Session 6, Health Care Technology

Presenters:
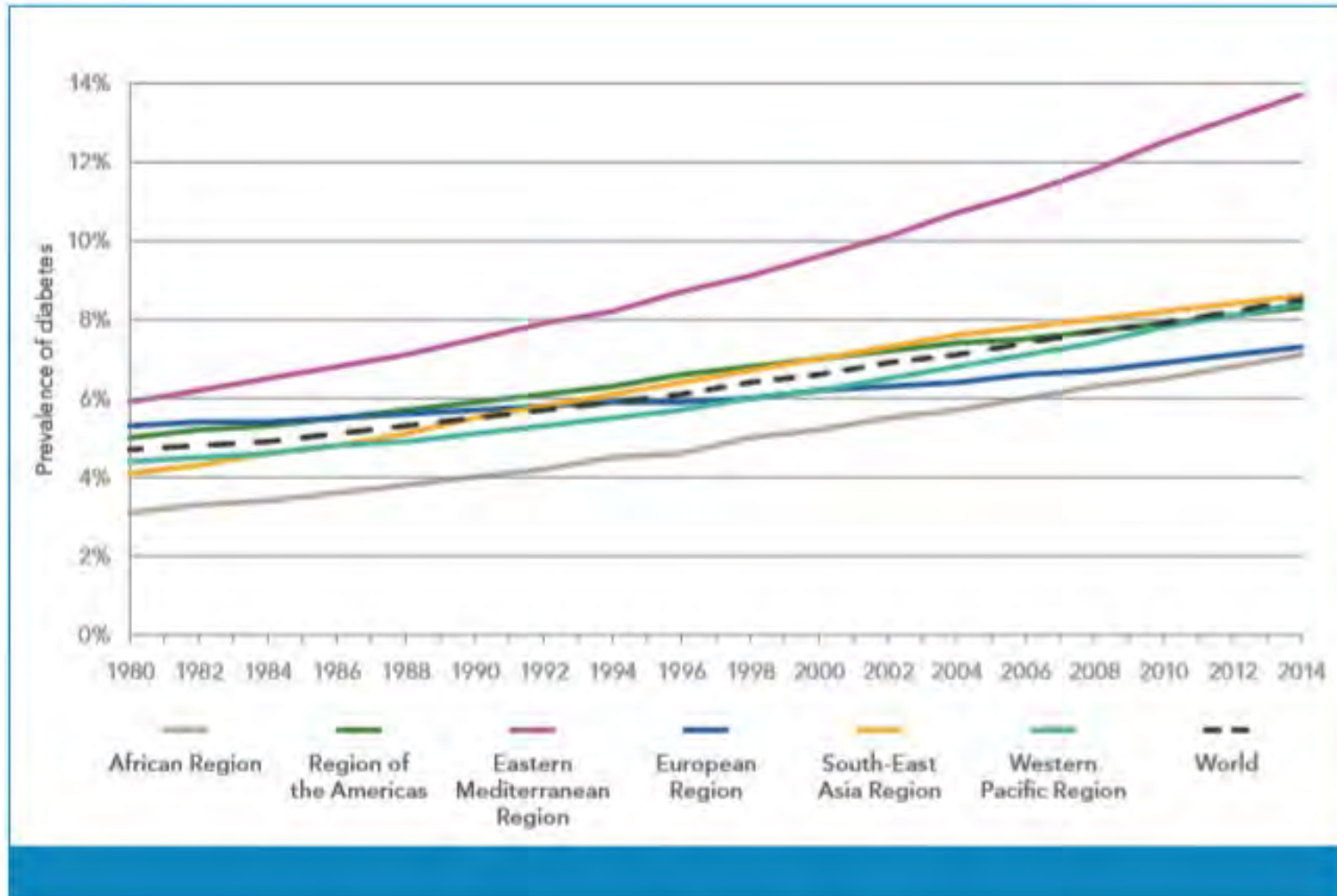Kamakhya Das
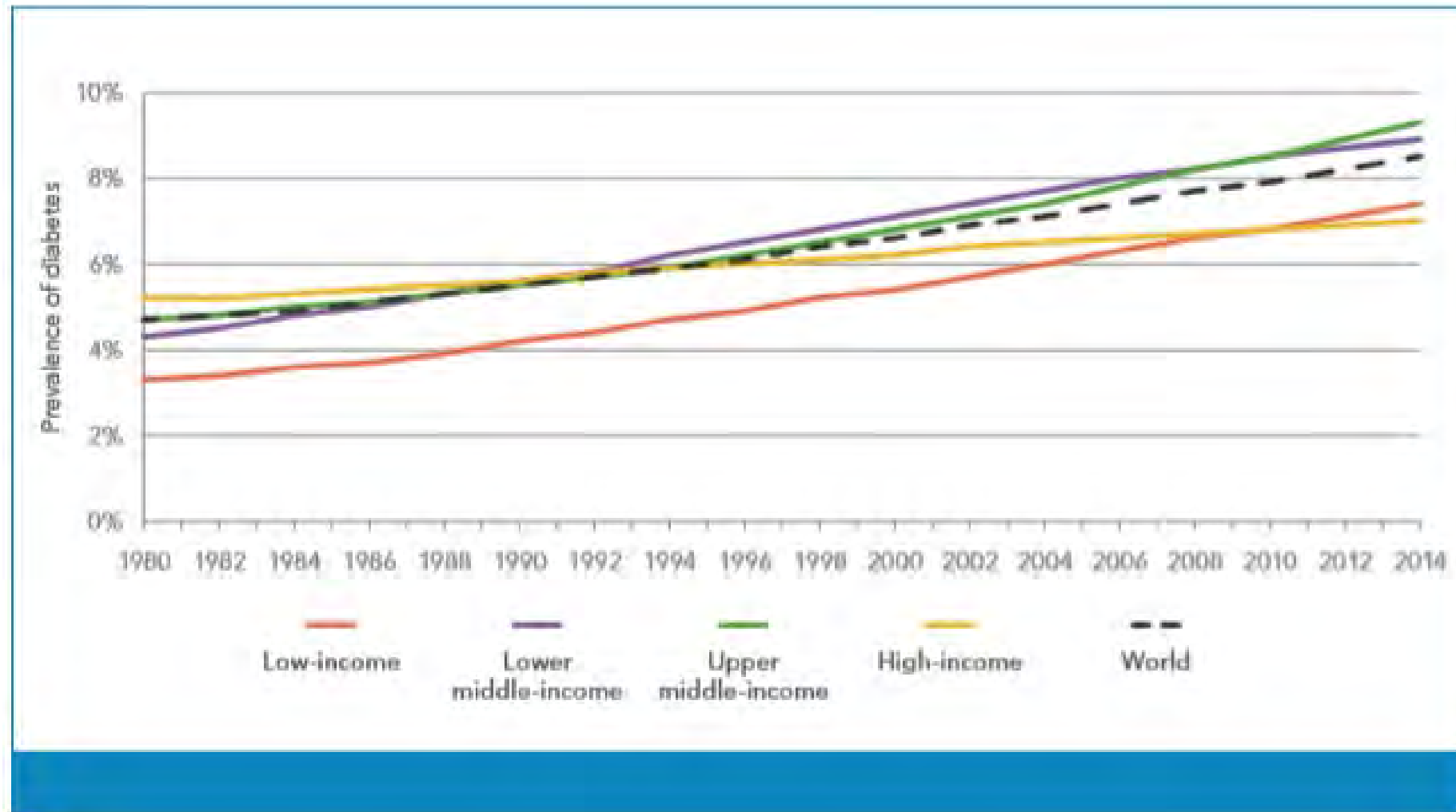R. Dale Hall, FSA, CERA, MAAA

