Disruption or Incremental Innovation?

What is the future of Biomedical Science, Technology and Healthcare?

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The Global Health Science University (GHSU) and its faculty, supporters, funders, collaborators in industry, government and society will provide leadership in shaping the future of humanity. Universities do so by fostering innovation and creativity and educating leaders of tomorrow. We must create an environment in which learners not only acquire new knowledge and skills to achieve professional licensure (such an outcome is the minimum requirement), but also develop and nurture adaptability for future changes. At GHSU, we wish to train future physicians who will lead the change process. Will this change be incremental and evolutionary, i.e. helping us to gradually create better healthcare products and services? Or will it be disruptive, where new ways of doing things will be so different that it will destroy and replace the existing healthcare landscape?

To the extent we can predict new directions in biomedical and clinical sciences, we can ensure an orderly transition through evolutionary and incremental change. However, like other industries (e.g. automobiles replacing horse drawn carriages), a disruptive change may occur in healthcare. For example, automation in image recognition may disrupt clinical disciplines such as radiology dedicated to interpretation of images. To enable students to cope with disruptive changes, the University has an obligation to its students and graduates to help adapt and retrain to survive in the new world. Therefore, first let me discuss predictable directions in biomedical research and technology. The GHSU will prepare its graduates to use such research and technology for the benefit of people they serve. Second, we will also discuss how the University can promote among its students the adaptability and capability to lead the change. We will discuss our game changing approach to organizing a University and a Medical School which will promote collaboration rather than turf battles and silos.

Goals of Biomedical, Clinical and Healthcare Delivery Research:

Incremental changes may come from (a) careful consideration of national and global goals of biomedical and clinical research and the common good it will produce for the society, (b) adopting appropriate institutional goals and (c) implementing the plan successfully. A prerequisite for people to access the common good produced by research, there must be a healthcare system that is equitable and affordable.

Overall goals of biomedical and clinical research as well as healthcare are to improve longevity and quality of life. Thus, the focus of research will remain on

(1) Promoting health and preventing diseases
(2) Improving diagnosis, treatment and cures of diseases and
(3) Delaying aging and/or preventing its consequences.

Globally, these research and healthcare priorities will remain relevant but there are other geographically specific concerns such as malnutrition and parasitic diseases such as malaria in developing countries that are not high priorities in the United States. It is important to think globally but act locally.

Improving delivery of these benefits leads us into health policy and healthcare delivery research. Obviously, a new organization cannot undertake all of the above goals right away and dilute its resources on too many areas for its research program. The GHSU will deliberate its directions with its leadership, faculty, donors and funding agencies and the Board of Trustees to focus its resources.

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Priorities established by Government and Industry Funding:

In determining prevailing direction of the research program in the United States, it will be useful to consider current and future funding sources, namely government support from agencies such as NIH, CDC or NSF; private industry, and philanthropy.

The NIH budget is expected to receive a $3 billion boost to $ 37 billion in 2018, the biggest percent increase since a 5-year effort to double the agency's budget ended in 2003[1]. (That doesn't include 2 years of stimulus funding during the recession.)

If ranked by congressional funding of each institute and centers of NIH, the current areas of emphasis of NIH are shown in Table 1.

Table 1: Funding of NIH: Top 10 Institutes and Center (in millions of dollars)

NIH Institute or Center	2016	2017
National Cancer Institute	4,418	5,894
National Institute of Allergy and Infectious Diseases	3,314	4,716
National Heart Lung and Blood Institute	2,512	3,114
National Institute of General Medical Sciences	1,966	2,512
National Institute of Diabetes, Digestive and Kidney Diseases	1,695	1,966
National Institute of Neurological Disorders and Stroke	1,598	1,695
National Institute of Aging	5,214	1,598
National Institute of Metal Health	1,519	1,519
National Institute of Child Health and Human Development	1,338	1,338
National Institute of Drug Abuse	1,051	1,051

The above analysis suggests national public health priorities in the following order; (1) Cancer, (2) Infectious Diseases and Vaccines, (3) Heart, Lung and Blood Diseases, (4) Obesity and Diabetes (5) Aging, (6) Mental Health and Drug Abuse and (7) other diseases affecting various organs.

Aging cuts across nearly all categories. Gerontology (study of old age) can be viewed as a science in its own right. The 2018 bill includes $414 million in new funding for Alzheimer's disease research, a 30% increase. The Brain Research through Advancing Innovative Neurotechnologies Initiative receive $140 million more, for a total of $400 million. The All of Us precision medicine study gets a $60 million increase, to $290 million. The bill also provides $40 million in new funds for research on a universal flu vaccine, for $100 million in total. At least $500 million in new funds will be targeted to research on opioid addiction.

