



Health~Holland, Grow~Motion

Knowledge and Innovation Agenda 2018 - 2021

Health and Care

(Gezondheid en Zorg)

by the Top Sector Life Sciences & Health

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Preface

After starting, to be honest, somewhat reserved in 2015 as the new Chair of the Top Sector Life Sciences & Health, I can only state: it's been an absolutely fascinating journey so far. As this sector has so much to offer to our citizens, our economy and to society at large, both here in The Netherlands as well as abroad. Every time when visiting our regions – from the north to the south, from the east to the west – the Top Team- and Advisory Board-fellows are always impressed by the passionate and precise workmanship of scientists, entrepreneurs and policy makers collaborating to make this sector to what it is now: an aligned ecosystem providing the nowadays' best new life sciences and health solutions to the world and adventurous to identify new ones for the future. We can be proud of national public-private initiatives as RegMedXB in regenerative medicine and Oncode Institute in breakthrough cancer research, but also of the numerous scientists and entrepreneurs who work day-in day-out to explore health solutions and thereby improve the chances of good health and quality of life for us all, allowing us to actively participate in and contribute to society. Carrying all of our accomplishments in the back of my mind, I was all the more privileged to accompany many of you together with representatives of our government on an increasing number of international trade missions. It was inspiring to see that our collaboration at home, in and across the regions, was also demonstrated internationally by you under the waving orange Health-Holland umbrellas at conferences and summits. On top of our excellent products and services, such a role-model of expertise and cooperation provides us with an enormous footprint globally, via export and international collaboration. And there is more to come. With this vibrant Top Sector LSH as our basis, we will continue to combine our efforts in the years to come with our colleagues in the other Dutch Top Sectors and Key Enabling Technologies for the Societal Challenge Health and Care. Our journey thus continuous, with all of you in the Life Sciences and Health sector and all who care. In contrast to 2015, I now feel no reserves whatsoever, but feel all the more privileged to be your Chair.

Please come along and let's continue our journey, here in The Netherlands and abroad. May this Knowledge and Innovation Agenda 2018-2021 Health and Care inspire us all for more innovative products and services. Please join as my guest in this collective grow motion.

On behalf of the coalition on Health and Care, led by the Top Sector Life Sciences & Health, The Hague, 30 June 2017:



Prof. Jan Raaijmakers
Chair Top Team LSH



Erik Gerritsen:
*Secretary General, Ministry of Health, Welfare and Sport / Government
Member Top Team LSH*




Prof. Huibert Pols:
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Len de Jong:
*CEO Enraf Nonius / SME Member Top
Team LSH*



Hans Schikan:
*Former CEO Prosensa /
SME Member Top Team LSH*



Prof. Nico van Meeteren:
Executive Director of Top Sector LSH

Management summary

Relevance

Vital functioning citizens contribute to the well-being and productivity of the Netherlands and stimulate the national economy. Nowadays our population is relatively rich and healthy, and our healthcare is excellent¹, although it can always be better. Improvements are necessary because of the rapidly rising demands on healthcare – due to our sub-optimal lifestyle choices and because we are all living longer, often with one or more chronic disorders. We collectively pay more for healthcare and our healthcare budgets are under increasing pressure, and this most affects people with a low social-economic status. Our aim is to better prevent and cure diseases, which requires interdisciplinary cooperation to bring about technological progress and social innovation leading to breakthroughs in healthcare. The Dutch *Top Sector Life Sciences & Health* (LSH) is working on innovative products and services for prevention and care, such as early recognition of health risks, lifestyles and living environments, and treatment of diseased organs (*Regenerative medicine*), new homecare concepts and technologies for the elderly and those with chronic disorders (*eHealth*)², and is also working on learning more about preventing epidemics in people and animals (*One Health*) on a national and international scale (*Global Health*). More decisive breakthroughs for Health and Care (*Gezondheid en zorg*) can be expected if other Top Sectors and Key Enabling Technologies (KETs) will, in the future, increasingly combine their expertise and efforts with those of LSH.

Programme

The healthcare of the future will help ensure we have *vital functioning citizens in a healthy economy*. Healthcare will predict risks (*predictive*) early to help citizens manage their own health extramurally to the best of their ability (*participation*) and thereby prevent illness and problems as much as possible

(*prevention*) and where necessary to treat or even cure them (*curative*), an option becoming more and more feasible, so that they can continue to participate in society as much as they wish to do so. Such preventive measures and care should take place in their own (home) surroundings³ as far as possible and will, on the one hand, contribute to a further rise in life expectation and reduction in disease burden, while on the other also ensuring that healthcare remains affordable, accessible and of good quality.

In 2016 we invested €730 million in LSH research and innovation, which led to an added economic value of €3,300 million, through work opportunities (54,000 FTE split between 2,900 companies), foreign investments and exports (€5,600 million)⁴. But this too can be improved upon. It is well known that healthcare professionals and patients only implement and use healthcare innovations in a rather limited manner. This means that LSH investments are not yet delivering the best return in a social and economic sense and that there is room for improvement, both in the Netherlands but also internationally. Our strong reputation in healthcare, our excellent science, and the involvement of companies in the Top Sector LSH and its infrastructure⁵ offer opportunities for LSH to earn a considerable amount for the Dutch economy in a worldwide healthcare market estimated to involve US\$6.5–7.0 trillion per year⁶.

The Dutch Ministries of *Economic Affairs, Education, Culture and Science* and of course *Health, Welfare and Sport* and *Social Affairs and Employment* work together closely in the LSH's coalition for Health and Care. For the current societal challenge, LSH cooperates with many partners in the NFU and ZonMw coordinated National Research Agenda Routes for “Healthcare research, sickness prevention and treatment”, “Personalised medicine: the individual at the centre”, and “Regenerative medicine: game changer moving to broad areas of application”, and is further involved in the Routes “NeuroLabNL: the ultimate living lab for brain, cognition and behavioural research” and “Sport and exercise”. The coalition further includes the Top

Sectors of *AgriFood, Chemistry, Creative Industry, High Tech Systems and Materials, Logistics and Horticulture and Propagation Materials*, and the KETs *Biotechnology, Photonics, Advanced Materials⁷, Nanotechnologies, Measurement and Detection technology* and *ICT*.

Implementation

Good collaborations between citizens, researchers, government and entrepreneurs (*the quadruple helix*), and between disciplines and institutes, are essential conditions for the healthcare of the future. In recent years, several Public Private Partnerships (PPPs) have been set up for fundamental, experimental and industrial LSH research⁸. For example, there are national PPPs that work on the prevention and treatment of cardiovascular diseases⁹ and dementia¹⁰, and on cancer in the *Onco Institute*¹¹, and diabetes, arthritis and kidney failure in the Dutch-Flemish *Regenerative Medicine Crossing Borders (RegMedXB)*¹² programme. Together with other Top Sectors, PPPs are working on new medications¹³, the growing problem of antimicrobial resistance¹⁴, the need for new medical technologies¹⁵ and ICT programs in healthcare, on artificial intelligence and decision support, connectivity and a national personalised medicine and health research infrastructure (Health-RI)¹⁶.

The economic impact of these PPPs is evident in the science parks growing around the university medical centres and (technical) universities. In order to enlarge the societal and economic return on investment in these PPPs, a better technology transfer to society and healthcare is required: it is known that valorisation and implementation of care innovations do not happen automatically or easily. For this the end-users (healthcare foundations¹⁷, patients¹⁸, current and future healthcare professional¹⁹, and entrepreneurs²⁰) have been closely involved in the choices made the PPPs: which prevention, cure and care innovations do the end-users consider important, at home and in schools, at the offices and in the care? Joint choices should lead to the desired innovations, which will be valorised and implemented more easily than before, aided by the staff of Universities of Applied Sciences and of Intermediate Vocational Education, the Human Capital Agenda LSH, aligned *Technology Transfer Offices*, by valorisation training routes²¹ and by covenants agreed by government, policy-makers and financiers in the form of *Health Deals*²². In this way the perspectives for the SME companies should also improve.

Innovation and valorisation of care innovations are a great common benefit, but carry the inherent risk of driving up costs and thereby threaten the affordability of our healthcare.

To avoid such events, LSH has set up a PPP with healthcare economists that is looking at the affordability of care innovations and of the healthcare system (*Value-Based Healthcare*²³). This takes place via so-called (*early*) *Health Technology Assessment* based on innovative scientific and economic insights and research. In the strategy for 2018-2021, the LSH collaboration will aid the PPPs mentioned above in continuing their success, also internationally through Horizon 2020²⁴ for science and via the *EIT Health*²⁵ for valorisation. Via the *Task Force Health Care*, the *World Economic Forum*, the *international network of innovation attachés*, and the *Netherlands Foreign Investment Agency*, LSH will work to expand the export and foreign investments of Dutch LSH²⁶ with respect to recent years.

The recent LSH successes are encouraging for the development of the PPPs and boosting the (Dutch) economy further. The driving points are that people manage to maintain good health and functioning in their living environment and gain a maximum effect from care, if it is unavoidable. This effort leads to benefits to individuals and society that are greater than the costs. Recent successes demand more: more interdisciplinary collaborations and controlled growth – national and also international, via exports. There is already confidence this can be achieved and now the evidence must be seen in financial benefits in the near future.

In addition to further developing the existing PPPs, LSH would like to support the development of new PPPs preferably to target also preventive strategies. LSH will retain its focus by working selectively. New PPPs will be assessed for their relevance to the societal challenges, as well as their scientific excellence and economic potential. The assessment will also include their technology transfer plans for implementation and valorisation. In principle, within this framework, LSH is also interested in PPPs set up for the elderly²⁷, lung diseases²⁸, and mental and neurological (brain) disorders, and for the development of home care, in addition to many other PPP-initiatives that have recently appeared.

Management and communication

The societal challenge *Health and Care* is being managed by the Top Sector LSH, in particular by LSH Chairman Prof. Jan Raaijmakers and his Top Team. The primary contact person is Prof. Nico van Meeteren, Executive Director of Top Sector LSH. Communications from the Top Sector are distributed via the website of **Health-Holland**²⁹, which is the branding name for the Top Sector LSH.

Management samenvatting

Relevantie

Vitaal functionerende burgers dragen bij aan het welzijn en de productiviteit van Nederland en stimuleren de economie. Nu is onze bevolking relatief welvarend en gezond, en onze gezondheidszorg van hoog niveau³⁰, maar wat goed is kan altijd beter. Dat moet ook wel, want onze zorgvraag stijgt snel, door onze 'suboptimale' leefstijl en doordat we allemaal ouder worden met meerdere chronische ziekten. De betaalbaarheid van de zorg staat hierdoor toenemend onder druk, hetgeen vooral mensen met een lage sociaal economische status treft. Ziekten nog beter voorkomen en genezen is dan ook het devies en dat vereist interdisciplinaire samenwerking aan technologische vooruitgang en sociale innovatie ten behoeve van gezondheidszorgdoorbraken. De *Topsector Life Sciences & Health* (LSH) werkt aan innovatieve producten en diensten voor preventie en zorg, zoals vroegherkenning van gezondheidsrisico's, een gezonde leefstijl en leefomgeving, genezing van zieke organen (*regeneratieve geneeskunde*), nieuwe thuiszorgconcepten en -technologie (*eHealth*) voor ouderen en mensen met chronische aandoeningen³¹, tot en met kennis om epidemieën bij mensen en dieren te voorkomen (*One Health*), nationaal en internationaal (*Global Health*). Meer beslissende doorbraken voor *Gezondheid en zorg* zijn te verwachten wanneer ook andere Topsectoren en sleuteltechnologieën meer nog dan voorheen hun inzet en revenuen combineren met die van de LSH.

Programma

De gezondheidszorg van de toekomst draagt zorg voor *vitaal functionerende burgers in een gezonde economie*. Die gezondheidszorg voorspelt vroegtijdig risico's (*predictief*) om burgers *persoonlijk* te helpen om naar vermogen hun gezondheid zelf extramuraal te managen (*participatief*) en zodoende ziekte en gebrek zo mogelijk te voorkomen (*preventief*) en waar nodig te genezen (*curatief*), om naar believen mee te blijven doen in de

samenleving. Dergelijke preventie en zorg vinden zo veel als mogelijk plaats in de eigen leefomgeving³² en dragen enerzijds bij aan een verdere stijging van de levensverwachting en vermindering van ziektelast en zijn en blijven anderzijds betaalbaar, toegankelijk en van hoge kwaliteit.

In 2016 investeerden we 730 M€ in LSH onderzoek en -innovatie, hetgeen resulteerde in een toegevoegde economische waarde van 3.300 M€, via werkgelegenheid (54.000 fte verdeeld over 2.900 bedrijven), buitenlandse investeringen en export (5.600 M€)³³. Maar ook dit kan beter. Het is immers bekend dat gezondheidsinnovaties maar moeizaam geïmplementeerd en gebruikt worden door professionals en patiënten. Daardoor renderen LSH-investeringen maatschappelijk en economisch nog niet optimaal en is er dus nog ruimte voor verbetering. In Nederland, maar ook zeker internationaal. Onze sterke gezondheidszorgreputatie en onze excellente wetenschap en betrokkenheid van het bedrijfsleven in de Topsector LSH en haar infrastructuur³⁴ bieden ons via internationale samenwerking en export van preventie- en zorginnovaties kansen voor een stevig verdienmodel voor de BV Nederland in een gezondheidszorgmarkt die wereldwijd jaarlijks naar schatting 6.5-7.0 biljoen \$ omvat³⁵.

Binnen de LSH geleide coalitie voor de maatschappelijke uitdaging *Gezondheid en Zorg* werken de Ministeries van *Economische Zaken, Onderwijs, Wetenschap en Cultuur* en, uiteraard, *Volksgezondheid, Welzijn en Sport* en ook *Sociale Zaken en Werkgelegenheid* nauw samen. Vanuit LSH wordt nauw samengewerkt met vele partijen aan de door NFU en ZonMw gecoördineerde routes uit de Nationale Wetenschapsagenda die voor deze maatschappelijke uitdaging van belang zijn: "Gezondheidsonderzoek, preventie en behandeling", "Personalised medicine: uitgaan van het individu", "Regeneratieve geneeskunde: gamechanger op weg naar toepassing", en is betrokkenheid bij de routes "NeuroLabNL: de werkplaats voor hersen-, cognitie- en

gedragsonderzoek” en “Sport en Bewegen”. De coalitie bestaat verder uit de Topsectoren *Agri&Food*, *Chemie*, *Creatieve Industrie*, *High Tech Systems and Materials*, *Logistiek* en *Tuinbouw & Uitgangsmaterialen* en met de sleuteltechnologieën *Biotechnologie*, *Fotonica*, *Geavanceerde Materialen*³⁶, *Nanotechnologie*, *Meet- en detectietechnologie* en *ICT*.