Global burden of diabetes

WHO: Global Burden of Diabetes

Trends In Prevalence of Diabetes, 1980-2014, By WHO Region
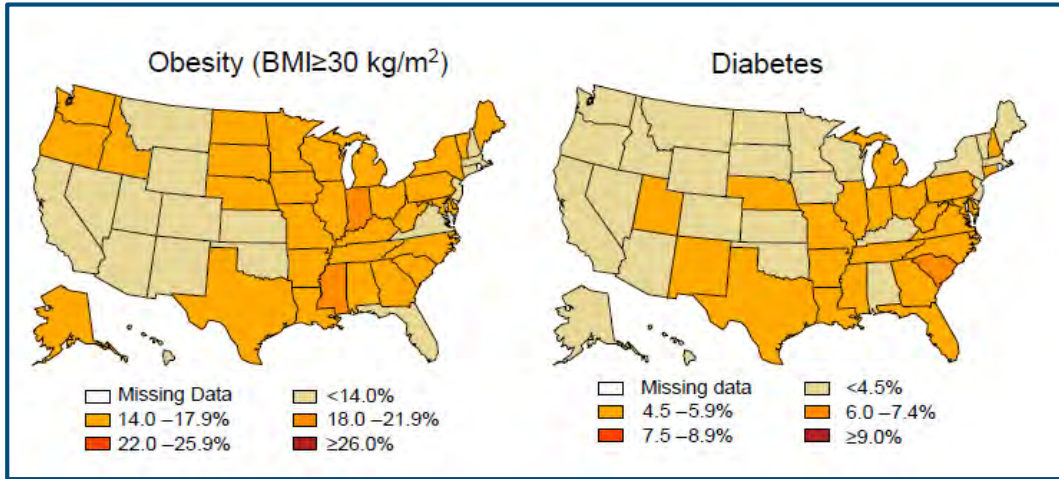
WHO: Global Burden of Diabetes