Since 2008, NIH has published analysis of funding for various research, condition and disease categories (RCDC). The Table 2 below presents the rank order of top 15 categories for 2017 and 2018.

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Table 2 Funding by Research Condition and Disease Categories (in millions of dollars)

Category	2017 Actual	2016 CR
Clinical Research	$12,695	$13,720
Genetics	$8,501	$9,080
Prevention	$8,052	$8,566
Neurosciences	$7,317	$8,129
Biotechnology	$6,556	$7,012
Cancer	$5,980	$6,635
Infectious Diseases	$5,684	$6,019
Brain Disorders	$5,156	$5,749
Womens Health 8/	$4,769	$5,047
Behavioral and Social Science	$4,613	$4,935
Pediatric	$4,547	$4,834
Bioengineering	$4,176	$4,447
Clinical Trials and Supportive Activities 17/	$4,106	$4,420
Aging	$3,775	$4,075
Rare Diseases	$3,572	$3,777

The US Pharmaceutical Industry is the largest contributor to funding research in the United States; in excess of $ 75 billion per year[2]. As a result, treatment strides have reduced death rates from cardiovascular disease, cancer, HIV/AIDS and Hepatitis C. In addition, research in Genome, transcriptome, proteome (generally covered under the term "omics") and gene editing technologies are revolutionizing drug discovery process.

Donations, gifts and grants from foundations and wealthy individuals is another source of funding for biomedical research. An estimated $59 trillion —divided among heirs, charities, estate taxes and estate closing costs—will be transferred from 93.6 million American estates from 2007 to 2061, in the greatest wealth transfer in U.S. history, according to a new report issued by researchers at the Center on Wealth and Philanthropy (CWP) at Boston College[3]. The sum directed from final estates (for which there is no surviving spouse) toward charity is estimated at $ 6.3 trillion. The Global Health Science University will have strategies to receive charitable gifts to support its program growth.

Focusing effort and resources for research will be informed by not only the funding resources (government, commercial or donor advice) but also by faculty's innovative potential. Taking a chance on a risky research proposal is the best way to produce game changing innovations; this should be part of the research portfolio of the University.

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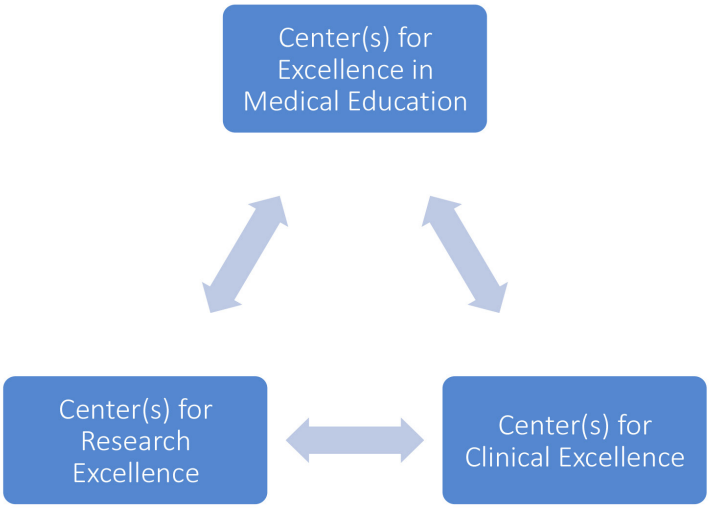
Innovative Organization of Research, Education and Clinical Care

In contrast to a traditional departmental organization, GHSU envisions a cohesive and collaborative organization of Centers of Excellence; without creating silos of customary departments. To accomplish the three major missions, the University and the Medical School will have three mission-based groups of Centers of Excellence as shown in the diagram below.



Rationale for Organizational Innovation:
Since our healthcare delivery system is structured for delivery of primary care and other specialty care functions, the medical schools are also generally organized into Clinical Departments of Family Practice, Pediatrics and Internal medicine with many sub-specialties within, Obstetrics and Gynecology, Psychiatry, Pathology, Radiology and Surgery with many sub-specialties organized as divisions within clinical departments. Basic biomedical sciences necessary to provide understanding of pathophysiology of diseases treated by these disciplines are also organized as Departments of Anatomy, Physiology, Microbiology and Immunology, and Pharmacology among others.

Departmental structures, thought to be necessary for medical education or clinical services, often lead to silos within medical education, research and healthcare delivery. Each department chair is incentivized for growth of the respective discipline and competes for institutional resources such as space and funds. Turf battles ensue, and collaboration is compromised.