Implementatie

Samenwerking tussen burgers, onderzoekers, overheid en ondernemers (de *quadruple helix*) en tussen disciplines en instituten is *conditio sine qua non* voor de Gezondheidszorg van de toekomst. In de afgelopen jaren zijn hiertoe reeds Publiek-Private Partnerschappen (PPPs) voor fundamenteel, experimenteel en industrieel LSH-onderzoek ontwikkeld³⁷. Zo zijn nationale PPPs ontstaan die werken aan het voorkomen en genezen van hart- en vaat-ziekten³⁸ en dementie³⁹, en van kanker en van diabetes, artrose en nierfalen in respectievelijk *Oncode Institute*⁴⁰ en het Nederlands-Vlaamse *Regenerative Medicine Crossing Borders* (RegMedXB)⁴¹. Samen met collega-Topsectoren wordt ook in PPPs gewerkt aan nieuwe medicijnen⁴², het groeiende probleem van de antimicrobiële resistentie⁴³, de behoefte aan nieuwe medische technologie⁴⁴ en zorg-ICT, artificiële intelligentie en beslisondersteuning, connectiviteit en een nationale personalised medicine en zorg onderzoeks-infrastructuur (Health-RI)⁴⁵.

Aan de groei van de bedrijventerreinen rond de Universitaire Medische Centra en de Technische universiteiten is de economische impact van deze PPPs goed te zien. Om het maatschappelijk en economisch rendement van de investeringen in deze PPPs verder te vergroten, is een verbetering van de technologie-transfer naar maatschappij en gezondheidszorg noodzakelijk: valorisatie en implementatie van zorginnovaties zijn immers geen sinecure gebleken. Hiertoe worden eindgebruikers via gezondheidsfondsen⁴⁶, patiënten⁴⁷, (toekomstige) zorgprofessionals⁴⁸ en ondernemers⁴⁹ nauw betrokken bij de keuzes van de PPPs: welke preventie- en zorginnovaties achten de eindgebruikers van belang, thuis en in scholen, op het werk en in de zorg? Gezamenlijke keuzes moeten leiden tot wenselijke innovaties, die zich gemakkelijker dan voorheen laten valoriseren en implementeren, daarbij ondersteund door de lectoren (HBO) en practoren (MBO), de Human Capital Agenda LSH, *Technology Transfer Offices*, door Valorisatie-opleidingstrajecten⁵⁰ en door convenantafspraken tussen overheid, beleidsmakers en financiers in de vorm van *Health Deals*⁵¹. Langs deze weg moet ook het perspectief van het MKB verder verbeteren. Innovatie en valorisatie van zorginnovaties

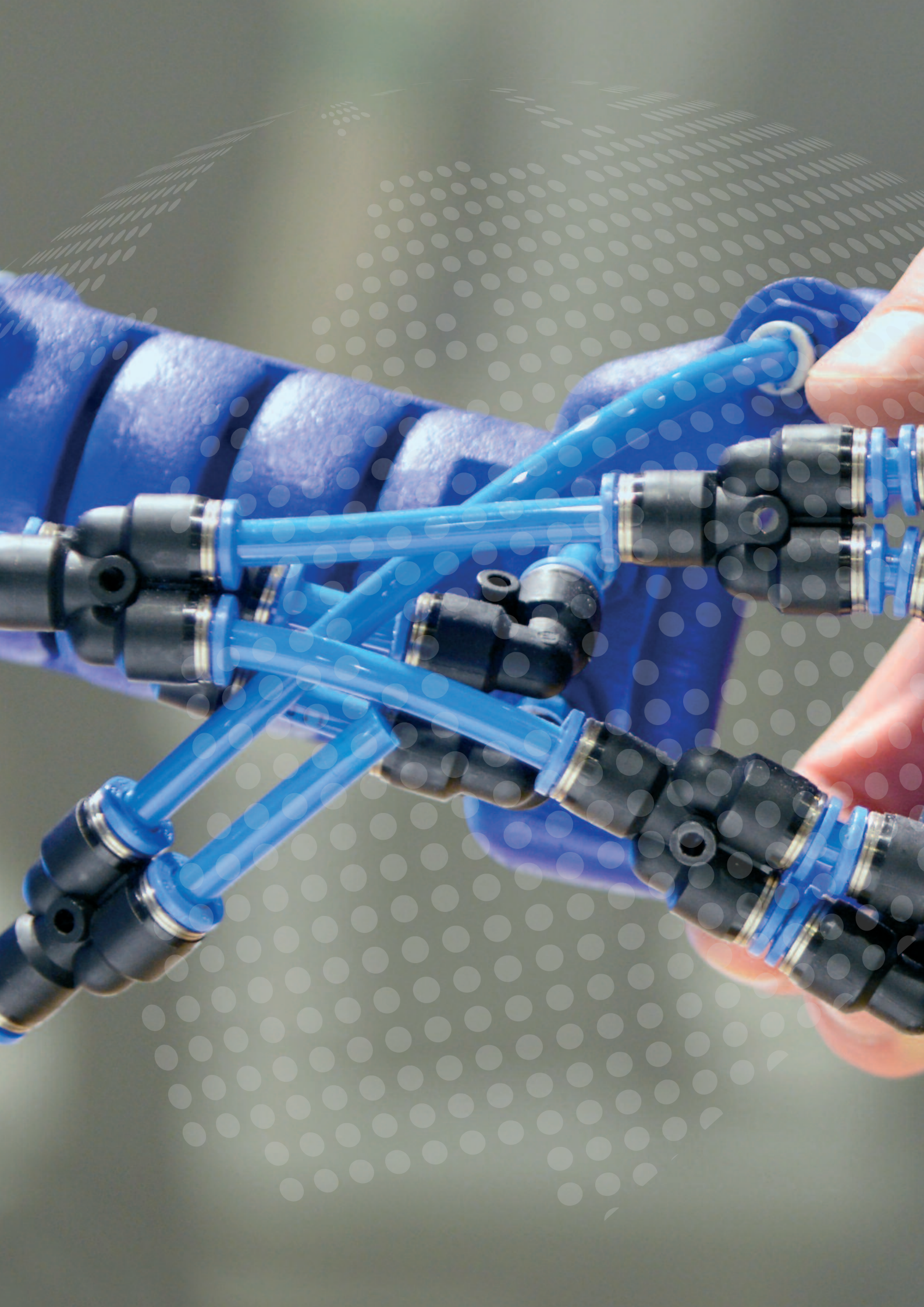
zijn uiteraard groot goed, maar dragen het risico in zich van zorgkostenopdriving en bedreigen dus de betaalbaarheid van onze gezondheidszorg. Om dit voor te zijn ontwikkelt LSH een PPP met gezondheidseconomen dat zich via zogeheten (*early*) *Health Technology Assessment* in wetenschappelijke en economische zin richt op de betaalbaarheid van zorginnovaties en van het gezondheidszorg-systeem (*Value Based Healthcare*)⁵². In de strategieperiode 2018-2021 faciliteert de LSH-coalitie de reeds genoemde PPPs om hun succes voort te zetten, ook internationaal via Horizon 2020⁵³ voor de wetenschap en via het *EIT Health*⁵⁴ voor de valorisatie. Via de *Task Force Health Care*, het *World Economic Forum*, het *internationale netwerk van innovatie attachés* en het *Netherlands Foreign Investment Agency* poogt LSH de export en buitenlandse investeringen van Nederlandse LSH⁵⁵ te verruimen ten opzichte van de voorbije jaren.

De recente LSH-successen enthousiasmeren om de PPPs door te ontwikkelen en de economie verder aan te jagen. Behoud van gezondheid en vitaal functioneren in de eigen leefomgeving en, wanneer onvermijdelijk, maximaal zorg-effect vormen daarbij de inzet. Een inzet waarbij de baten voor individuen en samenleving de kosten overvleugelen. Recente successen smaken naar meer, meer interdisciplinaire samenwerking en gecontroleerde groei – nationaal en via export ook internationaal. Het vertrouwen is er. Het bewijs daarvan moet zich de komende jaren verder verzilveren.

Naast het doorontwikkelen van de bestaande PPPs, is de LSH geleide coalitie graag bereid te overwegen nieuwe, bij voorkeur ook op preventie gerichte PPPs in hun ontwikkeling te steunen. Om focus te behouden gaat LSH daarbij selectief te werk. Nieuwe PPPs worden beoordeeld op hun relevantie voor de maatschappelijke uitdagingen, alsmede hun wetenschappelijke excellentie en economisch potentieel, inclusief hun technologie transfer voor implementatie en valorisatie. Ook PPPs gericht op ouderen⁵⁶, longziekten⁵⁷, en mentale- en hersenaandoeningen en op de ontwikkeling van thuiszorg zijn in dat kader in beginsel interessant, naast vele andere die zich recent aandienden.

Beheer en communicatie

De Maatschappelijke uitdaging “Gezondheid en Zorg” wordt beheerd door de Topsector LSH, in het bijzonder het LSH-Boegbeeld Prof. Dr. Jan Raaijmakers en zijn Topteam, en contactpersoon is Prof. Dr. Nico van Meeteren, Directeur van het TKI-bureau van de Topsector LSH. De communicatie van de Topsector verloopt via de website van **Health-Holland**⁵⁸, de merknaam van de Topsector LSH.

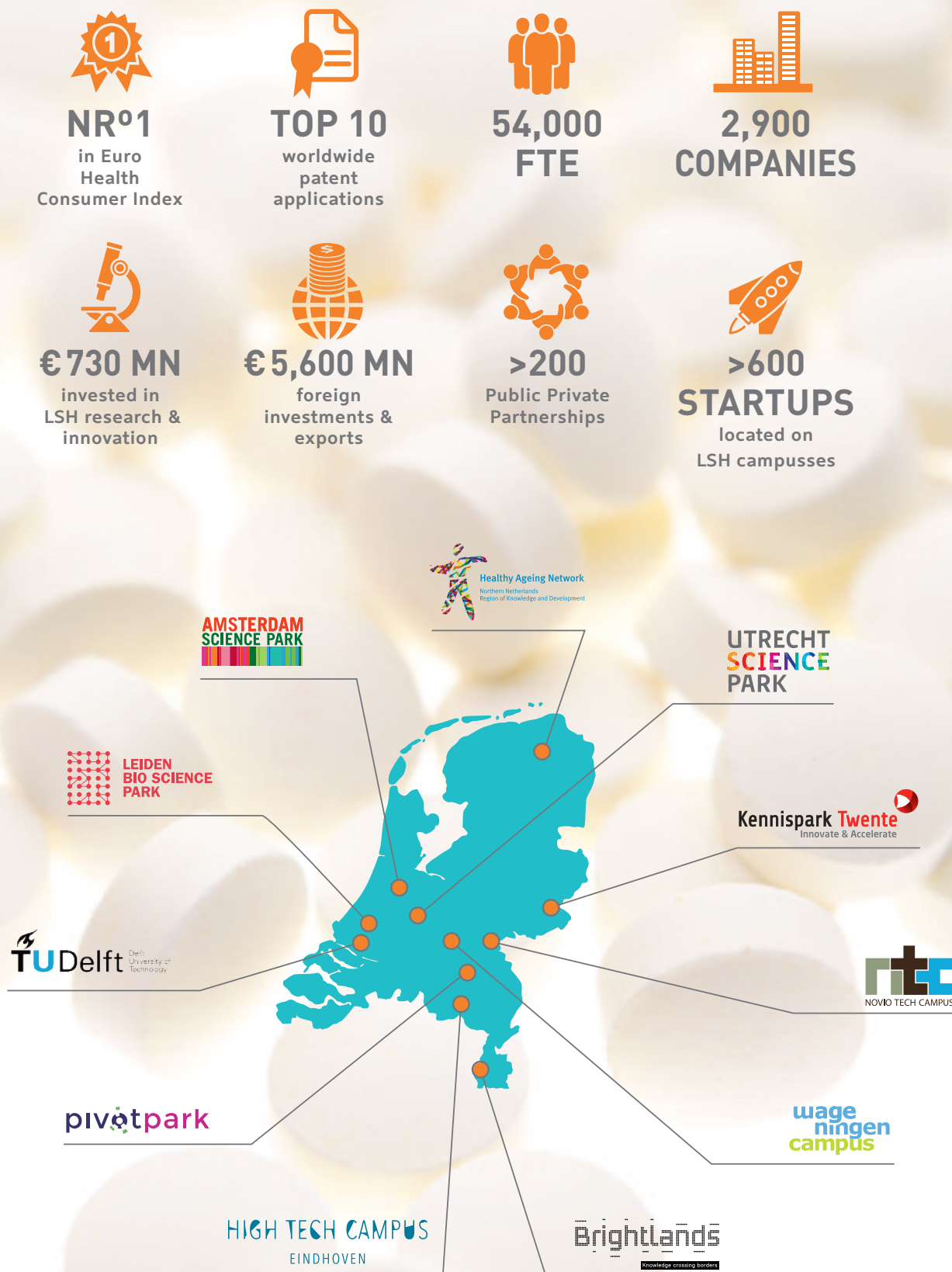


A close-up photograph of a person's hand holding a blue, braided cable. The cable has a textured, woven appearance and is connected to several black connectors. The background is a soft, out-of-focus grey.

‘Excellent and accessible nationwide infrastructure of knowledge, a long-standing tradition of public private partnerships and a multidisciplinary approach with a strong focus on the end user make the Dutch LSH sector distinctive on a global scale.’

- Len de Jong, CEO Enraf Nonius, SME Member Top Team LSH

Figure 1. Statistics of Dutch life sciences and health sector (2016) and overview of Dutch LSH campuses (based on Buck rapport).