Trends In Prevalence of Diabetes, 1980-2014, By Country Income Group

Obesity Epidemic

1994

2015
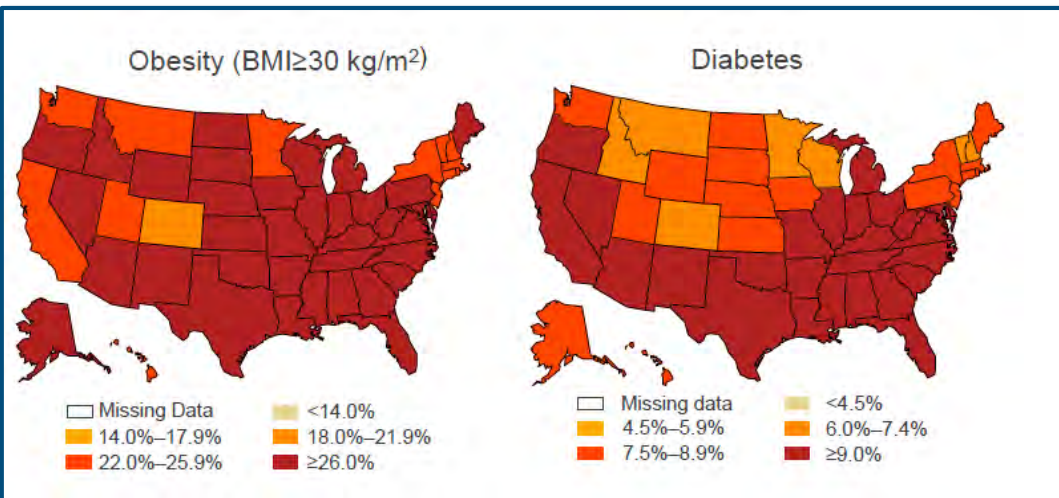
Pattern clear !
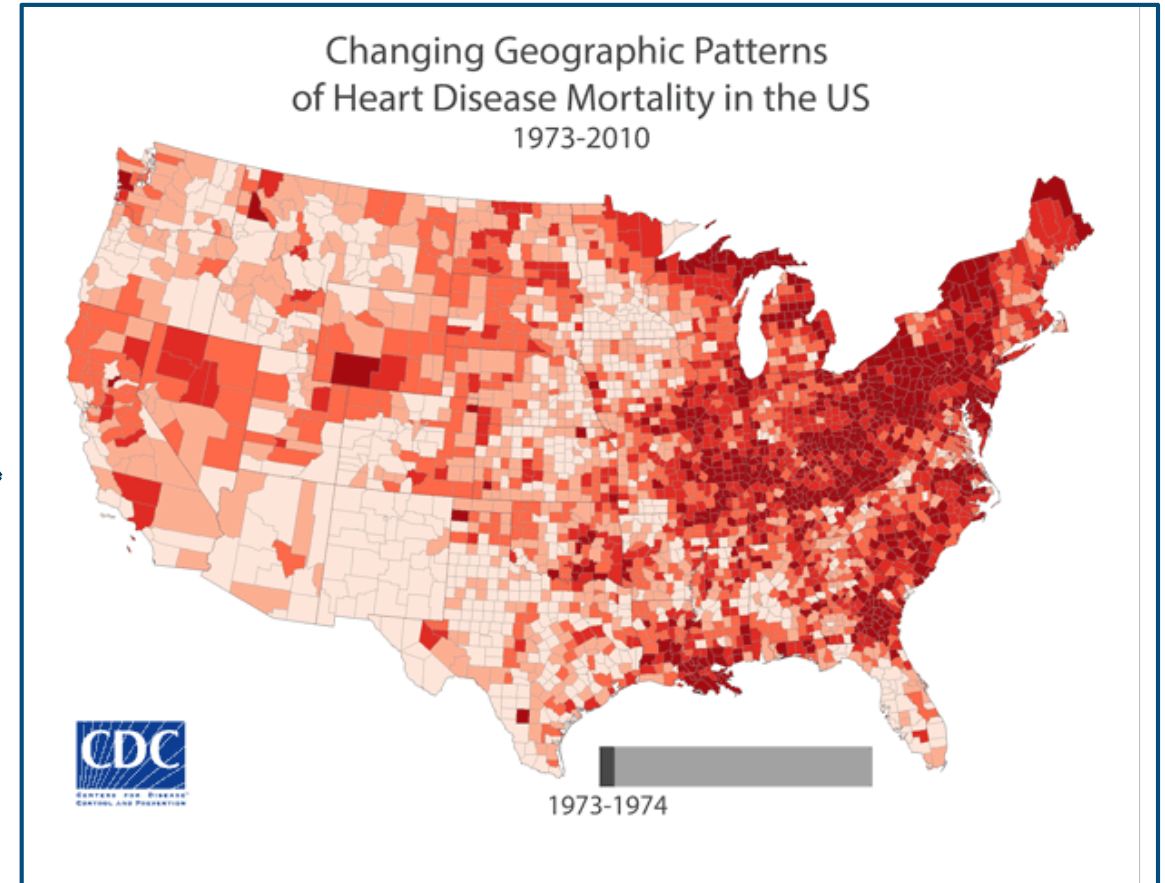
Pattern less/not yet clear

