better health leads to external benefits that arise because an individual’s health is also beneficiary to others: at the most basic level, a healthy individual does not infect others. But collectively, health is an important condition for a highly educated and productive population.

Beyond the undisputed improvement of health status, economic benefits of prevention for individuals themselves are also identified. In particular, a 2006 study published in the American Journal of Public Health shows that except for smoking cures, life extension as a consequence of preventive interventions would not lead to increasing lifetime medical spending on average, most notably with respect to obesity, diabetes or hypertension. The same study calculates the effects of prevention on life expectancy gains, revealing that a 51 or 52 year-old patient would live 0.85 additional years after being successfully treated for obesity, 2.05 years for hypertension, and 3.14 for diabetes. In addition, longer life expectancies may imply long-term care, the ability to live independently and potentially longer working lives. As a result, innovation in prevention anticipating and responding to these needs may help maintain physical function and optimize health for the elderly. This may mitigate the potential negative psychosocial effects of isolation and immobility.

For these reasons, focusing on disease prevention and health promotion deserves more attention in future health research strategies. This suggests a new way to look at prevention – not only as a
means to control spending – but also more generally at health, health outcomes and disease management within health-care systems.
Conclusion

The growing prevalence of health risk factors, demographic trends and fiscal pressures on public health-care expenditures call for the adoption of health-care systems that would place more emphasis on the prevention of diseases and the promotion of better population health. Driven by these health trends and an easier access to new technologies within our societies, an increasing number of innovative projects and initiatives are directed towards promoting health and preventing diseases. They range from the realm of new technologies and the health-care industry to the adoption of new organizational processes and new types of collaboration, as well as a more comprehensive transformation of values and behaviors toward the meaning of health and disease.

There is consensus that governments spend too much on treatment, and not enough on prevention, in spite of the relevance of this approach to our societies’ health challenges. At the same time, there is some evidence that spending more on prevention may not always help in controlling health-care costs. More research seems necessary to carefully evaluate this issue. And the role of governments may have to be reassessed: initiatives from communities and the private sector could provide solid alternatives to finance and promote prevention, and may even manage to upgrade health-care infrastructure. Shifting the focus to prevention will in any case involve a new perspective on the definition and meaning of health and individual or shared responsibility.

2 For more information on Personalization, see Issue Brief: “Innovation for Personalized Health Care” (HCSS & TNO, 2013).
6 ‘Prevention’ in this sentence refers to vaccination programs, public health campaigns on nutrition, physical activity, alcohol abuse and smoking – as defined by the OECD.
11 According to the WHO, the Body Mass Index (BMI) “is a simple index of weight-for-height that is commonly used to classify underweight, overweight and obesity in adults”. According to the BMI International Classification of adult underweight, overweight and obesity, a BMI superior to 25 means an individual is overweight, and a BMI superior to 30 corresponds to obesity.


34 The Deloitte Center for Health Solutions, “The Mobile Personal Health Record: Technology-Enabled Self-Care: Barriers and opportunities to accelerate use”, Issue Brief, 2010.
35 For more information on Personalization, see Issue Brief: “Innovation for Personalized Health Care” (HCSS & TNO, 2013).
37 Division of Sleep Medicine at Harvard Medical School, Healthy Sleep: Consequences of Insufficient Sleep”, http://healthysleep.med.harvard.edu/healthy/matters/consequences.
39 The Deloitte Center for Health Solutions, “The Mobile Personal Health Record: Technology-Enabled Self-Care: Barriers and opportunities to accelerate use”.
50 The Economist Intelligence Unit, A Silver Opportunity? Rising Longevity and Its Implications for Business, p. 11.
55 Nederlandse Vereniging voor Neurologie, Nederlandse Werkgroep voor Bewegingsstoornissen.
56 Parkinson Vereniging.