Introduction

Societal challenges and economic opportunities

Countless advances in society and medicine in the last decades have improved our health and well-being. This success offers longevity on the one hand, but poses the challenges of an increasingly ageing population and increasing healthcare costs, threatening the affordability of the healthcare system, on the other. In parallel, the inequalities of good health are becoming more pronounced, at the expense of the lower socioeconomic classes, while the elderly often suffer from multiple (chronic) diseases. These developments require a transition, an all-encompassing process of change, to be made, covering every aspect of health and the healthcare system. At the same time, it would be very beneficial to the Dutch economy if such a process could generate opportunities in the Netherlands and internationally, based on a worldwide recognition of its importance⁵⁹.

The Dutch Life Sciences and Health (LSH) sector is one of the most successful in the world. This top position is attributable to our strong knowledge and research position and to our dynamic and competitive industrial branch⁶⁰. These attract national and foreign investments and create new companies and jobs⁶¹. We further have a well-aligned infrastructure of regional science and innovation parks⁶², accessible and good healthcare, which is constantly ranked high on an international scale⁶³, and we are educating the LSH-workforce of the future. Consequently, the LSH sector stimulates society's health, well-being and economic growth, both in the Netherlands and abroad through international diplomacy and exports.

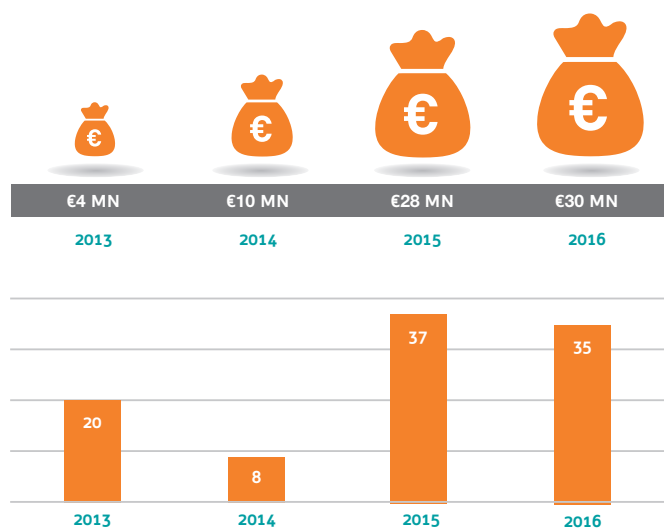
On many fronts the Netherlands presents a renowned role model for LSH: in the fields of pharmaceuticals⁶⁴, biotechnology, medical engineering, and information technology, but also through its leading companies and

public private healthcare system. Many Dutch LSH-highlights are famous worldwide, including the excellent science that brought us the first microscope, the first kidney dialyser and, more recently, through interdisciplinary and inter-institutional public private collaboration in research and development (R&D) Organoid Technology⁶⁵, ParkinsonNet⁶⁶ and, upcoming, the Dutch ICT-breakthrough innovation of the Personal Health Train that incorporates the FAIR principle⁶⁷ adopted by the European Commission and G20. The Netherlands, as an active member state of the European Union, United Nations, and World Economic Forum, also contributes to many international health and related initiatives, ranging from dealing with pandemics to tackling the rise of non-communicable diseases.

In line with the growth of the 9 Dutch Top Sectors⁶⁸, LSH has been increasingly successful since 2014. It is the most R&D intensive Top Sector. Its Public Private Partnership (PPP) Allowance increased exponentially from €4 million to €30 million between 2013 and 2016 and the number of PPP R&D-projects funded multiplied in parallel (see figure 2) which amplified the number of participating small and medium enterprises (SMEs). Besides investing in more projects, LSH was also able to invest successfully in several strategic PPPs, in which SMEs as well as global players combine their efforts with the knowledge and innovation infrastructure of the university medical centres⁶⁹ and universities⁷⁰. Fortunately, there was also financial support from many others, for example, from the *Samenwerkende Gezondheidsfondsen* (SGF), the Dutch ministries of *Economic Affairs*, of *Health, Well-being and Sports*, and of *Education, Research and Culture*, and from the provincial administrations. These investments permitted the setting up of strategic PPPs for fundamental, industrial and experimental R&D (see Appendix II for more information) by LSH as well as with our colleague Top Sectors (the so-called 'cross-over PPPs'). Valorisation of their revenues was facilitated by the educational pathway of the LifeSciences@Work accelerator programme (LS@W)⁷¹, and Task Force Health Care⁷² aided

the internationalisation and export activities. From 2016 onwards the first Health Deals⁷³ were set up – for encouraging application of validated LSH innovations in the Dutch healthcare system –and many future healthcare workforce initiatives were launched by Zorgpact⁷⁴. These successes led the Top Sector to reinforce its governance, especially with respect to the LSH Advisory Board⁷⁵.

Figure 2. Growth of the LSH PPP Allowance and the number of granted PPP projects



All in all, the Top Sector LSH has built an aligned national ecosystem and established a good societal, economic and scientific position in the recent strategic periods; this successful ecosystem can be further expanded in the future. In 2016 the Dutch Cabinet named Health and Care (*Gezondheid en Zorg*) as one of the eight most prominent Societal Challenges facing our society and assigned its further development to the Top Sector LSH⁷⁶. With respect to the next strategic period (2018-2021), the challenge of Health and Care will require extra public and private investments in an even more robust coalition of Top Sectors and ministries that will cooperate and further strengthen the existing ecosystem based on their Knowledge and Innovation agendas (KIAs) and Departmental Agendas. This coalition encompasses public and private players that are more and more acquainted with the enterprise policy frameworks⁷⁷ and inspired by the relevant routes and game-changers in the Dutch National Research Agenda⁷⁸. The coalition will be assisted by a government that facilitates, stimulates and involves in both R&D and innovation, as well as in implementing, valorising and commercialising its revenues and the results⁷⁹.

Several recent transitional developments are fulfilling both the needs of the Health and Care societal challenge, as well as creating economic opportunities. In brief, these developments comprise the following trends:

- Making health (as conceptualised by Huber *et al*⁸⁰) and healthcare more *personalised, preventive, predictive* and *participatory*⁸¹, and where and when necessary, more *curative*.
- Dutch population health has developed well and citizens can contribute more to the economic welfare and productivity. However, there is always room for improvement⁸², while also paying attention to the affordability of the healthcare system now and in the future:
 - Our life expectancy will continue to increase, while cancer, cardiovascular diseases and, increasingly, dementia will be the most frequent causes of death.
 - In addition, more people will develop chronic disorders and diseases like neck and lower back pain, visual disorders, diabetes, stroke, cardiac diseases, psychiatric disorders, and overweight and (morbid) obesity.
 - Despite these chronic disease burdens, and especially in the case of dementia or arthroses, more people will stay active and strive to continue to participate in their own environment and, within their possibilities, in society at large.
 - Relatives, as informal caregivers, and advanced technology, including eHealth, will assist them in this.
 - Challenges remain for people at risk, i.e. the lower economic classes, those with poor health and health-related restrictions, and those living in loneliness, especially during *major life events and transitions*⁸³. Without a change in current policies, they are the ones who will benefit much less from recent and upcoming revolutionary LSH discoveries.
 - Besides these risk groups, the whole population is at risk because of its sedentary lifestyle, increasing and antimicrobial resistance and the national trend towards a less affordable healthcare system that poses challenges to its quality and accessibility and to the solidarity amongst Dutch tax and health-insurance payers⁸⁴.
- Tailored services and products are therefore warranted that:
 - fit to the talent of the individual person, offering primarily technological solutions and, if necessary, (hands-on) treatment;
 - tackle the disease/disorder as well as assisting in people's daily functioning;
 - can be supplied in or close to people's home or living environment;

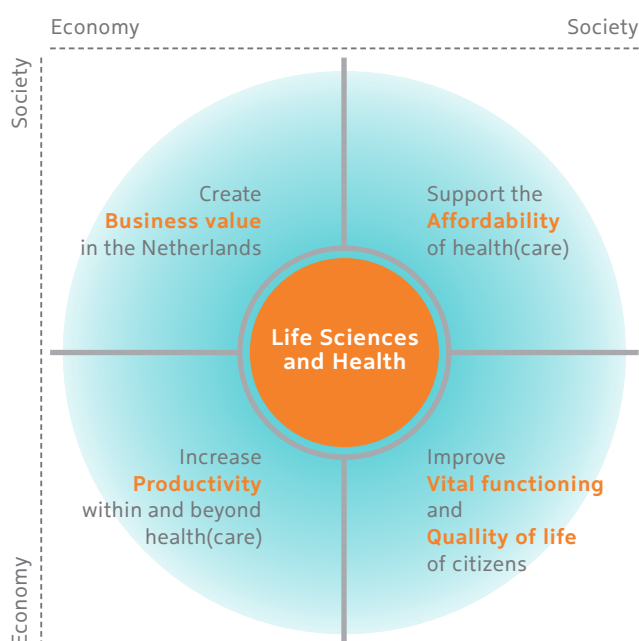
- can be organised based on a national framework of rules and regulations, enabling optimal regional and local use and taking safety and privacy considerations into account;
- can be delivered and applied in both urban and rural regions, according to specific context- and citizens' demands;
- are inspired by academic and professional PPPs, operating in innovative networks to discover, develop and deploy the latest validated knowledge and insights;
- are offered in a sustainable and affordable manner for all.

Vision, Mission and Ambitions

Vision

The Health and Care coalition headed by the Top Sector LSH envisages a thriving Dutch LSH sector that, through R&D excellence, will develop health-related technological, biomedical, and sociocultural innovations focussed on the real needs of citizens, as well as on *affordability* and *productivity* in the prevention, cure and care cycle. Such R&D and innovations will be achieved with serious and continuous end-user involvement and will, most importantly, *create business value* for public and private entrepreneurs in the Netherlands as well as abroad (see figure 3).

Figure 3. Overview of LSH/Health-Holland's vision and ambitions for Dutch society.



Mission

The coalition's mission is to invest in evidence-based innovations for the *vital functioning of citizens in a healthy economy*.

Ambitions

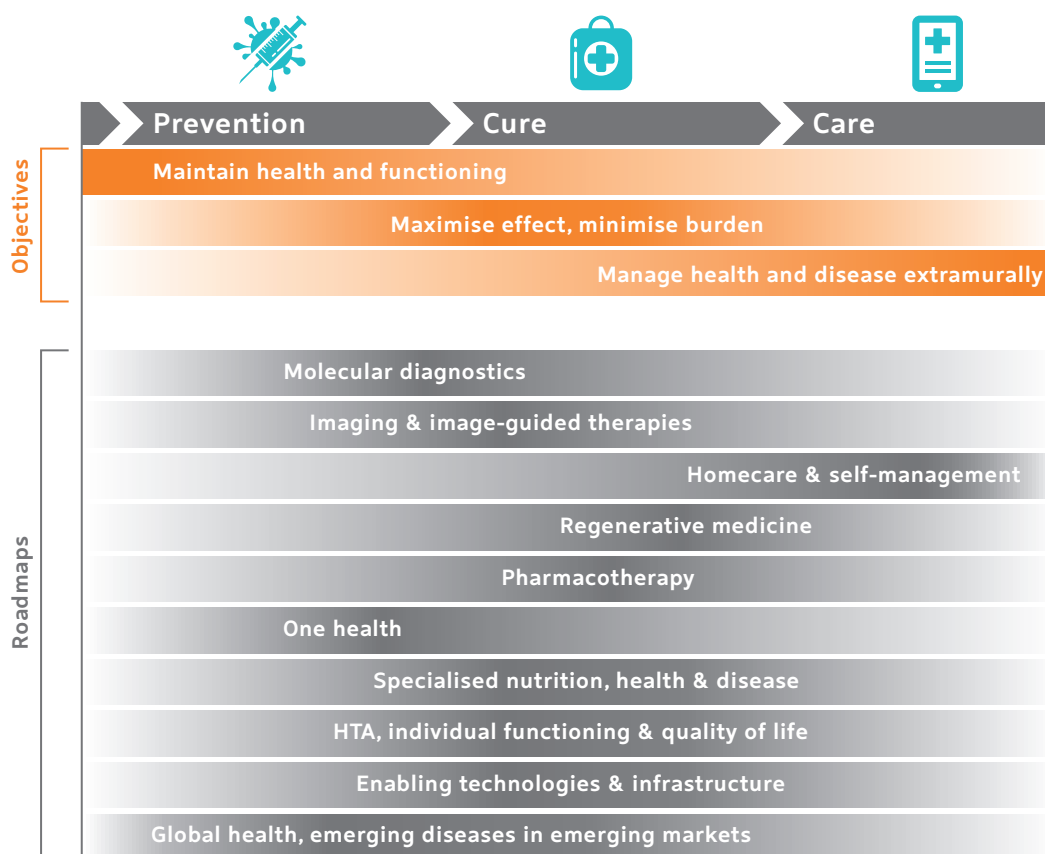
Based on the recent performance of the Dutch LSH and related sectors, and the renewed diligence of the Netherlands as an innovative nation⁸⁵, it is our firm intention to become one of the top-3 international LSH sectors by 2030 and to be active in *Global Health*⁸⁶ initiatives in developing countries. This will be a sector that competes and collaborates from a solid, future-proof, data- and research-infrastructure for health, healthcare and related research. It will steadily grow its entrepreneurship, facilitating start-up companies to scale up and even become potential global players, who will offer the world the most important LSH breakthroughs via new scientific paradigms⁸⁷ discovered, developed and deployed by our strategic PPPs. The sector will support the affordability of healthcare and delivery of value-based healthcare solutions, which will be developed by (early) Health Technology Assessment and objective measurements of outcomes and monitoring systems. The sector will help create and implement alternative business models for existing and innovative pharmaceuticals⁸⁸, medical technology, and healthcare services, thereby tackling the "innovation paradox"⁸⁹. It will also be a sector that helps increase productivity by reducing labour years lost to poor health and supporting extra productive years from people (our human capital) in all sectors, all of which will be achieved based on the highest ethical and moral standards with respect to minorities and inequalities, inclusion and involvement, privacy, safety, and human and animal welfare.

High-potential entrepreneurs and scientists are being attracted by the Dutch LSH ecosystem of PPPs, as are investors. These vibrant PPPs employ 54,000 full-time equivalents (FTEs) and their work will lead to several of the world's most wanted and most bought LSH products and services for prevention, cure and care. This will make Dutch Health and Care the premium interest of foreigners, with the same international standing as our traditional key assets like windmills, Rembrandt and tulips.

Prevention, cure and care

The coalition's opportunities are based on the three domains of Health and Care: prevention, cure and care (see figure 4).