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Recent medical advances impacting diabetes

Continuing evolution of precision health

- Diagnosis

  - Moving from a single metabolite glucose to a heterogenous approach.

- Complications

  - Shifting from traditional view of definite progression to complications to potential reversal of diabetes

- Management

  - Moving away from generalised treatment approaches to personalised treatments based on individual variability

Diagnosis of diabetes
(Shift from a single metabolite glucose to a heterogenous approach.)

Diagnosis of diabetes

- Classification of diabetes is undergoing a paradigm shift. (e.g. ANDIS study considers multiple factors like age at diagnosis, BMI, HbA1c, Insulin Resistance, Genotyping, etc to classify Diabetes into 5 different clusters
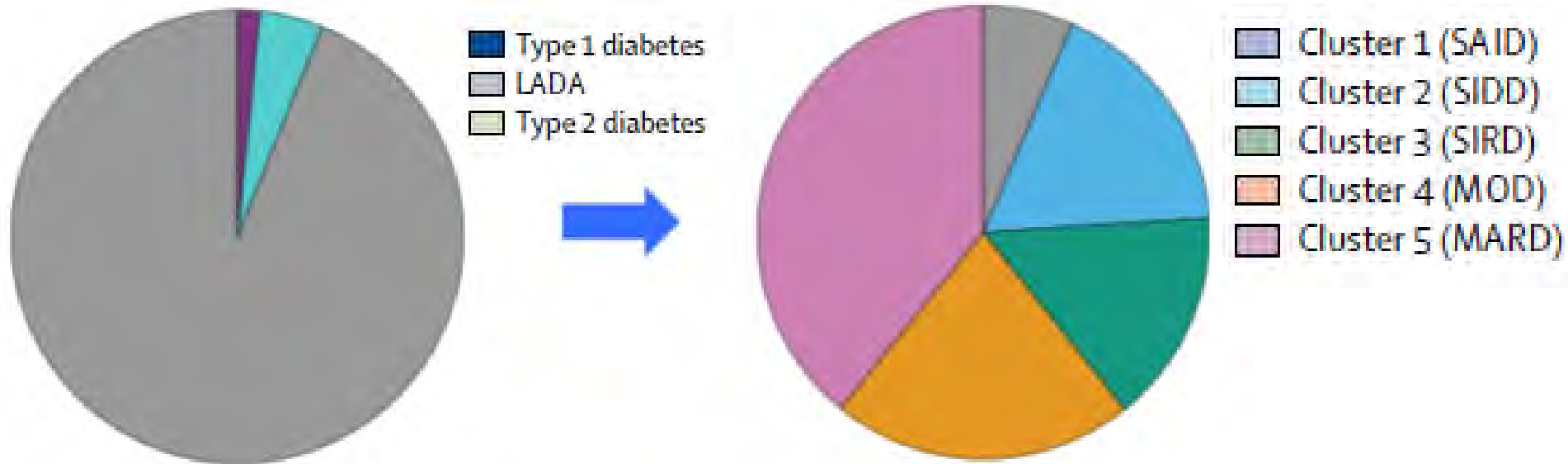
Today's classification ⟹   Potential Future Classification

Ahlqvist E, Storm P, Karajamaki A, et al;Novel subgroups of adult-onset diabetes and their association with outcomes: a data-driven cluster analysis of sixvariables. LancetDiabetes Endocrinol. 2018 Mar 1. pii: S2213-8587(18)30051-2. doi: 10.1016/S2213-8587(18)30051-2.