The departmental organization assumes that future world will always have existence or distribution of the same clinical disciplines or that basic science research will continue to follow the pattern established decades earlier. History shows that this has not been the case. Transplantation Medicine and Surgery did not exist in the early 20th century but are commonplace now. With image recognition information technology, needs of radiology and pathology services may drastically change. Similarly, focus in biomedical sciences have shifted from identification and sequencing of genes to functional studies of genome wide expression. With the threat of global transmission of infections, the NIH funding for infectious disease research has increased significantly while other priorities have remained stable or declined.

A word of caution: an organization around centers may also create silos of different kinds. The Center Directors may pursue turf battles just as department chairs do. However, the proposed organization of centers focuses on the tripartite institutional mission. In addition to keeping the organizational structure as dedifferentiated as possible, we will also develop an incentive system that promotes collaboration and accomplishes the institutional missions.

Centers for Excellence in Medical Education:

The GHSU will adopt a goal of designing a medical education program which will lead the process of transforming the system to a socially conscious, patient centered, value driven health-care delivery. The Medical Education will ensure learning of adaptive skills, ability to use science and technology for benefit of mankind in a compassionate ethical manner.

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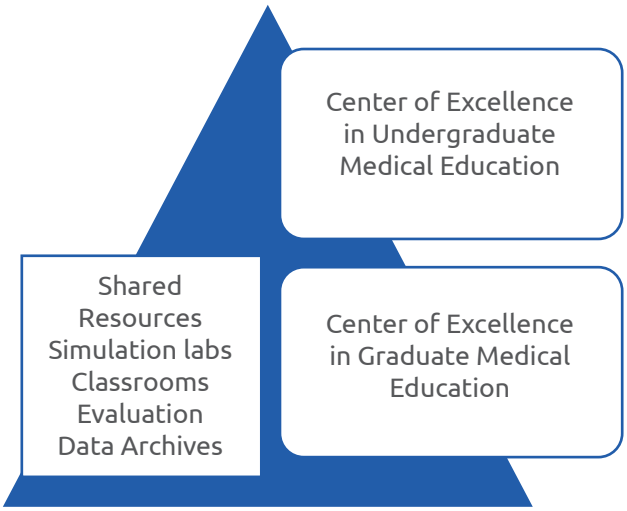
Therefore, scientists in the Centers for Research Excellence and clinicians in the Centers for Clinical Excellence will have their professorial appointment in the Centers for Medical Education.

Initially, there will be only one Center for Excellence in Medical Education; however, we envision the need for a Center for Excellence in Graduate Education as residency programs are developed.

Such an organization will allow educational programs to share resources such as classroom space, information technology, clinical simulation labs, educational research and statistical resources.

Figure 1: Centers for Medical Education



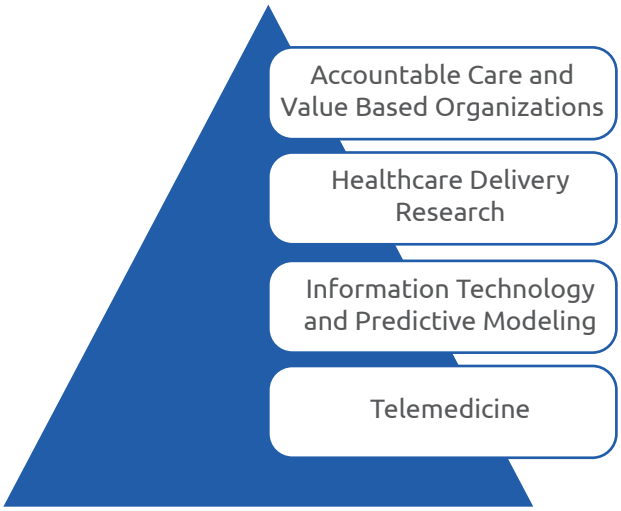
Centers for Clinical Excellence:

We envision the affiliated practices and hospitals to continue using departments organized around clinical disciplines. This is because in the near future, creation of a University is unlikely to change the healthcare delivery system which is organized around clinical disciplines. Residency education is also organized around clinical disciplines and promoted by various specialty societies and medical specialty boards. Licensure and board certifications are current requirements that must be met.

However, patient centered, accountable care is the future of medicine. A patient should not have to navigate around complex clinical organization and experience gaps in care. Quality and overall costs of care, i.e. the value delivered to patients and the society are of concern to all citizens, society, government and commercial insurance companies and providers of services.

Healthcare delivery research will also be one of the functions of the Centers for Clinical Excellence.