Figure 4 - The three basic health-related elements of societies (objectives) and ten LSH roadmaps.



Maintain health and functioning, with a focus on prevention (including personalised primary prevention and prognostic pathways) to assist people in retaining their vitality and functioning, without medical needs or supportive care situations, e.g. by developing real-life and digital contexts that offer support in making the right preventive lifestyle and behavioural choices. Such choices should be based on personalised and precise prognostics and demographics. They should aim to minimise risks derived from the food production chain and the environment and stimulate healthy living by urban and rural [re]design; all this can be achieved via low tech, high impact solutions in close collaboration with the National Prevention Plan *Everything is related to health (Alles is gezondheid)*⁹⁰;

Maximise effect, minimise burden. If disease or disability occurs, the aim is to support people to maintain and/or regain their vitality and functioning as much and as fast as possible (including development of personalised and precise tools for diagnosis, curative and regeneration (*repair*). In addition, this aim covers secondary and tertiary prevention and treatment options with *patient included*⁹¹ strategies);

Manage health and disease outside hospital. If disease and/or disability persists, the aim is to enable people to self-manage and function at their best in their own living environment (*home care*) and in society at large (including developing and implementing personalised and precise technological applications and solutions, like human-centred eHealth or digital decision-support systems for patients). The aim is also to connect their informal and formal networks of care with the help of Dutch Big Data solutions like the FAIR principles and Personal Health Train).

Means

The ambitions for the Health and Care challenge are best led by the LSH coalition that will:

- Focus on:
 - Increasing private investment in R&D via PPPs;
- Maximise return of the scarce public and private investments through alignment and joint R&D programmes with:
 - The knowledge and innovation infrastructure of university medical centres (NFU)⁹², universities



The Minimally Invasive Assistant in the OR; a Pontes Medical project in which the UMCU collaborates with the company Lapara Surgical to further develop the new product and bring it to the market.

(VSNU⁹³; including universities of technology⁹⁴), the Applied Research Federation TO2⁹⁵ – especially the Netherlands Organisation for Applied Scientific Research (TNO)⁹⁶ – and KNAW⁹⁷, institutes like NIVEL⁹⁸ and VILANS⁹⁹, universities of applied sciences¹⁰⁰ and their *Centres of Expertise*¹⁰¹ and the *Centres for Innovative Crafts*¹⁰² of the secondary vocational education and training systems¹⁰³;

- Funding agencies such as NWO, ZonMw, SGF, NRPO SIA;
- Regions and the Regional Development Partnerships (*Regionale Ontwikkelingsmaatschappijen; ROMs*)¹⁰⁴, as the strongholds of the Top Sectors and their regional agendas¹⁰⁵;
- In line with the Top Sectors' overarching Human Capital Roadmap¹⁰⁶;
- National alignment and professionalisation of Technology Transfer Offices;
- Aligned departments in the Ministries of Economic Affairs, of Education, Sciences and Culture, of Health, Welfare and Sports, Ministry of Social Affairs and Employment, and of Foreign Affairs;
- A concerted internationalisation strategy, agenda and diplomacy, within the government's budgetary constraints, that aims at acquisition, export and R&D, for example via:

- Incoming and outgoing missions, whenever possible in conjunction with members of the government;
- Strategic scholarships.

Monitoring and evaluating success

The coalition emphasises continuous process improvement by means of data-driven decision-making on developments of initiatives in the Dutch PPPs' R&D for *Health and Care* during the strategic period of 2018-2021. For this, the governance of LSH is monitoring and evaluating success on the basis of key performance indicators (setting targets and monitoring performance), Lean Six Sigma methods (actual to target performance by process review and optimisation), and data mining (measurement and analysis)¹⁰⁷. With this approach and the strategic plans laid out in this Knowledge and Innovation Agenda (KIA), the coalition aims to extend former successes and contribute to the further development of both economic spin-offs and LSH's positive influence on innovation¹⁰⁸ and R&D in health and care.

Indicators ¹⁰⁹	Value:	Source:
Societal indicators:		
Employment/FTE in LSH	n	CBS, EZ
Implementation LSH-products and -services		
• Health Deals	n	RVO
• Health Impact Bonds	n	Societal impact
• In Zorgstandaarden Zorginstituut Nederland	n	ZiN
Economic indicators:		
Top Sector's added value	M€	OECD, CBS, EZ
New strategic programmatic PPPs and PPP-projects	n	TKI Office
(New) Companies and SME-involvement in PPPs	n	EZ
R&D Expenditures/Investments		
• Regional		
- MIT, EFRO, InterReg, etc.	M€	ROMs, SKBN, RIS ¹¹⁰
• National		
- PPP Allowance, e.g. via SGF, ANBI's	M€	TKI Office
- MIT, SBIR, RIF, etc.	M€	RVO, EZ, OCW
• International	M€	NFIA
LSH funnel accomplishments (including TRL-shifts)		
• (Bio)Pharma	TRL/%	HollandBIO/VIG
• MedTech	TRL/%	MedtechPartners
• Services	TRL/%	VWS
- Patents	n	Patent registrations
- Market Authorisations	n	EMA, NZa
Valorisation		
• New start-ups	n/%	KvK, RVO
• Start-up conversion into scale-up	n/%	KvK, RVO
• Scale-up conversion into global players	n/%	RVO
Productivity (gains)	M€	EZ
Internationalisation		
• Incoming missions	n	TFHC, RVO
• Outgoing missions	n	TFHC, RVO
Export goods	M€	RVO, EZ
Healthcare affordability index ¹¹¹	M€/%	VWS, Fin.
Scientific indicators:		
Top 10/25% Scientific Citation Index publications	n/%	Thomson Reuters
Aggregated Scientific Citation Index rankings	SCI	CWTS, Web of Science
Competitive funding (EU, Horizon2020, etc.) awarded	M€	RVO, OCW

FTE: Full Time Equivalents;
LSH: Life Sciences and Health;
n: number;
CBS: Centraal Bureau Statistiek;
EZ: Ministry of Economic Affairs;
RVO: Rijksdienst voor Ondernemend Nederland;
ZiN: Zorginstituut Nederland;
M: million;
OECD: Organization for Economic Cooperation and Development;
PPPs: Public Private Partnerships;

TKI: Topconsortia voor Kennis en Innovatie;
ROMs: Regionale Ontwikkelingsmaatschappijen;
MIT: MKB Innovatiestimulering Regio en Topsectoren;
EFRO: Europees Fonds voor Regionale Ontwikkeling;
InterReg: Interreg Community Initiative;
SKBN: Stichting Kennisalliantie Bedrijventerreinen Nederland;
RIS: Regional Innovation Scoreboard;

SGF: Samenwerkende GezondheidsFondsen;
ANBI's: Algemeen Nut Beogende Instellingen;
SBIR: Small Business Innovation Program;
RIF: Regionaal Investeringsfonds;
OCW: Ministry of Education, Culture and Science;
NFIA: Netherlands Foreign Investment Agency;
TRL: Technology Readiness Level;
VIG: Vereniging Innovatieve Geneesmiddelen;

VWS: Ministry of Health, Wellbeing and Sports;
EMA: European Medicines Agency
NZa: Nederlandse Zorgautoriteit
KvK: Kamer van Koophandel (Chambers of Commerce);
TFHC: Task Force Health Care;
Fin: Ministry of Finance;
SCI: Scientific Citation Index;
EU: European Union;
CWTS: Centre for Science and Technology Studies.

Innovation and R&D

Strategic focus points

The societal challenge of Health and Care is based on the strategic policies of the Dutch Government ¹¹² and currently encompasses six routes in the *Dutch National Research Agenda* and their related game-changers. To be successful, the Top Sector LSH will take the lead and cooperate via *Public Private Partnerships (PPPs)* in 10 specific *Roadmaps* in a coalition with colleagues in the Top Sectors AgriFood¹¹³, Chemistry¹¹⁴, Creative Industry¹¹⁵, Horticulture & Starting Materials¹¹⁶,

High Tech Systems and Materials¹¹⁷ and Logistics¹¹⁸, and with those in the Key Enabling Technologies (KETs) of Dutch Digital Delta/ICT¹¹⁹, Biotechnology¹²⁰, Photonics, Measurement and detection Technology, Quantum- and Nanotechnology¹²¹ and the Smart Industry in their field labs approach¹²². It is essential these cooperatives have available validated innovative products and services for *prevention*, *cure* and *care* (see figure 5 for an overview).

Besides taking the lead in the Health and Care societal challenge, Top Sector LSH will also contribute to the societal

Figure 5. Overview of the strategic focus points of the Health and Care societal challenge





challenges of “Security” and “Smart agriculture, smart food”, led by colleagues of the Dutch Digital Delta (René Penning de Vries) and the Top Sector AgriFood (Aalt Dijkhuizen and Loek Hermans), and to the KETs of Quantum- and Nanotechnology (Amandus Lundqvist).

Routes and game-changers in the Dutch National Research agenda

Almost 40% of the 11,700 research questions posted for the Dutch National Research Agenda were related to the life sciences and health/healthcare. All interrelated questions were combined in routes around complex themes, thereby promoting interdisciplinary collaboration throughout the entire knowledge value chain. The agenda should generate more synergy in science, technology and innovation as a whole. Game-changers in these routes indicate the societal, scientific and economic opportunities we have. With respect to the challenge of Health and Care, least three main routes in the agenda are evident and another four are related or enabling routes of interest:

Healthcare research, sickness prevention and treatment. To ensure that our healthcare system is ready for the future, we need a new perspective on health that acknowledges the differences between people and

corresponds more closely to their personal performances and experiences. *Game-changers* in this respect are:

A new perspective, a new research paradigm. Good health is a basic condition for being able to participate in society. Inter-individual differences are key to good treatment so personalised medicine is becoming important. We need new research methods and outcome measures to supplement existing methodology.

Investing in preventing sickness. For society to have a healthy future and affordable healthcare, preventing disease is crucial. We need to study interactions between individuals and the environment in a broad sense.

A new perspective on treatment: personalised and regenerative. Personalised medicine should make safer and more effective healthcare possible. The repair of damaged tissue by regrowth can actually cure diseases, including chronic ones. We need new approaches for targeted treatment.

Investigating care. The healthcare system of the future requires a new perspective on the roles of all those who are involved. We need to investigate healthcare systems and what is needed to implement and scale up validated innovations on a structural basis.

Personalised medicine: the individual at the centre.

Giving each and every patient the right care, at the right moment, in his or her own home environment, with maximum effect and minimum side-effects and costs, within the recently identified focus fields of cardiovascular- and respiratory diseases, oncology, and mental health. *Connections.* Individuals differ and illnesses differ: this considerably affects the ways in which individuals respond to treatment. Enormous amounts of longitudinal data on individuals, their diseases and the consequent dynamics in their daily functioning need to be studied in order to understand the biological and functional variations between individuals.

Targeted research. Researchers will refine knowledge of the sickness process and interventions in an interdisciplinary manner. We need new methods and imaging and monitoring technologies that will speed up the pipeline between the laboratory and life.

Good communication and education. Citizens and healthcare professionals will use more and more new digital technologies and personalised decision-support systems for individuals as well as for their formal and informal supportive networks to help patients manage their own health and functioning. We therefore need new eHealth support systems and mass and personal communication techniques, on the one hand, and educational courses and post-graduate training on the other.

New alliances. The new products and new forms of care will further close the innovation gap between the laboratory and individual patient. We need to set up new cooperation between partners and different stakeholders, who do not always move in the same circles.

Broader dialogue. The far-reaching opportunities in the health chain will involve everyone. We need to have a broader dialogue especially with patients and the public at large and it should also cover ethics and the legal implications.

Regenerative medicine: a game-changer moving to broad areas of application. Regenerative medicine offers opportunities to repair damaged tissue and organs without resorting to transplantation, to test drugs without using laboratory animals, and to customise drugs to a specific patient. The time has come to transit this technique from the laboratory to the clinic.

Investing in training and talent. Various disciplines are already working together. We need scientists whose expertise lies at the interface between technology and medicine.

Investing in infrastructure and research (both fundamental and translational). Major national alliances and infrastructure should make it possible to take the next step from basic concepts to real solutions for patients. We need to study the genome, interactions between biomaterials and cells, and new imaging platforms.

Responsible research and innovation. We need an open dialogue on the societal, ethical and legal consequences of regenerative medicine and to define a strong theme based on technology transfer.

Creating value through responsible access to big data and its use. The phenomenal rise of the number and variety of new (mass) communication technologies and databases is already evident and their impact in virtually every facet of the economy, science and society will grow, including in the healthcare sector, mostly in the form of new eHealth solutions. Responsible access to data and its use will lead to tremendous value creation. Big data is functioning as a game-changer by combining different types of data; this demands new analytical techniques, decision-support systems, well-trained people, experimental environments with good facilities, and innovative data infrastructures.

NeuroLabNL: the ultimate living lab for brain, cognition and behavioural research. This 'living lab' should bring major breakthroughs in our understanding of how the brain develops and changes during the life cycle. We need research into the complex relationships between



brain, cognitive functions, behaviour and environment to lead to innovations in healthcare.

Sport and exercise. Sport and exercise are important throughout the life cycle, stimulate good health, and bring people together, contributing to social cohesion. The aim is to make personalised sports and exercise available to everyone whatever their age and in this context the LSH-led coalition cooperates with the Top Team Sport¹²³.

Quality of the environment: game-changer 'Exposome'. In the Netherlands, 12% of deaths have been attributed to various environmental factors, such as fine particles in polluted air (WHO 2016¹²⁴). To develop prevention measures for the health effects we need to know more about combined exposures and the revolutionary concept of the 'exposome' integrates all these environmental factors. Environmental quality in relation to health and well-being can be much better quantified, while the scientific challenge is now to integrate large amounts of data in multiple dimensions of time and place so that practical conclusions can be reached.

Roadmaps

The ten Dutch LSH roadmaps are designed to address priorities in health outcomes (age-related, focussed on functioning, chronic, acute, infectious, orphan and neglected diseases) and along the health chain, from prevention, through diagnosis and prognosis, to cure and care (see figure 4). The roadmap themes represent the areas in which public and private parties are committed to co-creating solutions and asking stakeholders, from government to health foundations, to co-invest. Companies, research institutes, practitioners, patient organisations, health foundations, health insurers, regulators and many others have contributed to and endorsed these roadmaps. All of the roadmaps can also be linked to other Top Sectors within the LSH coalition.

