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HEALTH

Introduction

Sri Lanka boasts an outlier status compared to countries of comparable economic development in respect of the important health indicators such as life expectancy at birth, maternal mortality rate, infant and pre-school mortality rates. We are well above other countries of the South Asian region. This is despite a relatively low per capita expenditure on health, even below the minimum recommended by the WHO. This pattern of adult morbidity and mortality do not leave room for complacency. Due to increased life expectancy there is significant change in our demography with a rapidly increasing proportion of elderly. This coupled with the nutritional transition from traditional diet to a more refined, sugar and animal fat rich diet, with reduction of physical activity at both work and leisure and increased consumption of alcohol and tobacco has led to an increase in non-communicable diseases such as obesity, diabetes, metabolic syndrome, ischemic heart disease, cerebrovascular diseases, chronic kidney disease, chronic obstructive respiratory disease and cancer in epidemic proportions. In spite of the rising prevalence of obesity amongst all social classes, under nutrition has not been eliminated. Energy protein malnutrition in childhood and iron deficiency anemia in all age groups continue to be significant public health problems.

Although most vaccine preventable diseases have been almost eliminated newly emergent infections such as Dengue pose a major threat to health and life. Though malaria and polio are under control at present eternal vigilance is needed, especially in view of our close proximity to the Indian sub-continent, to prevent their re-emergence. The same can be said of our present low rates for HIV infection. The widening network of motorable roads and even more rapidly increasing number of motor vehicles has resulted in rapid increase in road traffic accidents as a major cause of morbidity and mortality. Though the incidence of rabies has declined the number of stray dog bites requiring prophylactic post exposure vaccination are large thus incurring huge costs. Snake bites continue to be an important cause of mortality among the rural population. The most distressing new entity affecting the rural agricultural population in some parts of the country is Chronic Kidney Disease of unknown etiology (CKDu). There is a strongly dissenting view point which claims that no specific link to an agro –chemical has yet been made. All these health problems have resulted in a rapid escalation of health care expenditure which is being met in roughly equal proportions by the state and out of pocket expenditure by the public. While the state accounts for a major part of the inpatient care costs, the out of pocket expenditure by the public accounts for a major portion of the outpatient care costs. This pattern however is changing with more and more of the middle and upper classes seeking inpatient care in the private sector where a highly cost intensive model of health care is being delivered with very little regulation.

We have a rich tradition of indigenous knowledge for health which has not been adequately exploited. We need to leap-frog into the future and be competitive by identifying technologies that are most appropriate for our needs. We have presented the technologies that need to be introduced and strengthened for the desired outcomes.

We have also identified certain catalytic activities that are likely to have multiplier effects in generating new research funding in areas of relevance and importance to Sri Lanka. These are strategic investments in research infrastructure and systems that will greatly strengthen the health research capability of the country by enabling Sri Lankan scientists to access hitherto untapped sources of funding from developed country research funding agencies which fund research for global health needs.

Sub Areas, Issues and Relevant Interventions

Table 1: Sub Areas and Justifications

Sub Areas	Justifications
1) Reliable, affordable and equitable healthcare	Need to addresses equity and access to healthcare across systems (Western, Ayurvedic and other alternatives) and sectors. There is wide disparity of services across areas.
2) Prevention, control and management of Non Communicable Diseases (NCDs)	Need to develop new therapeutic and preventive modalities to address the high burden of NCDs in the country in a cost-effective manner
3) Improved utilization of mathematics and computer applications in healthcare	Need to utilize mathematics and computer applications in planning and decision making in healthcare (e.g.: use of mathematical modeling and risk mapping)
4) Public health innovation for improving nutritional status	Need to address malnutrition in Infants and Young Children up to 3 years, especially in rural and estate sector
5) Local & export market for indigenous medicine	Need of enhanced attention to exploit the potential of readily available indigenous knowledge and herbal resources to develop new high quality drugs
6) Prevention ,control and management of Vector Borne Diseases	Need to use novel technologies in vector control, understanding disease transmission and pathogenesis and in drug development
7) Control of re-emerging Tropical Diseases such as Dengue, Rabies, Snake envenomation and Leishmaniasis	Establishment of Good Manufacturing Processes (GMP) certified antibody production plant is needed to cater for any of the future needs in infectious diseases
8) Utilizing modern technology for health promotion and community empowerment in health	Application of new technologies for dissemination of health information (e.g. mobile platforms), innovative social technologies for health promotion and community empowerment (e.g. in resisting tobacco & alcohol)are needed