Output: From Spot Testing to Data Cloud
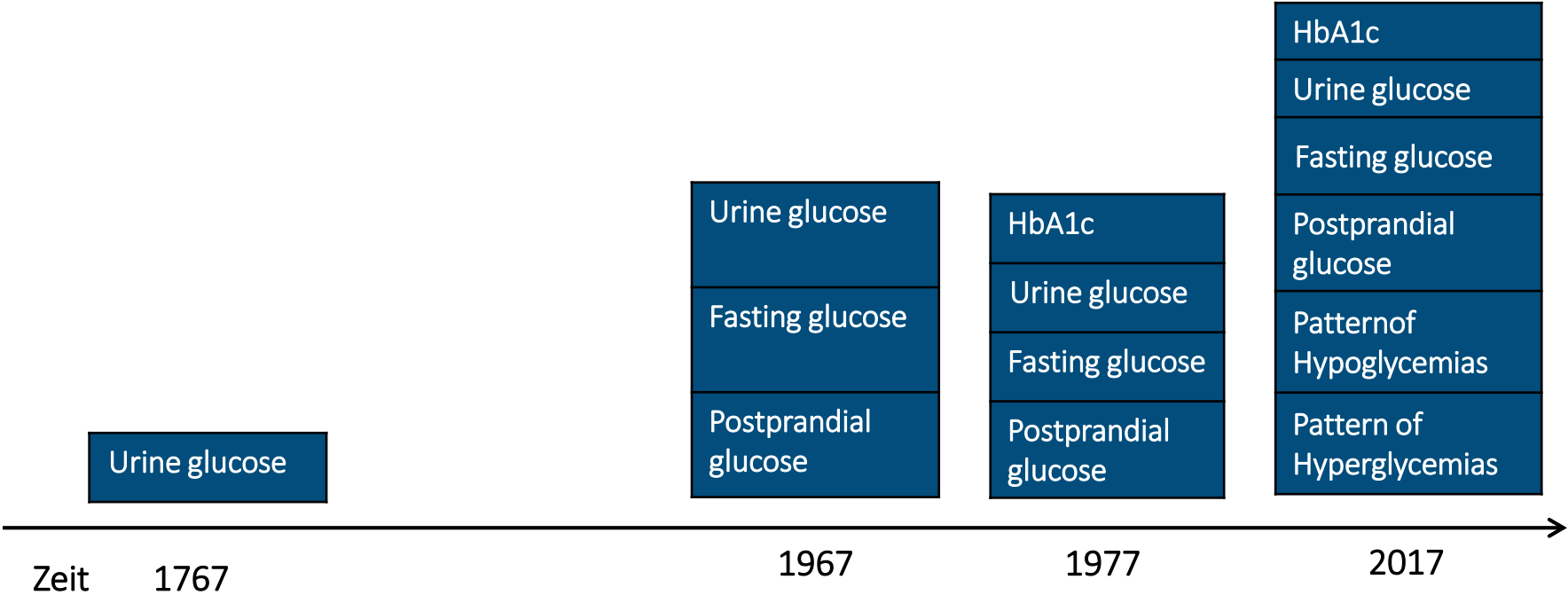
Complications of diabetes
(Shift from definite progression to reversal)

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Diabetes and Survival, according to Gender and Diabetes Status

- **What are the diabetics dying of ?**
  - Biggest study ever: 97 prospective studies
  - n= 820,900 - no preexisting