Seven roadmaps (1 through 7) are highly product-oriented. They are supported by two more that will deliver (early) health technology assessment (8) and KETs, infrastructure and systems development (9). The final roadmap (10) is centred around diseases that cause a high burden globally but mainly in the developing world. The developing world can make advances in solving these diseases with assistance from the Dutch Top Sectors.

- 1 Molecular diagnostics:** Developing (candidate) biomarkers into validated molecular diagnostics for clinical use.
- 2 Imaging & image-guided therapies:** Developing imaging applications for more accurate and less invasive diagnosis, prognosis and monitoring and titration¹²⁵ of treatment.
- 3 Homecare & self-management:** Developing, assessing and implementing technologies, infrastructure and services that promote *life span*, i.e. individuals' abilities to live and function independently and to manage their own health, care and daily functioning, adequately helped by intelligent decision-support agents, technology and, when necessary, by healthcare professionals.
- 4 Regenerative medicine:** Developing curative therapies for diseases caused by tissue damage and ensuing organ dysfunction, through repair or renewed growth of the original tissue, or its replacement by a synthetic or natural substitute.
- 5 Pharmacotherapy:** Discovery, development and deployment of new, safe and cost-effective personalised medications in order to cure or prevent progression of a disorder or disease.
- 6 One health:** Developing solutions like vaccines, optimised antimicrobial use, and early warning systems

to improve the health status of humans and animals by combining the know-how and infrastructure available in the human and veterinary/agricultural domains.

- 7 Specialised nutrition, health & disease:** Studying specialised nutrition for intervention as part of integrated healthcare solutions in terms of prevention, cure and care of chronic, acute or rare diseases.
- 8 Health technology assessment, individual functioning & quality of life:** Development of methods and knowledge for health technology assessments in which the impact of health innovations on individual functioning¹²⁶ and quality of life, cost-containment, and productivity is assessed.
- 9 Enabling technologies & infrastructure:** Developing and offering expertise and infrastructure in cutting-edge molecular life science technologies (e.g. next generation sequencing, proteomics and bioinformatics), in biobanks and in ultramodern research facilities readily accessible to industry and academia, and in the transition of intramural healthcare facilities towards personalised primary care and digital support for citizens' behaviour in their own daily life. These aspects already have strong links to other Top Sectors (AgriFood, Horticulture, Chemistry, Logistics, High Tech Systems and Materials and the Dutch Digital Delta team).
- 10 Global health, emerging diseases in emerging markets:** Development and delivery of solutions to diseases associated with poverty that affect more than 2 billion people in the developing world.

National Icons

In 2014, and more recently in 2016, the Dutch government nominated so-called 'National Icons', of which three are relevant to this KIA: Organoids¹²⁷, Bioneedles¹²⁸ and Lighthouse¹²⁹. The programmes of the first two icons have been supported by the Top Sector LSH since 2014. The LSH coalition on Health and Care will continue to support them – and Lighthouse (cancer diagnostics without nuclear waste) – during the strategic period 2018-2021.

Strategy

Introduction

As stated earlier, both the existing and new focussed PPPs are key to the Dutch strategy for tackling the Health and Care societal challenge. To be successful, PPPs require initial investments (*capital*), exposure via *PR and communication* and eventual *valorisation, implementation and commercialisation* of their validated products and services via healthcare *Human Capital Agenda*, as well as via national and international entrepreneurs through diplomacy guided export. The latter should preferably be based on a solid *internationalisation strategy*. The *governance* of the Top Sector LSH, supported by the *executive office (Stichting TKI-LSH, see Appendix III)*, aligns and involves all the relevant stakeholders and partners in each PPP.

Public Private Partnerships

Preferably, Public Private Partnerships (PPPs) should consist of teams of experts and institutes that combine interdisciplinary knowledge bases, creativity and resources in robust, long-term, intra- and inter-sector collaborations. These *strategic* PPPs strive for innovative *moon shots* that will contribute to improving Health and Care and economic growth¹³⁰. The coalition led by the Top Sector LSH and its governance will, for the coming strategic period, primarily facilitate existing strategic PPPs, helping them to become viable and successful (see Appendix I, figure I.1). As such, five disease-specific PPPs are being facilitated: initiatives on cardiovascular diseases (Dutch CardioVascular Association¹³¹), oncology (Oncode Institute¹³²), infectious diseases (Netherlands Centre for One Health¹³³, including the antimicrobial resistance targeted initiative of the Netherlands Antibiotic Development Platform)¹³⁴, dementia (Delta Plan on Dementia¹³⁵ and Memorable¹³⁶), and the regenerative medicine initiative (Regenerative Medicine

Crossing Borders; RegMedXB)¹³⁷. The regenerative medicine initiative focusses on a cure for diabetes, arthrosis and kidney failure via the principle of restoring degenerated, diseased or damaged tissue and organs.

In addition, (seven) generic PPPs focussing on diagnostics and therapeutics will be facilitated, namely those that develop intra- and extramural medical technologies and eHealth (Innovative Medical Devices Initiative¹³⁸, including Neo-kidney¹³⁹, Co-Create Health¹⁴⁰, and organs-on-chips in Human Organ and Disease Model Technologies¹⁴¹) and ICT infrastructure and developments (Health-RI¹⁴², FAIRdICT, and GO FAIR¹⁴³) and, last but not least, the European Lead Factory¹⁴⁴ for pharmacology and drug development. Special attention will be paid towards PPPs working towards prevention. National initiatives of the *Prevention coalition* will be aligned with international initiatives in which the Netherlands is already a partner for ageing (More Years, Better Lives¹⁴⁵) and for obesity (A Healthy Diet for a Health life¹⁴⁶). To complete this knowledge and innovation infrastructure, the Top Sector LSH has invested in recent years in highly fundamental R&D (Building Blocks of Life¹⁴⁷) and, on the other side of the spectrum, in practice-based research by the universities of applied sciences and their integrated health agenda¹⁴⁸ (SPRONG¹⁴⁹). These universities and their agenda harbour interesting potentials for implementing R&D in educational and societal 'living labs' guided by embedded innovators and scientists¹⁵⁰. Knowing that progress is best made by interdisciplinary R&D, the LSH governance will invest in connecting the relevant Top Sectors and KETs with the LSH's knowledge and innovation infrastructure to strengthen the ecosystem. These links with the most relevant PPPs per institute or sector should be made immediately.

Inspired by the above successes of LSH-PPPs, many new strategic PPP initiatives targeting Health and Care products and services are being planned, constructed and/or explored, mostly initiated bottom up by the LSH knowledge



and innovation infrastructure and its related facilities. With respect to the coalition's prominent emphasis on the success of the many PPPs, it is willing to consider facilitating new strategic PPPs. These PPPs will first have to be fitted into the existing knowledge and innovation infrastructure, as *stand-alone* PPPs are no longer an option. PPPs that can fulfil these conditions and add to the ecosystem are reviewed and selected based on the following three main factors:

Organisation

- end-user involvement
- energy, diligence and efficiency
- continuity potential
- congruence of the operational, logistic and personal prerequisites of the PPP with those of the founding organisations¹⁵¹

Relevance

- for the societal challenge on Health and Care based on the Dutch National Research Agenda and the LSH Roadmaps (see next chapter)

Impact

- economic potential
- scientific excellence
- technology transfer potential to establish valorisation and implement the products and services
- and the PPP's interdisciplinary and inter-institutional cooperation and focus on talented *new kids on the block*.

Examples of PPPs that may fit these criteria in the future are – mature and new – disease-specific options like those for respiratory (*Nationaal Programma Longen*¹⁵²) and neurological diseases (*NeuroTech-NL*). Generic PPP options that will be reviewed in the near future are those targeting R&D on ageing (*Dutch Society for Research on Ageing*¹⁵³), physical functioning (*FysiotherapieWetenschap Next Steps*), reducing animals used in research (Humane Meettechnieken 3/4V en Proefdierlijke Innovaties), unravelling pathology pathways (*PATH-and-beyond*), Laboratory sharing (*InSciTe Biomedical*¹⁵⁴), early Health Technology Assessment (Gezondheidseconomie concerning for instance the *Innovatie-paradox*), and Value-Based Healthcare (together with the World Economic Forum), along with the cross-sectoral PPPs like analytics (*COAST*¹⁵⁵) and the *Advanced Research Centre's Chemistry for Future*

Medicines¹⁵⁶. Each PPP will be reviewed, firstly in collective sessions to inspire and learn from each other by best practices and to avoid duplicated efforts and redundancy in the knowledge and innovation infrastructure.

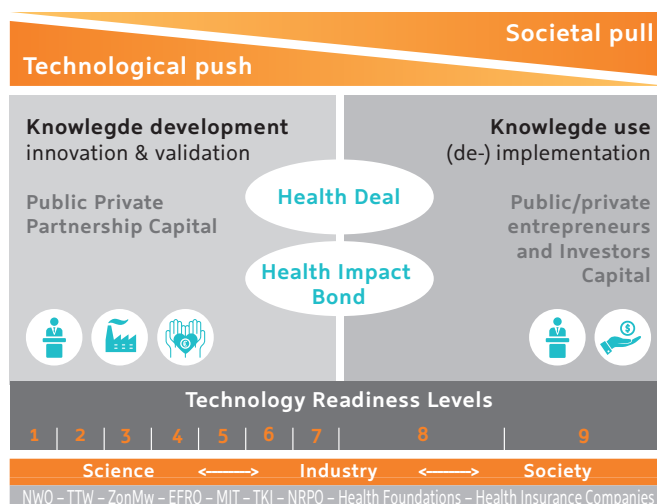
Strategic PPPs are initiated either via a top-down approach by the Top Sector’s governance or bottom-up via one or more of the many stakeholders in the sectors. In addition to these two routes, some strategic PPPs may be started from a conventional PPP project set up via Match Call for PPP Allowance¹⁵⁷. For the latter to become strategic PPPs, the criteria listed above should hold true. All of the strategic PPP options are listed and explained briefly in Appendix I.

The *technological push* of knowledge and innovation towards Technology Readiness Level (TRL) 7 is organised well (see figure 6 and Appendix II for details). The apparent success of this strategy requires the extra attention of private and public stakeholders, and of partners in the societal challenges, to ensure innovative products and devices lead towards TRL 8 and 9. This is the *societal pull*: deployment, or implementation–valorisation–commercialisation. The coalition for Health and Care, as a whole, should therefore organise the implementation (or de-implementation) of products and services through evidence-based socio-cultural R&D, which is a difficult process and hard to get funding for. In this respect, much is expected of combining a *Health Deal* (regulatory part) and a *Health Impact Bond* (financial part), which should help guide bringing products and services to the healthcare market, both in the Netherlands and abroad. Without an emphasis on this market pull, end-users (public or private) will not profit fully from the combined efforts of science and industry.

Capital

A large part of the coalition’s success in the societal challenge of Health and Care relies on synergy, cooperation and R&D inventiveness. Adequate financial support is, however, a prerequisite for success. Yet, in recent years, it has become increasingly difficult to gain funding for R&D. This has had a wide range of negative effects on the whole process, from developing innovative ideas to product market entry. The PPP Allowance Regulation was established by the Ministry of Economic Affairs, and has enabled LSH and its partners to lubricate the process for the PPP initiatives in TRL 1-7. With respect to initiatives focussing on valorisation and commercialisation (in

Figure 6. Overview of the process and funding agents that can guide an idea (TRL 1) via innovation and validation to the healthcare market (TRL 9).



TRL 8-9), alternative funding options and new financiers will have to be found.

To deploy the PPP Allowance as efficiently as possible, the coalition will use various processes to allocate the financial means available. Several health foundations are using their PPP Allowance to support strategic PPPs like RegMedXB (via Diabetes Fonds, Reuma Fonds and Nierstichting) and Oncode Institute (via KWF). About 50 percent of the annual PPP Allowance is thus deployed in collaboration with the members of the SGF. In addition, part of the PPP Allowance is being used to set up calls in collaboration with other funding agencies like ZonMw. LSH has also introduced the **Health-Holland International (HHINT) Kickstarter** to establish a long-term foreign PPP in R&D¹⁵⁸. Approximately 40 percent of the annual PPP Allowance is awarded to collaborative projects submitted through LSH’s Match Call¹⁵⁹. Another important financial instrument, supported by LSH governance and TKI-LSH, is the SME Innovation Incentive Scheme for Regions and Top Sectors (MIT; €55.75 million in 2017) Allowance¹⁶⁰. This fund enables innovative small- and medium-sized enterprises to apply for knowledge vouchers, innovation consultancy projects, feasibility projects, and R&D joint ventures. We expect this financial instrument be continued in the next strategy period of the Enterprise Policy.

Communication & Branding

Communication facilitates and unites. Under the flag of **Health-Holland**, the coalition aims to connect all Dutch stakeholders and partners taking part in the societal challenge of Health and Care¹⁶¹. The recognisable orange **Health-Holland** brand name will be used to maximise the visibility of its PPPs, nationally and internationally. By liaising closely with all the stakeholders, including the *Dutch LSH Alliance*¹⁶² and regional, national and international representatives, one voice and one message can be spread and heard. Our efforts to increase exposure are paying off with new connections made every day, expanding and strengthening networks, and a wider reach in an easily accessible and interactive manner. LSH has already developed a range of communication tools using the **Health-Holland** brand name for all stakeholders to use: a *website*¹⁶³, an *online portal* that serves as a sector gateway, a *project page* that illustrates the PPPs, and online *magazines* and *webinars*¹⁶⁴, which include the bimonthly *Update*¹⁶⁵, the annual *Year in Review*¹⁶⁶, and *Guide*¹⁶⁷ that provides a comprehensive overview of Health and Care companies. The coalition also organises, participates in, or sponsors several regional, national and international *events*. In this way the orange **Health-Holland** brand travels abroad regularly to leading conferences and trade shows, including the Medica and BIO International Convention. A set of attractive promotional tools were developed to spread the Dutch LSH sector: a motion graphic, various infographics, presentations, templates and factsheets. For 2018-2021, the coalition will continue and expand its communication activities, aiming to further unite and involve the entire LSH sector under the flag of **Health-Holland**.