Sub Areas	**Justifications**
9) Enhanced R&D activities on Genomics	Need of a National Genome Centre with a National Genome Data Repository
10) Develop facilities for stem cell research and Regenerative Medicine	It's a therapeutic modality worth exploring for previously incurable conditions and address the needs of a rapidly ageing population.
11) Seed funding for National Health Cohort studies	Health changes over a long time in developing countries undergoing demographic, epidemiological and nutritional transition have not been adequately studied. They will provide data for long-term health planning.
12) Research for better understanding of Sri Lanka`s exceptional achievements in health	Sri Lanka was and remains a global health outlier but our achievements are largely unknown or unappreciated in the global community, and not well understood even in Sri Lanka.

Table 2: Issues/Problems, R&D Needs and Relevant Interventions

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
1) Reliable, affordable and equitable healthcare	I) Need for national health systems research center which could also function as a health observatory to monitor equity and access II) Address equity across systems	i) A fully equipped and adequately resourced Health systems research center cum health observatory ii) Research to improve equity and access to healthcare	**Innovations** a) Establishing a National Health Systems Research Centre cum Health Observatory b) Identifying priorities for studies to improve equity and healthcare(e.g. palliative care for terminally ill) Monitoring access and equity related data c) Study the feasibility of providing integrated 'western' and ayurvedic care in a carefully selected list of conditions in which such potential is identified.
2) Prevention, control and management of Non Communicable Diseases (NCDs)	I) Ageing population, high disease burden from chronic NCDs and escalating costs of treatments II) High burden of CKDu amongst farmers in North Central Province. III) High disease burden due to	i) Making available low cost devices, diagnostics, drugs and complementary medicines ii) Low cost population screening and surveillance tool iii) Evaluate ayurvedic/herbal therapies for CKDu iv) A web based national cancer registry in to which all	**Pure and Applied Research** a) Cost-benefit analysis of HPV vaccine in high risk groups b) Identifying molecular markers Validating model /marker in high risk populations. **Innovations** a) Development of low cost devices for weight reduction, home based oxygen delivery, diabetic foot care, wound healing devices,

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
	cancer. IV) Need for accurate epidemiological data on cancer V) High morbidity and mortality due to oral cancer VI) Inadequacy of data on role of Human Papilloma Virus (HPV)in oral and cervical cancer	stakeholders upload data. v) Develop feasible model for early detection of oral pre-cancer vi) Identify prognostic indicators of oral cancer vii) Develop herbal preventive agents/ therapies for oral cancer viii) Serotyping high risk groups for HPV	devices for bronchial asthma, self-operated infusion devices for iron chelating thalassemia, appliances for the elderly/disabled b) Development of low cost diagnostics glucometers, simple population screening diagnostic tools for NCDs Sleep study diagnostics c) Establishing a central mechanism for developing, validating and marketing above mentioned devices Develop a urinary biomarker for CKDu **Indigenous Knowledge and Intellectual Property Rights** a) Identify ayurvedic/ herbal recipes with potential as a drug for cancer and further develop them and progress to clinical trials b) Development of topical anti-oxidant preparations from herbal ingredients for the prevention of oral and pharyngeal cancers
3) Improved utilization of mathematical modelling and computer application in Health care	I) Lack of data (e.g. spatial data) from a range of sources and novel methods required to better understand disease epidemics	i) Improved utilization of computer applications in health sector	**Pure and Applied Research** a) Development of mathematical models **Information and Communication Technologies** a) Use of satellite images b) Risk mapping