  ⇒ Diabetes ≈ 6 years reduced life expectancy (50 yr male)
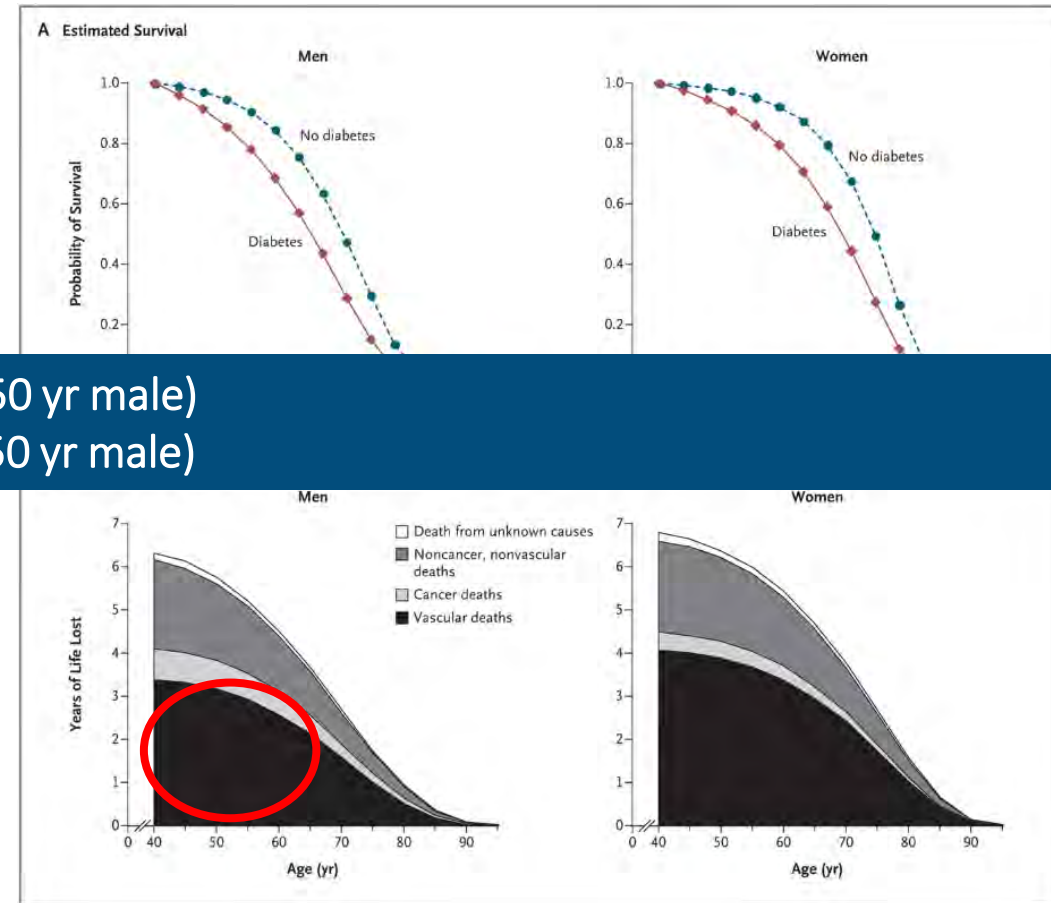 ⇒ Smoking ≈ 10 years reduced life expectancy (50 yr male)

  - 123,205 deaths
  - Adjusted for age, sex, smoking status, BMI
  - Cause-specific deaths

Seshasai SR, Kaptoge S, Thompson A, et al. Diabetes mellitus, fasting glucose, and risk of cause-specific death. N Engl J Med 2011;364:829-841[Erratum, N Engl J Med 2011;364:1281.]

International Trends of Diabetes Mortality and Complications (1995-2013)

✓ **Complications Diabetes (USA 1990-2010):**
- Heart attacks ↓ **68%**
- Strokes ↓ **53%**
- Amputations ↓ **52%**
- End stage renal disease ↓ **29%**

✓ **Diabetic Blindness (1990-2000)**
- USA ↓ **25%**
- Israel ↓ **40%**
- Germany ↓ **50%**

✓ **Mortality rates among Diabetics (1995-2013):**
- ↓ **15%** up to ↓ **40%** (Every 10 Years)

(USA, UK, Scotland, Canada, Taiwan, Israel)
- The improvement more in older adults (>65)