Valorisation

The LSH start-up climate is fruitful. More venture capital has become available for start-up investments and large investment deals and exits are being realised¹⁶⁸. These successes seem to be associated with the growing attention in the Netherlands towards start-ups, with more accelerators, innovation hubs and campuses, which all aim to provide maximum support to start-ups (and scale-ups). They need to be aligned on a national level. It is for this reason that the coalition, led by the Top Sector LSH, opted for a national approach that complements and aligns regional activities towards a national ecosystem in which innovative start-ups

can flourish to become companies with international impact. With regard to valorisation, the coalition fulfils the roll of aligning and adjusting the national innovation ecosystem, along with providing direct support for start-ups through the LS@W programme. This programme has shown excellent output results: as of 2017, LS@W has become an integral part of the Top Sector and is funded by the PPP Allowance and industrial partners. The programme consist of three stages to support start-up initiatives from an early idea stage (TRL3-4) up to growth stage (TRL7-8). Stage 1 is the proven Venture Challenge, an essential step in building a solid business case for start-ups. Stage 2 contains the Expert Classes: in-depth and interactive workshops and mentoring sessions by industry experts and experienced entrepreneurs on critical aspects for building life sciences and medical technology companies. Stage 3 is the Value Centre that helps start-ups and scale-ups to find the right partners to help them grow. As of 2017 there are new BiotechPartner meetings. The key to the success of LS@W is its focus on life sciences and medical technologies, its national scope, and its involvement with industrial experts, entrepreneurs, investors, and alumni who provide participants with sector-specific expertise and experience.

A second pillar of the valorisation strategy is aimed at building the next generation of Health and Care entrepreneurs. This is facilitated by aligning national LSH business education and development programmes. The Business Education Roadmap covers all stages of development from orientation on entrepreneurship until international expansion. The programmes in the roadmap work together for their communication, they align the content of their curricula, and combine their alumni networks. The programmes currently on the roadmap are the *BioBusiness Summer School*, *Venture Challenge*, *BioBusiness Masterclass*, *Master of Business Innovation LSH*, and *Global Scale-Up Programme*. The Business Education Roadmap not only aims to help starting entrepreneurs, but also offers opportunities to existing entrepreneurs who want to grow internationally or to people who are pursuing a career as LSH business developer.

Human Capital Agenda

Today's home care facilities, robotics and artificial intelligence are calling for an educational revolution. The classic model of education – a burst at the start and top-ups through company training – is no longer sufficient. To enable workers to learn

and earn in new ways, we need to create new pathways, for example, following massive open online courses (MOOCs), doing virtual and augmented reality and gamified challenges, and practising innovation in learning communities. Learning today often happens in informal and experimental settings, while many workplace skills cannot be acquired in a course. The challenge is to make adult learning, including workers in small firms and large organisations, and the self-employed, accessible to all, as the workforce needs to adapt constantly to a changing world. There is an increasing gap between formal education and the skills and knowledge sought by employers evident. Employers and educators need to cooperate closely to keep the workforce mentally well-equipped to meet the challenges of constantly adapting to innovative new technologies and settings.

The Human Capital Agenda, both the LSH agenda and the combined Roadmap of the Top Sectors¹⁶⁹, actively promotes learning and development through learning communities. Learning communities create opportunities to seek each other out, and make it possible to learn, both in a formal and informal setting. Above all, learning communities provide inspiration and offer a platform to exchange useful knowledge, experiences and skills, not only within LSH, but also in connection and co-creation with other sectors, such as logistics, the creative sector, the food sector, and information technology. Here again Top Sector LSH acts as a connector, building bridges between organisations, disciplines and sectors, to smooth (career) transitions and to help keep the Health and Care workforce looking towards the future in a world of continuous re-training and greater self-employment.

To remain in pole position and offer an attractive innovation climate for spin offs, start-ups, SMEs and multinational companies, the available workforce must fit the demands of the LSH sector. In the LSH field, data science and information technology are becoming more prominent. Top Sector LSH will stimulate training and development of skills in dealing with information technology and the handling of data, not only in the Netherlands, but also in cooperation with partners in Belgium. In an ageing society, technological aids, such as sensors and robotic devices, will be necessary to keep healthcare affordable. The present and future workforce, from manual workers to scientists, must be well prepared to work in this new environment, not just their technological and scientific/engineering skills will count, but there will also be more emphasis placed on specific human skills, such as creativity and empathy, that cannot be automated. Guided by strong ambition, the coalition will seek



cooperation and take initiatives to have a skilled workforce and well-prepared entrepreneurs available to care for patients and to deliver breakthrough innovations for them, thereby enabling them to live longer and in better health.

Internationalisation

In 2015, the Top Sector LSH's International Strategy¹⁷⁰ was launched to better structure and organise its priorities and international activities. For the period 2018 – 2021 the biggest growth potential and opportunities for the international ambitions in the line of Health and Care are:

Strengthen the current international structures.

To continue the positive and successful structuring of the various health stakeholders with international interests. Currently, it is estimated that at least 1,000 of 2,900 Dutch LSH organisations are being reached, with 1,600 active internationally and at least 400 Dutch LSH organisations joining in **Health-Holland**, TFHC and RVO activities. The aim is to increase these numbers by 40% by investing in meaningful and inclusive meetings, continuing to organise



high-quality and effective activities, and creating accessible and attractive support tools and activities for start-ups and R&D spin-offs.

Internationalising the KIA Roadmaps.

To align and integrate the PPPs in the more than 40 annual LSH activities worldwide. Moreover, closing the gap between (fundamental) R&D and the market (end users) leading to a substantial higher innovation output and thus better return-on-investment of national, European and regional research funds.

Global Health on the Dutch Development Aid agenda.

To open-up the enormous possibilities for hundreds of Dutch innovations, R&D, and smart solutions that can help address challenges in developing countries. This will include a strong alignment with the focus region of East Africa.

The coalition, together with TFHC, RVO, Dutch ministries and Dutch representation abroad (innovation attachés), distinguishes three types of markets, in terms of their available resources, support functions and need for a specific approach. This has led the coalition to focus on the

United States (developed market), China (emerging market) and East Africa (developing/underdeveloped market) for 2018-2021. In addition to the three focus countries, each year the *Dutch LSH Alliance* (see below) publishes the Priority Countries Overview¹⁷¹, ranking 25 carefully identified countries as priority. The ranking is based on an annual survey, hundreds of contacts with Dutch companies, current trends, and input from Dutch representation abroad (e.g. embassies, consulates and business support offices).

The Task Force Health Care (TFHC, mission to *improve international healthcare with the use of Dutch smart solutions*) is a key partner in the *Dutch LSH Alliance*¹⁷² and the main platform for the Dutch LSH sector internationally. TFHC has set up various platforms for international work per country/region. Currently it manages platforms focusing on China, India, Indonesia, Middle East, Russia, United States, and Africa. Pending the next strategic period (2018-2021), the TFHC will further develop and organise these platforms to work towards six regions, each with a specific focus or priority countries. The platforms mean the TFHC has created a structure which acts as a national and international front desk, which will soon have global coverage. The aim is to build bilateral relationships between The Netherlands and the countries or regions. The platforms are open for any Dutch LSH organisation interested in deepening their business or international activities in these countries and they serve as *centres of excellence* and a *central point of contact* to facilitate R&D sharing and cooperation. All the platforms develop an agenda based on the Dutch proposition for Health and Care.

The unique selling points of the Dutch LSH field are topics in which the coalition can also contribute to the European R&D agenda. This leads to an increased visibility in Brussels, strengthens collaboration between Europe's member states and the European Commission, and helps ensure that Europe makes optimal use of Dutch expertise and innovations in this field¹⁷³. Horizon 2020 is an important source of income for our R&D, adding up to €1.85 billion EU-support in 2014-2016. The Netherlands contributes 4.8% of the H2020 budget, and the return amounts to 7.7% of this budget. EU-funded projects form a solid base for long-term and successful cross-border cooperation. The Dutch LSH sector has been effective in winning grants (receiving 255 M€ EU support in 2014-2016). The coalition of Health and Care will support the sector partners in their R&D initiatives such as ELF and EIT Health, and support Dutch participation in ERA-Nets, Joint Programming Initiatives, Joint Undertakings, ESFRI roadmap-initiatives and EIPs,

especially those on active and healthy ageing. Besides these, the coalition will seek ways to influence and to participate in preparing the next EU Framework Programme for Research and Innovation (known as FP9)¹⁷⁴.

Organisation and Collaboration


The recently enhanced alignment in the Top Sector LSH, and the growth of the responsibilities of its governance, including financial ones (*Innovation Contract 2016-2017*¹⁷⁵), required a secure governance and supportive execution model. In 2017, the governance of the Top Sector LSH has been reorganised and now consists of a *Top Team* and an *Advisory Board*. Both are supported by a legal entity: a foundation (*Stichting TKI-LSH*) that has an *Executive Office* supervised by a *Board* (see Appendix III)¹⁷⁶.

The coalition collaborates with regional clusters to facilitate their regional and inter-regional cooperation; they want to create synergy and to interconnect public and private partners via the consolidation of a critical mass in R&D in the form of start-ups and PPPs. As such, the regions will be supported to further expand their collaborations with citizen cooperation, R&D institutes, higher education partners and institutions, SMEs, public health and primary, secondary and tertiary care facilities including university medical centres¹⁷⁷, universities of applied sciences^{178,179}, regional training centres¹⁸⁰ and, where applicable, the Ministry of Health, Welfare and Sport's Test beds (*VWS Proeftuinen*)¹⁸¹. This will mostly be done under the guidance of economic boards that integrate the regional, societal and economic challenges in profitable R&D.

Figure 7: Top Sector LSH Network







‘In the Netherlands hundreds of thousands of passionate people are spending their days, their years, their careers on helping patients to live normal lives. By continuous innovation in new treatment paradigms, novel medicines and diagnostics, and new interventions. And it is paying off.’

– Hans Schikan, former CEO of Prosenza,
SME Member of Top Team LSH

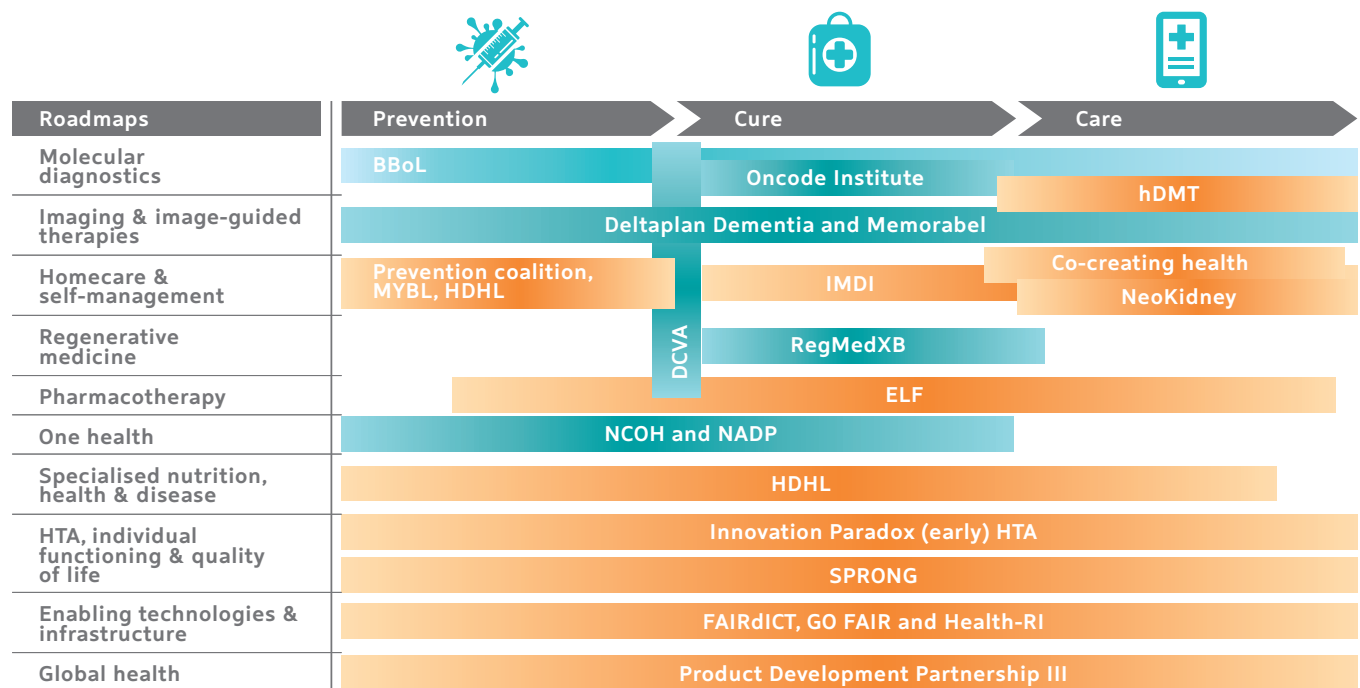
Appendix I – Overview of LSH R&D Strategic PPPs

The overview in this appendix presents, per 30th June 2017, all the strategic LSH PPPs, both mature (and thus *operational*) and new ones (either in the phase of *planning* and/or *coalition building* or in the phase of *exploration*). Strategic PPP initiatives are either set up top-down by the Top Sector’s governance or bottom-up via all sorts and combinations of stakeholders. Based on their societal relevance, scientific quality and economic potential, the governance will support and facilitate these PPPs until they can stand on their own and progress further. The relation of such PPPs to the LSH governance will then change into one that focuses on monitoring and targeting policies mutually

agreed upon according to the Top Sector’s strategic planning and the PPP.

After that Top Sector LSH will offer support as needed to establish R&D coalitions, programmes, funding and/or other PPPs. In their facilitation Top Sector LSH will pay particular attention to connecting initiatives, within the sector as well as between sectors. With respect to the Innovation Contract 2016-2017, a content template for PPP descriptions will be offered to facilitate the coalitions. This content may cover the following issues: working title and an acronym, if applicable; ambition; the R&D challenge; possible solution pathways, and the coalition involved.

Figure 8: Overview of the Strategic PPP landscape in 2017 in which LSH is directly involved, mapped along the prevention-cure-care value chain and the 10 LSH roadmaps. Disease specific PPPs are printed in blue, generic PPPs in orange, and the PPP for fundamental LSH R&D - BBoL - in light blue.