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4) Public health innovation for improving nutritional status	I) Lack of infrastructure for standardization and quality testing of ayurvedic /herbal medicines	i) Development of low cost complementary food for infants and young children ii) Use of mobile technology to improve Infant and young child feeding practices	**Innovations** a) Development of low cost complementary food for infants above 6 months and developing a social marketing mechanism for same **Information and Communication Technologies** a) Establishing a mobile phone platform for advising Infant and Young Child Feeding practices
5) Local & export market for indigenous medicine	I) Lack of systematic cultivation and utilization of herbal materials through direct contacts between farmers and manufactures II) Inadequate attention to produce high quality ayurvedic drugs with local ingredients	i) Improved Ayurveda Medicine based healthcare system for Sri Lankans (Note: Ayurveda shall mean Ayurveda, Sidda, Unani and Deshiya Chikithsa systems)	**Testing, Standardization & Accreditation** a) Validation of drugs/drug regime as per prioritized schedule b) Standardization of raw materials and drugs c) Setting up testing facilities for herbal drugs **Popularization** a) Popularization and active intervention in the cultivation of herbal plants in suitable agro-climate zones
	III) Exploiting the full potential of indigenous knowledge for better health	i) Further research into indigenous medicine, especially Deshiya Chikithsa, using texts and oral traditions prevalent in the country (hitherto untapped)	**Indigenous Knowledge & Intellectual Property Right** a) Research into ancient texts and oral traditions in the country in order to identify or recognize other forms of treatment.

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
Local & export market for indigenous medicine (Contd.)	IV) Lack of a credible regulatory mechanism for ayurvedic/herbal medicines meant for export		**Policy Studies** a) Develop relevant policies and establish a credible regulatory body for ayurvedic/herbal medicines
	V) Use of indigenous knowledge in medicine for income generation	i) Promote medical tourism in the sector (Indigenous Medicine based treatment systems for foreign tourists and visitors)	**Testing, Standardization & Accreditation** a) Validation and Standardization of services (physical environment of service providing Institutes, HR and other facilities)
	VI) Use of indigenous knowledge blend with novel technology	i) Clinical herbal product development	**Innovations** a) Reverse pharmacological approach to identify effective herbal medicines **Pure and Applied Research** a) Herbal clinical product development through clinical research - crude form, fractional form and single molecular level
		ii) Update and validate the current Ayurveda pharmacopeia	**Testing, Standardization & Accreditation** a) Authentication of herbs , minerals and other ingredients in formulae of current ayurveda pharmacopeia including possible adverse reactions or any other complications b) Develop standards for finished ayurvedic products
	VII) High burden of NCD in the country and need for alternative therapeutic modalities	i) Identifying candidate herbal recipes for Diabetes Mellitus (DM) treatment and transforming it to modern dosage form	

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
	VIII) Development of the methodologies that considerably shorten drug discovery process using reverse chemical biology	i) Functional protein microarray technology in herbal drug research	**Innovations** a) Development of target specific isolation techniques to isolate and characterize biologically active therapeutic molecules from Ayurveda herbal extracts which are non-toxic and time tested, and clinically verified
	IX) Preparation of comprehensive national level database for the country	i) Molecular level to pharmacopeia level development of comprehensive electronic databases for indigenous medicine.	**Information and Communication Technologies** a) With the help of the Dept. of National Archive, preserving the traditional medicinal knowledge as databases using high performance server facility.
6) Prevention ,control and management of Vector Borne Diseases (VBD)	I) Use novel technologies in vector control, understanding disease transmission and pathogenesis and drug development	i) Vector control	**Innovations** a) Larval control using innovative methods (e.g. nanotechnology, biotechnology, biological control) b) Use of new and existing techniques to understand vector biology in order to understand transmission dynamics of VBDs and to coordinate these activities by a dedicated centre/institute
		ii) Diagnostics	**Innovations** a) Develop novel, rapid, easy- to- use, diagnostic methods (e.g. saliva based tests, dip-stick tests, finger-prick methods) for diagnosis of Leishmaniosis, Japanese Encephalitis (JE) and Malaria. b) Immunoassays to identify biomarkers or prognostic markers for VBDs

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
Prevention ,control and management of Vector Borne Diseases (VBD) (contd.)		iii) Mapping transmission patterns of VBDs for early intervention during epidemics and better control	**Pure and Applied Research** a) Research on immuno-epidemiology of dengue infections in order to understand dengue transmission dynamics and immune correlates of protection in implementing dengue vaccines
			Information and Communication Technologies a) Use of GIS technology for understanding environmental factors contributing to VBD transmission
		iv) Drug development	**Nanotechnology** a) Drug development using Nano-technology **Innovations** a) Understanding the pathogenesis of common VBDs such as Dengue, Leishmaniosis and JE, so that already existing drugs could be used in the treatment of these diseases (e.g. many existing drugs that are used for other diseases can be effectively utilized for treatment of Dengue if we can determine the mediators that cause severe disease, liver injury etc.)