Gregg, E. W., Sattar, N. & Ali, M. K. The changing face of diabetes complications. Lancet Diabetes Endocrinol. 4, 537–547 (2016).
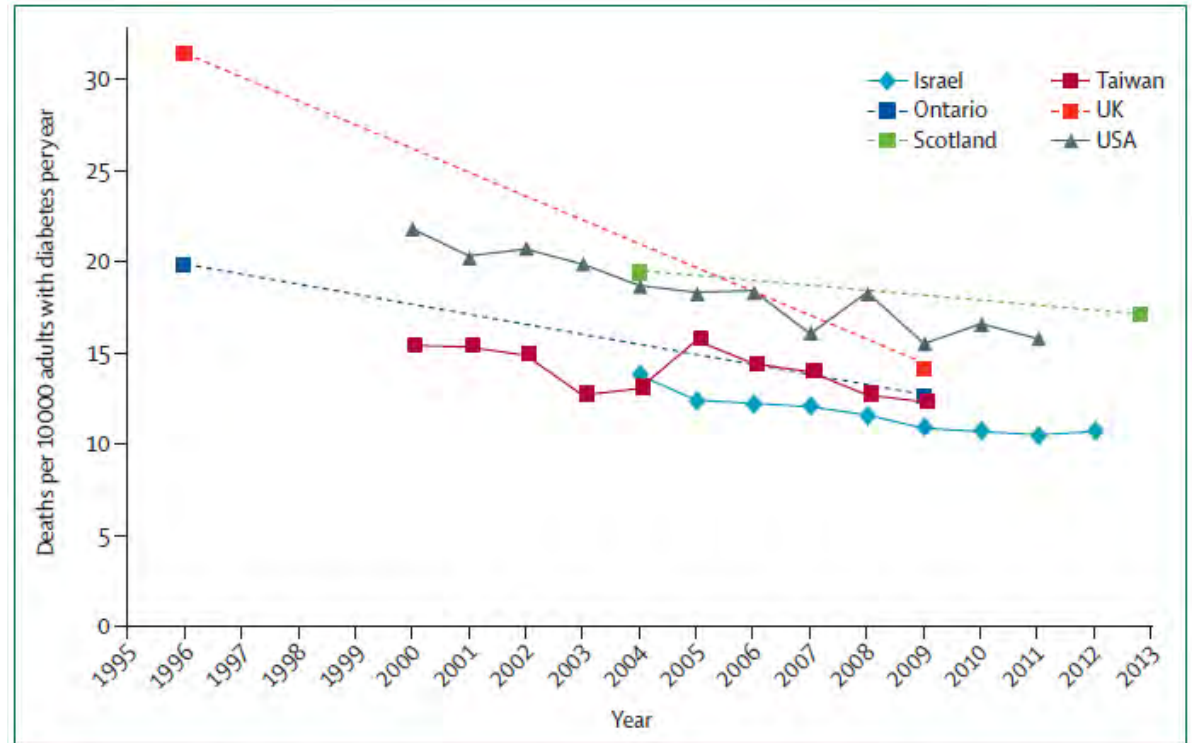
Causes?
1. Better screening
2. Better behavior
3. Better treatment

Diabetes Reversal- Key Observations

- Counterpoint study: Low-calorie liquid formula diet
- Mean weight change: 15.3 kg (in 8 weeks)
- Plasma glucose normalized in a week

Liver Fat ↓ by 30% → Normalization of liver insulin sensitivity → Reawakening of the β cell
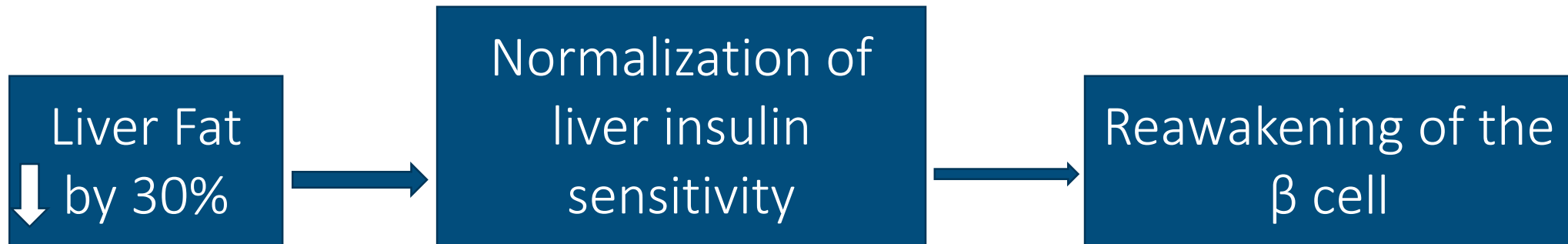
- Key Questions:
  - Could the return to normal glucose metabolism be maintained?
  - Would people with long-duration Type 2 diabetes benefit similarly?

Taylor R[1], Valabhji J[2 et al] *Prevention and reversal of Type 2 diabetes: highlights from a symposium at the 2019 Diabetes UK Annual Professional Conference. Diabet Med. 2019 Mar;36(3):359-365. doi: 10.1111/dme.13892. Epub 2019 Jan 25.,*

Management of diabetes
(Shift from generalised to personalised treatment approach)

Personalised treatments based on individual variability

Cluster	Old	New Sub Group	Metabolic & Vessel Complications
1	Type 1	**Autoimmune** Diabetes (SAID)	▪ High HbA1c ▪ Insulin deficiency (impaired insulin production) ▪ GADA-positive (glutamate acid decarboxylase antibodies) ▪ Often insulin treatment in the short term
2	Type 2	**Insulin-deficient** diabetes (SIDD) Similar to cluster 1	▪ GADA-negative ▪ High HbA1c ▪ Low insulin secretion ▪ **Highest incidence of early retinopathy** ▪ Often insulin treatment but time to reaching the treatment goal (HbA1c <52 mmol/mol) was longest
3	Type 2	**Insulin-resistant** Diabetes (SIRD)	▪ Insulin resistant ▪ Relatively low HbA1c ▪ Persistent microalbuminuria ▪ **Highest incidence of nephropathy (kidney)** ▪ Highest prevalence of non-alcoholic fatty liver disease ▪ Almost no insulin treatment
4	Type 2	**Obesity**-related diabetes (MOD)	▪ Not insulin resistant ▪ Almost no insulin treatment ▪ "Healthier" obesity?
5	Type 2	**Age** -related diabetes (MARD) Similar to cluster 4	▪ Modest metabolic alterations ▪ Almost no insulin treatment