BBoL: Building Blocks of Life; **hDMT:** The Institute for Human Organ Disease Model Technologies; **MYBL:** More Years, Better Lives, **HDHL:** Healthy Diets, Healthy Lives; **IMDI:** Innovative Medical Devices Initiative; **DCVA:** Dutch Cardiovascular Association; **RegMedXB:** Regenerative Medicine Cross Borders; **ELF:** European Lead Factory; **NCOH:** Netherlands Centre for One Health; **NADP:** Netherlands Antimicrobial Development Platform; **HTA:** Health Technology Assessment; **SPRONG V&G:** Stimulering van Praktijkgerichte Onderzoeksgroepen; **V&G:** Vitality and Health; **FAIRdICT:** Findable, Assessable, Intra-operable, Reusable data Information and Communication Technology; **GO FAIR:** Global Organisation for Findable, Assessable, Intra-operable, Reusable data; **Health-RI:** Health Research Infrastructure.

Overview Strategic PPPs

Operational PPPs

Co-creating Health

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Collaboration between creative industries and the health sector is expected to accelerate and improve innovations for vital citizens in a healthy economy. Therefore an agenda for the development of knowledge and innovations on this intersection is developed, the Roadmap Co-Creating Health. Sustainable public private partnerships on the intersection of health and creative industries will be launched as a result of the roadmap. Their efforts will be enhanced by national and European research funding programmes. The work of the public-private partnerships results in societal, economic and scientific innovations that are interesting from an international perspective. Ultimately, collaboration between the health sector and creative industries becomes a matter of course and contributes to a better society.

Deltaplan Dementia

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The cooperative Deltaplan for Dementia is the Dutch national platform to address and manage the growing problem of dementia. Our goals are to: 1) prevent and cure dementia, 2) improve healthcare for people with dementia, and 3) create a more dementia friendly society. For this goals are three national programmes in place: 'Memorabel', 'Dementiezorg voor elkaar' en 'Samen dementievriendelijk'. By means of these national programmes we aim to create a dam against dementia together.

Dutch CardioVascular Alliance

Acronym DCVA

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Cardiovascular diseases (CVD) are on the rise due to aging, changing lifestyles, and the success of turning CVD from terminal into chronic conditions. Early detection can reduce the number of chronic patients and recurrence by detecting disease (progression) before irreversible damage occurs. The Dutch CardioVascular Alliance (DCVA) will develop solutions to CVD based on early detection. It builds on an excellent scientific community organized through the CVON program (EUR 220 million since 2011). DCVA aims to mobilize EUR 1 billion private and public funding over ten years, investing in five priorities: science, communities, talent, valorization & implementation, and research infrastructure.

European Lead Factory

Acronym ELF

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The European Lead Factory is a collaborative public private partnership aiming to deliver innovative drug discovery starting points. Having established the first European Compound Library and the first European Screening Centre, the EU Lead Factory gives free access to up to 500,000 novel compounds, a unique industry-standard uHTS platform, and much more. The EU Lead Factory is open to all defined molecular targets in all human disease areas. Any researcher from a European academic institution or SME can apply for screening of their potential drug target of interest.

GO FAIR for the Internet of data and services

Acronym GO FAIR

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With the Life Sciences in the lead, The Netherlands, together with Germany will kick start the developments towards the Internet of FAIR data and Services (the final aim of the EOSC). The two Secretaries of State have just signed a commitment and will call on the Commission and all other MS to join. This will make The Netherlands a 'silicon valley' of FAIR data and services development in which many companies (from Elsevier to Ordina) and public sector institutes (i.e. all DTL partners) can contribute. We propose that LSH takes a leading role as this exciting development is a direct outcome of the LSH funded FAIRdICT project and its relationship with the World Economic Forum.

Institute for human organ and Disease Model Technologies

Acronym hDMT

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hDMT is a public private organ-on-chip consortium of renowned scientists from multidisciplinary fields, that share their knowledge, expertise and facilities to develop organ-on-chip models. Our objective is to develop validated cultured cell models of healthy and diseased human tissues and organs through organ-on-chip technology, and enable their valorisation, implementation and availability to interested users for a wide variety of applications. We focus on human organ and disease models (Brain-, Cancer-, Heart- and Vessels-on-chip), and Organ-on-chip technology platforms. Ultimately, we generate organ-on-chip models 1) that mimic any part of the human body, and 2) to study human sickness and health, for personalized disease treatment or even prevention – available and affordable for everyone.

Health Research Infrastructure

Acronym Health-RI

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Personalized medicine and health research focusses on identifying which approaches will be effective for which patients based on genetic, environmental, and lifestyle factors. The development of novel personalized healthcare solutions requires the integration of highly diverse collections of longitudinal health and biomedical data, generated at different hospitals and research centers. In Health-RI, the common goal is to interconnect these biomedical resources, empowering researchers to develop better personalized medicine and health solutions. Health-RI is the interconnected infrastructure for personalized medicine & health research in the Netherlands.

Innovative Medical Devices Initiative

Acronym IMDI

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IMDI Centres of Research Excellence work on technology for sustainable healthcare. Within public private partnerships we develop and implement imaging, minimally invasive and homecare & rehabilitation technologies that show how they impact sustainable care. Ultimately, we aim to 1) support independence, 2) provide professional care closer to home, and 3) do more with less healthcare workers.

Netherlands Antibiotic Development Platform

Acronym NADP

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As antimicrobial resistance is one of Min. VWS' three societal priorities, the Netherlands Antibiotics Development Platform (NADP) was established in 2017 through funding by Min. VWS (working budget 2017-2021). Herein, the Netherlands Center for One Health, Center for Antimicrobial Research (Leiden), Center for Sustainable Antimicrobials (Groningen), and Immuno Valley collaborate to facilitate research and development of new antibiotics and alternatives. The NADP aims to realize sizeable PPPs on national and international level, where existing fundamental, translational and clinical research from several institutes and enterprises will be combined in the broader context of One Health.

Netherlands Centre for One Health

Acronym NCOH

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The Netherlands Centre for One Health (NCOH) aims for an integrated One Health approach to tackle the global risk of infectious diseases. NCOH commits to create durable solutions for this major challenge by bundling world-leading academic top research in the Netherlands in the area of One Health. For development of concrete solutions to One Health challenges, NCOH has a common Strategic Research Agenda (SRA). This SRA defines multiple Solution Sets for its four Strategic Research Themes. The Solution Sets – preferably developed in co-creation with private partners - are a combination of projects that span from predictive and fundamental research to preventive strategies, treatment strategies, and policy-oriented research (patient/host and population).

NeoKidney

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NeoKidney aims to develop a portable artificial kidney (PAK) for extramural hemodialysis treatment. The PAK enables longer and better dialysis treatments which improve the health condition whilst minimizing the impact on daily life. The first version of the PAK is currently under development and will be clinically tested in 2018/2019. In the coming years NeoKidney will continue to improve the ease of use by delivering hardware and software for personalized treatment, a better solution for long-term vascular access and new membranes and filters for blood purification. Ultimately, these innovations will result in a re-invented dialysis machine that is (partially) implantable.

Oncode Institute

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Oncode is a new independent world-class, innovative institute that unites, under a common strategy, more than five hundred of the Netherlands' most outstanding scientists, specialized in the field of fundamental oncological research (i.e. research on how cancer operates at a basic, molecular level). Oncode incorporates the knowledge and experience to identify and foster scientific discoveries that are potentially beneficial to patients. The institute helps to pave the path leading from such discoveries towards translational and clinical research and practical applications. The institute fosters a climate in which contribution to valorization is as highly esteemed as the scientific endeavour itself.

Product Development Partnership III

Acronym PDP III
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PDP III contributes to innovation of healthcare products and technologies specifically aimed at diseases and conditions related to poverty and sexual and reproductive health and rights (SRHR). PDPs are public private partnerships set up to accelerate the development and availability of products which are unlikely to attract private investment while in development. The fund focuses on the development and availability of affordable, effective medicines, vaccines, diagnostics and innovative products for neglected diseases and conditions. The Fund is executed by the Netherlands Enterprise Agency (RVO.NL) at the instigation of the Dutch Ministry of Foreign Affairs.

Regenerative Medicine Crossing Borders

Acronym RegMedXB
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RegMedXB is a large Dutch-Flemish collaboration between physicians, scientists and companies, aiming to cure type-1 diabetes, kidney disease and osteoarthritis. Health funds and governments contribute to a planned research budget of 250 million euros in the first 10 years. RegMedXB is a public private partnership which combines the skills of first rate professionals each in their own existing institutes. These joint specialized forces and focus of the universities of Utrecht, Leiden, Eindhoven, Leuven and Maastricht will speed up the development of real cures through regenerative medicine. The research itself will lead to new high-value employment, entrepreneurship, intellectual property and knowledge.

SPRONG Programme Vitality and Health

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SPRONG is a Research Capacity Building Programme on Vitality and Health for Universities of Applied Sciences and their public and private partners. The main objective of the programme is to enhance more focus and volume of applied research in the field of Vitality and Health by the creation of strong research groups that will enlarge their expertise over a longer term, in collaboration with education and the industry. Within eight years, there are five applied research groups that are widely acknowledged for the excellence of their research programmes and their contribution to education. The volume of these programmes has multiplied over the years, as a result of the strong public-private partnerships which support them.

Healthy Work: Good for Business (part of the prevention coalition)

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We aim to realise sustainable employability by innovative technology: self-sensing systems, smart intervention tools and ICT systems. Thereby decreasing the number of influential sick days and incapacitation by 25%. Toolbox with self-sensing systems is developed, including smart intervention tools and ICT systems, ready to exploit. In 2030, 50% of the citizens in The Netherlands have taken responsibility of their own health. Smart self-sensing systems determine their overall condition. A self-learning decision system gives advice on interventions that improve their health. The company Healthy@Work=Good4Business BV exploits this system, financed by their employers and by health insurance companies.

Personalised Nutrition & Health (part of the prevention coalition)

Acronym PNH
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The ultimate goal of the PNH consortium is to enhance the health and wellbeing of society by empowering consumers to choose and maintain an optimal personalized diet & lifestyle. Therefore, TNO and Wageningen Research initiated this PPP that develops innovative systems that enable consumers to make optimal food choices by providing personalized coaching based on do-it-yourself measurements of health and behavior. The consortium has a unique approach in that it combines different scientific disciplines, from life sciences and behavioral research to data science and sensor technology. The consortium involves a broad selection of private partners spanning the entire value chain of personalized nutrition and health.

Personalised, preventive youth health care (part of the prevention coalition)

Contact Symone Detmar (TNO) and Igor Ivakic (NCJ)

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This initiative offers an integrative set of personalized health technology to improve (1) youth and family empowerment (2) increase participation, provide tailored services and increase efficiency. Development of an integrated Youth Health Digital Platform for youth, their parents and professionals including 1) Methods for effective and adequate detection and treatment of at-risk youth; 2) Instruments to predict risks with the ability to prevent the occurrence of risks; 3) Effective person-tailored interventions. Within a single platform, diagnostic and prognostic tools, personalized advice and treatment, and effective ehealth/coaching modules will be offered. Data and results available for youth, parents and professionals.

Plan and coalition formation

InSciTe Biomedical

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InSciTe Biomedical is an initiative of DSM, TU/e, UM/MUMC+ and the Provincie Limburg focused on accelerate and translate biomedical/regenerative medicine concepts towards patient and market. InSciTe Biomedical bridges the gap between fundamental research and market entrance. InSciTe is an RT&D institute with its own dedicated infrastructure (incl. cleanrooms) and training program crucial elements needed for this accelerated transition towards patient and market. InSciTe and its initiators actively seek for and work with partners that want to co-invest in the institute and the projects that are running there. Within projects (that run up to and including first-in-man studies), partners perform part of their development work side by side in the InSciTe facilities according to the necessary quality regime.

NeuroTech-NL

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Brain diseases impose a huge burden on patients, their caregivers, and society. The economic burden in the Netherlands has been estimated at approximately 20 billion euros per year. NeuroTech-NL aims to ameliorate brain diseases by creating clinically implantable devices to interface with neural tissue at high spatial and temporal precision that enable direct reading out and influencing the brain's representations. This initiative will bring the Netherlands to the forefront of the technical developments for (1) improving the capabilities for brain reading in paralysis and writing for sensory prosthesis, (2) enhancing deep brain stimulation and (3) to develop better interfaces with the peripheral nervous system.

Predictive, Preventive, Personalized and Participatory (4P) Medicine for More Oxygen (O₂)

Acronym P4O2

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According to the WHO, lung diseases jointly are listed number one for mortality and disease burden worldwide. The P4O2 program aims to identify treatable traits and innovative personalized therapeutic strategies to preventing progression of early stage damage and reversing established damage by stimulating repair. Personalized medicine approaches for patients with chronic lung diseases are available and applied in clinical practice thereby improving disease burden and societal participation, distributed along milestones and deliverables at 5, 10 and 15 years: 1) Using novel biomarkers, disease development, progression and treatment responses can be predicted and monitored with minimal burden to patients 2) Through better understanding of main phenotypic hallmarks, corresponding to treatable traits of lung disease, patients have access to tailored interventions that are not restricted to traditional categories of disease

Vitality Oriented Innovations for the Lifecourse of the Ageing society

Acronym VOILA

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The Dutch Society for Research on Ageing aims to sustain vitality and health during the life course of the ageing society via two PPP pipelines. The first identifies molecular and cellular targets for intervention in the aging process to initiate novel trials based on 1) identification of key molecular targets in the ageing process 2) target these molecules by genetic, pharmacologic, or dietary interventions and 3) test these interventions in model systems and eventually in human studies. Ultimately, a trial based on a targeted intervention to stimulate vitality and extend health span by repairing derailed key pathways of ageing. Secondly, personalise prevention and treatment protocols to counteract age-related loss of vitality and to stimulate evidence based medicine in the elderly. Ultimately, we realize profile based protocols for personalised prevention and treatment of heterogeneous elderly in the second half of life.

Plan formation

Animal free innovations (working title)

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Animal testing is a hot topic in The Netherlands and abroad. Society has a critical opinion on the use of animals for scientific purposes. More and more scientists realize the animal model is not the best model for biomedical research. Therefore, we aim that the Netherlands is world leader in animal free innovations in 2025, by 1) development of better science based on native biology, 2) involvement of an ever growing group of scientists and technologists for this goal, and 3) addressing the wish of the Dutch society by showing which steps are taken in replacing animal testing.

