The Future of Medical Research

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What others have said about predicting the future

- The most reliable way to predict the future is to create it. A. Lincoln

  Television won’t last because people will soon get tired of staring at a plywood box each night. Darryl F Zanuck

- There is not the slightest indication that nuclear energy will ever be obtainable. It would mean that the atom would have to be shattered. Albert Einstein

  The future ain’t what it used to be.

  Its tough to make predictions especially about the future. Yogi Berra
The Future of Medical Research

1. Technology dependent areas
2. Team based Research;
3. Big Data
4. Patients as Partners in research projects
5. Implementation Science
6. Responding to challenges of climate and societal change.
The Future of Medical Research

- 7. Immunotherapy of Cancer
- 8. Chronic Disease – prevention and treatment
Technology dependent – lots of intersection amongst these. * major ethical challenges;

CRISPR – Cas 9 – gene editing*; optogenetics. SC cure
Reprogenetics and heritable enhancements *( why not make a better you – credit Francoise Baylis).

Artificial Intelligence*
Cyborg – physical joining of tissue and technology*
Microbiome – influence of your microbiota on health
Personalized medicine*; Digital Health
Stem cells (beware of charlatans); Exosomes, Microsome
Collins FS, Gottlieb S. The next phase of human gene therapy oversight. NEJM 2018; 379: 1393-5

- 2017 – 3 gene therapy products approved in US.
- Currently 700 active investigational new drug applications for gene therapy.
- In vivo clinical trial to correct Hunter’s syndrome using zinc finger nucleases.
- Clinical trials of gene therapy for Sickle Cell Disease will start soon.
- July 2018 FDA draft guidance documents re: gene therapy.
Brain Initiative [NIH] – dependent on the technology to assess function of millions of neurons.

- Understanding brain circuits and networks that underlie intelligence and learning
- Machine learning and its applications to neuroimaging data (MRI) to identify biomarkers and predictors of disease and their management
- Drug discovery using computational power to interrogate repositories of small molecules
- Precision Medicine
Prostate Cancer diagnosis is time-consuming for radiologists & a natural candidate for Deep Learning
Microbiome – past, present and future

Cardiovascular disease

Liver disease

• Appetite disorders
• Parkinson disease
• Alzheimer disease
• Neurodegenerative diseases
• Multiple sclerosis
• Anxiety
• Depression
• Autism
• Stress
• Addiction

Diabetes
• Insulin resistance

Obesity

Low-grade inflammation
• Arthritis
• Allergy
• Eczema

Numerous factors are influencing the complex gearing
• Lifestyle
• Food
• Immune priming
• Host metabolic signalling

Cani P. Nature Reviews Gastroenterology & Hepatology June 2017
Microbiome groups by frailty of mice
MRI – stronger and stronger – 3 T – most clinical magnets.

Ultra High-field MRI

- The engineering and biosafety limits of MRI are being pushed with ultra-high field MRIs to advance our understanding of in vivo physiology and biochemistry.

- MRI of the human brain @ 9.4 T (courtesy R. Pohmann, Max Planck Institute) and mouse brain @ 21 T (courtesy, R. Sharma, NHMFL).

Ultra High-field MRI... even higher?

- CEA NeuroSpin in France recently commissioned an 11.75 T whole body MRI (pictured below).
- It weighs 150 Tons and its magnetic field is roughly 300,000 times stronger than the earth’s field!
ImageStreamXMarkII combines high resolution microscopy with ability to analyze 5,000 cells/sec via flow cytometry.
Team Based Research – will continue to grow and evolve

- Country wide (international) teams in many research areas; Locally Wave 1 and Wave 2
- Downsides –
  - A. Further compromises support for the “lone” investigator who is still essential to fundamental science.
  - B. Academic credit; IP rights in such settings
  - C. For the many – will it be satisfying
Big Data – will find increasing application to everyday medicine

- The potential is in integrating biological (DNA, proteins, metabolites, organ function and ecosystem influences) with conventional medical data and the massive amounts of data from wearable devices to build better predictive models around individual patients.

- NIH – All of us Program – 1 million people

- [www.projectbaseline.com](http://www.projectbaseline.com) 10,000 people; 4 clinic visits per yr; tracking of daily habits; wearable devices; surveys etc; Duke, Stanford, Google, Verily

- Privacy concerns
Senesence Research – the next frontier

- 120 years is the upper limit of human life
- If we can alter cell senescence we can all live to a healthy 120?? Emphasis has to be on healthspan.
- Senolytic drugs reduce the number of cells in cell cycle arrest. These cells accelerate the aging process by elaborating proinflammatory proteins and small molecules.
Implementation Science

- Implementation science – the study of methods and strategies to promote the uptake of interventions that have proven effective into routine practice with the aim of improving health.

  Wound infection rate post joint replacement ranges from 0.5 to 3.2% in one Health Authority and on and on.

- Collaborative care centers are they better, the same or worse than the standard physicians office? Align remuneration with quality of care.

- Need a whole new generation of scientists of a different ilk

- HA’s will have to have their own research programs to address issues such as above
Responding to challenges of climate and societal change – will need a

- Legalization of marijuana; Opioid crisis
- An app challenges a traditional physical examination (CMAJ 2018 April 3; 190; E380-8) – Med Ed Research
- Disaster Medicine; viral pandemics – M,M,R
- Migration of pathogens – eg Lyme D currently in NS,
  Precision medicine vs personalized care - balance.

2016 ICMJE – “to require authors to share with others the deidentified patient data presented in the article .. Within 6 mos”
Immunotherapy of Cancer

T-cells taken from the patient are genetically engineered in the lab in a way that they express a certain receptor which identifies a particular marker on the patient's cancer cells and then these cells are infused back to the patient to start cancer killing.
The Near Future

- Health Research Strategy – alignment of Government; University (VP Research); Medicine, Health, Dentistry and NSHA – Drs. Aiken and Anderson
- NS as a living laboratory
What won’t change in the Future

- Adequate preparation for a research career
- Recruitment, mentoring and retention of young scientists who will shape the future.
- Need for local and national financial support [DMRF, Department grants, CIHR etc]
- Astute clinical observations that lead to the research questions.
Acknowledgements

- Francoise Baylis PhD
- Morgan Langille PhD
- Jean Gray MD
- Johan Van Limbergen MD
- Paul Armstrong MD
- Rick Rachubinski PhD
- Gerry Johnston PhD
- Madeleine Scott MD/PhD Candidate
- Carla Ross BSc
- Victor Rafuse PhD
- Jack Jhamandas MD
- Craig McCormick PhD
- Ken Rockwood MD
- Sir John Bell MD
- Alan Fine PhD
- Darrell White MD
- Steven Byea PhD
- Mahmoud Elsway MD