Figure 2: Centers for Clinical Excellence



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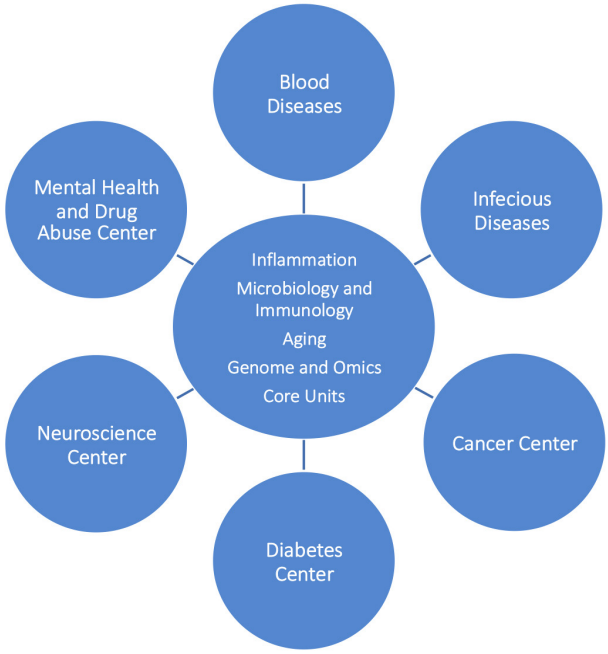
Therefore, clinicians associated with the Global Health Science University will have appointments in one or more of the Centers for Clinical Excellence. Such an organization will allow clinical services to develop patient centered, accountable care and share resources such as information technology, predictive modeling, and telemedicine.

Centers for Excellence in Biomedical Research

In a medical school organized around departments, research occurs on the basis of interests of individual faculty and chairs creating silos and obstacles for collaboration. In response, the medical schools create Research Centers to eliminate or reduce silos created by departments and schools and to promote multi-disciplinary and interdisciplinary collaborations. However, in many medical schools, the Centers are often created from among faculty recruited by departments for a very different purpose, to educate and generate workforce in each discipline. Primacy of departmental reporting structures weaken the research within the centers.

Therefore, one possible scenario for organization of research in the Global Health Science University is shown in the figure below.



Nursing, pharmacy, dentistry, and various allied health disciplines are taught in schools designed for such functions as our current healthcare delivery system requires. The Global Health Science University will design an educational system that teaches team work among healthcare professionals.

Game changing approach to the Future of Medical Education, Clinical Care and Biomedical Research

Medical Education: The Universities and medical schools are generally faculty centric. Students are often thought of as "coming in the way" of faculty advancement who must generate clinical or research dollars for promotion and survival. Students are asked to learn skills based on interest of the faculty members rather than what they will need upon graduation. Skills such as adaptability, team work, accountability, compassion and ethics are compromised in favor of cognitive achievements. Graduates find much of what they learn irrelevant when they practice medicine and are unable to cope with changes. Finally, the medical education is too expensive creating massive debt for graduating physicians who must sacrifice their ideals in order to make payments on loans.

Therefore, the Global Health Science University is committed to promoting student-centric education through its Centers of Excellence in Medical Education. By using information technology, we wish to constrain costs of education. We will make a firm commitment to not raise the tuition for at least five years.

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Clinical Care: Although national and regional healthcare delivery system is resistant to change and may remain in the silos of clinical disciplines, we note with interest the alliance of Amazon, Berkshire Hathaway and JP Morgan revolutionize healthcare delivery. GHSU will promote patient centered, accountable, cost effective, and compassionate care. Medical students will work in teams with nurses and nurse practitioners, pharmacists, and other healthcare disciplines to achieve population health goals.

Biomedical Research: Our focus will be on increasing longevity and improving quality of life. Organization of Centers for Excellence in Biomedical Research will be both disease based (e.g. Cancer, Infectious Diseases, Blood diseases, infectious diseases, neuroscience including stroke and dementia, etc.) but will also bring together expertise in various disease processes such as inflammation, immunology, aging and gene editing to make an impact on multiple diseases.

In summary, the Global Health Science University will promote and train future leaders in medicine, other health professions and biomedical sciences. It is not clear whether healthcare will experience disruption in the future similar to recent disruptive changes in telecommunication, transportation, or retail businesses. Whether change comes incrementally or by disruption, the leadership, faculty and graduates of GHSU will be prepared to lead and adapt to the change.

References:

1. Jocelyn Kaiser, Final 2018 biomedical budget eases biomedical researches' policy worries, Science, March 22, 2018
2. PhRMA Industry Profile 2017 (https://www.phrma.org/industryprofile/)
3. Boston College Center on Wealth and Philanthropy, May 28, 2014