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7) Control of common tropical diseases	I) The establishment of Good Management Practices (GMP) certified antibody production plant for the first time in Sri Lanka. This can be applied to any of the future needs in infectious diseases `	i) Development of vaccine candidates, monoclonal antibodies, peptides and protein therapeutics	**Innovations** a) Development of vaccine candidates for rabies b) Production of monoclonal antibodies for snake venum. c) Improvement of currently clinically failed vaccines (e.g. Malaria) using a newly established proteomics technique d) Production of high quality Dengue specific monoclonal antibodies and virology reagents for research and diagnostics.
		ii) Development of contact lenses disinfection system.	**Innovations** a) One-pot neutralization technique for hydrogen peroxide based disinfection
8) Utilizing modern technology for health promotion and community empowerment in Health	I) Innovative social technologies for health promotion and community empowerment using IT is needed	i) New technologies for dissemination of health information ii) Study social technology, potential for scaling up and cost-benefit of community-based health promotion interventions for a variety of problems	**Information and Communication Technologies** a) Mobile phone based health information platform to disseminate health information **Pure and Applied Research** a) Study the interventions for following; Tobacco use, Reducing underweight in young children, Reversing obesity b) Minimizing alcohol-induced aggressive behavior

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9) Enhanced R&D activities on Genomics	I) Need for regulation of the ethical aspects of bio-medical research II) Need for comprehensive genetic testing and a central facility for Sri Lankan scientists to use for both service and research III) Need for a central repository to obtain information about genetic variations of Sri Lankans when planning research.	i) Need for a bio-ethics regulatory framework at national level ii) Establishment of a fully equipped National Genome Centre with a National Genome Data Repository	**Policy Studies** a) Establishment of a National Bio-ethics Authority with wide ranging regulatory powers. **Capacity Building** a) Establishment of a fully equipped National Genome Center **Information and Communication Technologies** a) Establishment of a National Genome Data Repository
	IV) Enabling equitable access to the facilities to all Sri Lankan scientists.		**Policy Studies** a) Establishment of a Governing Mechanism and Policies for accessing the National Genome Centre and the National Genome Data Repository. **Pure and Applied Research** a) Conducting a comprehensive study to map the genetic diversity of the Sri Lankan population

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	V) Reduce unnecessary expenditure on import of drugs that are harmful and/or ineffective for Sri Lankans because of their unique genetic makeup	i) Incorporation of the pharmaco-genomic profile of Sri Lankans in the regulatory approval process for medicinal drugs used in Sri Lanka and facilitate the availability of pharmacogenomic testing in Sri Lanka	**Information and Communication Technologies** a) Cataloguing the prevalence of pharmaco-genomically important genetic variations in the Sri Lankan population
10) Develop facilities for Regenerative Medicine	I) Aging is a rising problem in Sri Lanka. This reduces the workforce efficiency and affects the country's economic progress.	i) Developing anti-ageing agents using antioxidants	**Innovations** a) Use of antioxidants as potential anti-aging agents targeting mitochondrial dysfunctions and biochemical changes associated with ageing. b) Use of antioxidants as agents preventing mitochondrial DNA damages associated with ageing
11) Seed funding for National Health Cohort studies	I) Health changes will occur differently in developing countries experiencing demographic and health transitions. They need to be monitored over a long period	i) Funding to support establishment and recruitment of national cohorts at birth and also in early adulthood and their long-term monitoring.	**Pure and Applied Research** a) Recruit national cohort at birth and early adulthood and track long-term changes in health status, disease and their determinants
12) Research for better understanding of Sri Lanka`s exceptional achievements in health	I) Lack of understanding and recognition of exceptionally high achievements related to health in Sri Lanka, globally as well as locally	i) Fund research that will lead to better understanding and global awareness of Sri Lanka's health miracle, its achievements, explanations, and those that provide lessons to rest of the world	**Pure and Applied Research** a) Award competitive grants for research into the aspect of Sri Lanka's achievements in health