Extramuralisation 50%

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With new technologies a large share of healthcare treatment can be transferred to home. This especially concerns diagnoses, guarding and repeating treatments of chronic diseases such as CPD, CHF and diabetes. We aim to 1) use pilot projects such as kidney dialysis to learn and realize actual breakthroughs in diseases like CFH, 2) improve practice, 3) define what this means for the work and education for healthcare practitioners such as nurses, doctors and professionals in the first line, 4) transfer 50% of the health treatments from healthcare providers to home, and 5) educate and facilitate the professionals to work in that world.

Global Anti-Microbial Resistance Consortium

Acronym AMR-GLOBAL

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Antimicrobial resistance (AMR) is spreading globally, threatening our ability to treat common infectious diseases, resulting in prolonged illness, disability, and death. Examples of increasingly concerning resistant pathogens are extensively drug-resistant TB (XDR-TB), and an outbreak of a superbug resistant to all drugs in China. AMR endangers achievement of the Sustainable Development Goals. Many recent initiatives to fight AMR focus on developed countries. The AMR problem is however particularly relevant to low – and middle-income countries. AMR-GLOBAL brings together science and business to achieve a true global focus in the fight against AMR, via better diagnostics, stewardship, and new antimicrobial drugs.

Humane Meettechnieken (3/4V)

Contact Erica van Oort

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This initiative focusses on animal free innovations in applied- and fundamental research throughout the biomedical, chemical and technical field. We promote animal free innovations (translatable and reliable human based innovations) and stimulate of new innovations to acquire a world leading expertise environment within NL. Ultimately, in 2025, the Netherlands is world leading in animal free innovations

Optimizing Personalised Cancer Therapy in the Netherlands

Acronym PATH-and-beyond

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Targeted therapies and immune-therapies are a breakthrough in the treatment of cancer. The big challenge is to predict which patients benefit from these expensive drugs. Predictive biomarker analysis is considered instrumental for this. Fast technological developments and complexity of personalized cancer therapy ask for a coordinated approach for optimal accessibility and quality. In PATH-and-beyond, a nation-wide infrastructure for sharing and connecting science, innovation and continuous evaluation of everyday diagnostics and clinical diagnostics will be established for optimal personalized diagnostics for today's cancer patients and future cancer patients. PATH-and-beyond aims to create a continuously learning system for personalized medicine.

Exploration

Biomedical Matrix

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High costs and more stringent quality requirements, prevent too many medical innovations of reaching patient and market. The Biomedical Matrix is an open innovation infrastructure+ concept dedicated to help start-ups and research projects progress more quickly and successfully from (proof-of-)concept to first-in-human. Focusing on Class IIb/III Medical Devices, Advanced Therapy Cell Products and combinations thereof, the Matrix is based on sharing of knowledge, infrastructure and equipment within a certified Quality Management System. The potential by first market-analyses: a reduction in time-to-market by 6-18 months, CAPEX by 50-75%, and risk (by improving chances of success, limiting up-front investment and better, earlier go/no-go decisions).

Improving Mental healthcare using Personalized treatment based on analyses of Routine data for Optimal Value and Effectiveness

Acronym IMPPROVE

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Mental disorders constitute the largest disease burden in modern societies. Healthcare has not reduced this burden but Netherlands psychiatric epidemiology is worldclass. New insights on development and course of disorders combined with innovative use of routine and survey data will improve treatment and prevention. This initiative aims to 1) improve personalized mental health care and selfmanagement through linkage and analysis of data from multiple sources at micro, meso, and macro level, 2) employ advanced statistics and e-health with utmost care for security and privacy, and 3) collaborate between professionals, patients and societal and commercial stakeholders. Ultimately, regional and national innovation platforms are used for mental wellbeing.

mICF

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ICF aims to facilitate person-centred, interprofessional holistic care by addressing the needs of service users through shared decision-making and service user-reported outcomes. It will utilise service user-driven big data to empower users and service providers. mICF will embrace person-centred care that goes beyond reactive care, health promotion and disease prevention by using big data analytics to inform individualised, predictive healthcare. To realise this aim, we will be developing, researching and commercialising a new information and communication technology (ICT) solution for the management of integrated care, based on the World Health Organization's (WHO) International Classification of Functioning, Disability and Health (ICF). The ICF is a comprehensive coding system for functioning and disability that serves as a universal information structure, conceptual framework and a common language between all professions.

Metabolic Health Innovations: From Care to Cure

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Increasingly, there is proof that lifestyle change can reverse or cure "lifestyle related diseases", incl. metabolic syndrome, obesity, Type 2 diabetes, and cardiovascular complications. Yet, lifestyle change is hardly practiced as therapy, although this would enormously reduce healthcare costs. The PPP 1) Designs lifestyle(-pharma) interventions restoring all aspects of systems flexibility, 2) Develops adequate tools for this purpose (diagnostics, products, services, eHealth), 3) (Pre)clinically tests and validates diagnosis – intervention combinations, and 4) Implements, evaluates and pursues accreditation. We initially focus on Type 2 diabetes, with the aim to cure this disease within 10 years. We reapply the learnings to other lifestyle-related diseases.

Personalized Psychiatry

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Our society has become more and more demanding in terms of emotional stability and high cognitive functioning for citizens to fulfil their social and economic competence. To achieve this required level of mental competence, preventative action and early and effective treatment of mental illness is essential. This requires a shift from treating psychiatric disorders towards preventing them. Personalised medicine and personalised mental healthcare, including new strategies applying hormone treatment, food supplements, immune modulation therapy, cognitive enhancers and (digital) cognitive training will enhance effectiveness of treatment. Partners (i.a. NFU) in Dutch mental healthcare will cooperate with other PPP initiatives from 2015 on to construct a definitive long-term research programme in 2017.

Appendix II – Types of research and Technology Readiness Levels

Table IIa: Types of research

Type of research	Definition
Fundamental research	Experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any direct commercial application or use in view
Industrial research	The planned research or critical investigation aimed at the acquisition of new knowledge and skills for developing new products, processes or services, or for bringing about a significant improvement in existing products, processes or services. It comprises the creation of component parts of complex systems, and may include the construction of prototypes in a laboratory environment or in an environment with simulated interfaces to existing systems, as well as of pilot lines, when necessary for the industrial research and notably for generic technology validation.
Experimental development	Acquiring, combining, shaping and using existing scientific, technological, business and other relevant knowledge and skills with the aim of developing new or improved products, processes or services. This may also include, for example, activities aiming at the conceptual definition, planning and documentation of new products, processes or services. Experimental development may comprise prototyping, demonstrating, piloting, testing and validation of new or improved products, processes or services in environments representative of real-life operating conditions, where the primary objective is to make further technical improvements on products, processes or services that are not substantially set. This may include the development of a commercially usable prototype or pilot that is necessarily the final commercial product because it is too expensive to produce for demonstration and validation purposes only. Experimental development does not include routine or periodic changes made to existing products, production lines, manufacturing processes, services and other operations in progress, even if those changes may represent improvements.

Table IIb: Technology Readiness Levels*

TRL	Definition	Type of research
TRL 1	Basic principles observed	Fundamental
TRL 2	Technology concept formulated	Fundamental
TRL 3	Experimental proof of concept	Fundamental
TRL 4	Technology validated in the laboratory environment	Fundamental
TRL 5	Technology validated in relevant environment (industrially relevant environment in the case of Key Enabling Technologies)	Industrial
TRL 6	Technology demonstrated in relevant environment (industrially relevant environment in the case of Key Enabling Technologies)	Industrial
TRL 7	System prototype demonstration in operational environment	Experimental
TRL 8	System complete and qualified	Beyond the scope of the PPP Allowance Regulation
TRL 9	Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)	Beyond the scope of the PPP Allowance Regulation

* The link of the three types of research to the technology readiness levels is only an indication. No rights can be derived from this table.

Appendix III - Governance

Introduction

The recently enhanced alignment in the Top Sector LSH and the growth of the responsibilities of its governance, including financial ones (*Innovation Contract 2016-2017*¹⁸²) required a secure governance and supportive execution model to be put in place. In 2017 the governance of the Top Sector LSH has been reorganised and now consists of the following: a *Top Team* and an *Advisory Board*. Both are supported by a legal entity: a foundation (*Stichting TKI-LSH*) that has an *Executive Office* supervised by a *Board*.

LSH Top Team

The Top team is responsible for the formulation, execution and monitoring of success of the strategic policies of the Top Sector LSH and those of the coalition of the societal challenge on Health and Care. The Top team, appointed by the Minister of Economic Affairs, consists of 5 members who represent industry and SMEs, science and the Dutch government; a 6th colleague is an observer on behalf of ZonMw. Together they also act as ambassadors for the LSH sector. Each member holds a portfolio of specific themes from funding to internationalisation. The LSH chairman of the Top team also acts as the main representative of the LSH sector and the societal challenge.

LSH Advisory Board

The Advisory board acts more or less independently of the Top team and consists of 16 independent members selected for their experience and expertise in the sector. They are appointed by the Top team in a personal capacity. The Advisory board focusses on strategic issues in the LSH sector and advises the Top team. Every member has a portfolio of themes and initiatives specific to the sector and/or societal challenge. The Advisory board appoint their own chairman and vice-chairman.

Stichting TKI-LSH

Executive Office

The executive office is responsible for the day-to-day support of the governance of the Top Sector and the societal challenge Health and Care. Under the guidance of the Top team and Advisory board the office coordinates, executes, and supports the sector's activities. In addition, under the brand name **Health-Holland**, the office is a service point for the sector's public and private stakeholders and partners and it facilitates PPP development and applications. In addition **Health-Holland** is the Top Sector's national and international brand and communication channel¹⁸³.

TKI-LSH Foundation Board

As a foundation, the executive office of the Top Sector LSH is formally supervised by an independent board. The board consists of three members with legal, financial and scientific expertise and, in addition to supervising the executive office and its staff, it awards PPP Allowances after taking advice from the PPP Allowance evaluation committee.

List of abbreviations

ANBI's	Algemeen Nut Beogende Instellingen	KIC	Knowledge and Innovation Contract	R&D	Research and development
BBoL	Building Blocks of Life	KNAW	Koninklijke Nederlandse Akademie van Wetenschappen (The Royal Dutch Society of Arts and Sciences)	RegMedXB	Regenerative Medicine Crossing Borders
CBS	Centraal Bureau Statistiek	KNCV TB	Koninklijke Nederlandse Centrale Vereniging tot bestrijding der Tuberculose	RIF	Regionaal Investeringsfonds
CLICKNL	Top Sector Creative Industry	KvK	Kamer van Koophandel (Chambers of Commerce)	RIS	Regional Innovation Scoreboard
COAST	Comprehensive Analytical Science and Technology	LS@W	LifeSciences@Work Accelerator	ROMs	Regionale Ontwikkelingsmaatschappijen
CVON	Cardiovasculair Onderzoek Nederland (Cardiovascular Research Netherlands)	LSH	Life Sciences and Health	RVO	Rijksdienst voor Ondernemend Nederland
CWTS	Centre for Science and Technology Studies	Min. EZ	Ministry of Economic Affairs (Ministerie van Economische Zaken)	SBIR	Small Business Innovation Program
DCVA	Dutch Cardiovascular Association	Min. OCW	Ministry of Education, Culture and Science (Ministerie van Onderwijs, Cultuur en Wetenschap)	SCI	Scientific Citation Index
EU	European Union	Min. VWS	Ministry of Health, Welfare and Sport (Ministerie van Volksgezondheid, Welzijn en Sport)	SGF	Samenwerkende Gezondheidsfondsen
DuSRA	The Dutch Society for Research on Ageing	MIT	MKB-innovatiestimulering Regio en Topsectoren	SKBN	Stichting Kennisalliantie Bedrijventerreinen Nederland
EFRO	Europees Fonds voor Regionale Ontwikkeling	MYBL	More Years, Better Lives	SME	Small and Medium-sized Enterprises
ELF	European Lead Factory	NADP	National Antimicrobial Development Platform	SPRONG V&G	Stimulering van Praktijkgerichte Onderzoeksgroepen Vitality and Health
FAIR	Findable, Assessable, Interoperable, Reusable	NCOH	Netherlands Centre for One Health	SZW	Ministry of Social Affairs and Labour
FAIRDICT	Findable, Assessable, Intra-operable, Reusable data Information and Communication Technology	NFIA	Netherlands Foreign Investment Agency	TFHC	Task Force Health Care
Fin	Ministry of Finance	NFU	Nederlandse Federatie van Universitair Medische Centra	TKI	Topconsortia voor Kennis en Innovatie (Top consortium for Knowledge and Innovation)
FME	Federatie voor de Metaal-nl Electrotechnische Industrie	NPL	Nationaal Programma Longen	TO2	Federation of Applied Scientific Research Organisations
FTE	Full Time Equivalents	NRPO SIA	Nationaal Regieorgaan Praktijkgericht Onderzoek SIA	TRL	Technology Readiness Level
GO FAIR	Global Organisation for Findable, Assessable, Intra-operable, Reusable data	NWO	Nederlandse Organisatie voor Wetenschappelijk Onderzoek (Netherlands Organisation for Scientific Research)	TTO	Technology Transfer Office
HCA	Human Capital Agenda	OCW	Ministry of Education, Culture and Science	VIG	Vereniging Innovatieve Geneesmiddelen
HDHL	Healthy Diet, Healthy Living	OECD	Organization for Economic Cooperation and Development	VSNU	Vereniging van Samenwerkende Nederlandse Universiteiten (Association of Universities in the Netherlands)
hDMT	The Institute for Human Organ Disease Model Technologies	PFN	Patiënten Federatie Nederland (Patient's Federation Netherlands)	VWS	Ministry of Health, Wellbeing and Sport
Health-RI	Health Research Infrastructure	PPP	Public Private Partnership	WEF	World Economic Forum
HTSM	Top Sector High Tech Systems and Materials	PPS-Allowance	Public Private Cooperation (Samenwerking) allowance	WHO	World Health Organisation
HTA	Health Technology Assessment			ZiN	Zorginstituut Nederland
IMDI	Innovative Medical Devices Initiative			ZonMw	Nederlandse Organisatie voor Gezondheidsonderzoek en Zorginnovatie (The Netherlands Organisation for Health Research and Development)
I&M	Ministry of Infrastructure and Milieu				
InterReg	Interregional Community Initiative				
KETs	Key Enabling Technologies				
KIA	Knowledge and Innovation Agenda				

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