Source: R&D PartnerRE Life&Health

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Novel Medication Principles (from 2015)

1. Glucagon Like Peptide 1 Agonist
   (GLP-1)   ⇒

   stimulate Insulin Release

2. Sodium-Glucose Co-transporter
   Inhibitors Type 2 (SGLT2)   ⇒
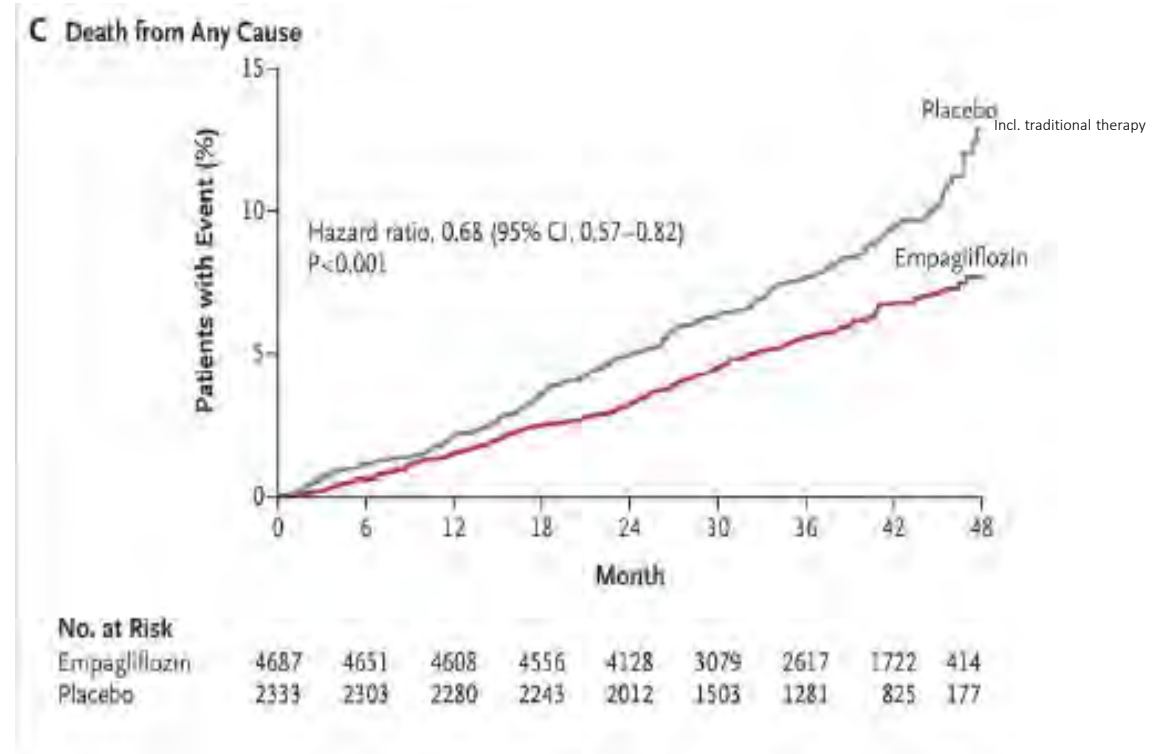
   prevent Glucose Reabsorption in the Kidney

3. Dipeptidyl Peptidase 4 Inhibitors
   (DPP-4)   ⇒

   prev

C Death from Any Cause

Patients with Event (%)

Placebo   Incl. traditional therapy

Hazard ratio, 0.68 (95% CI, 0.57–0.82)
P<0.001   Empagliflozin

No. at Risk									
Empagliflozin	4687	4651	4608	4556	4128	3079	2617	1722	414
Placebo	2333	2303	2280	2243	2012	1503	1281	825	177

SGLT2 Inhibitor Vs Traditonal Treatment: Total mortality ↓ 32% (∅ f-up 3.1 years)

Zinman B, Wanner C, Lachin JM, et al. Empagliflozin, cardiovascular outcomes, and mortality in type 2 diabetes. N Engl J Med 2015;373:2117-2128

AI in diabetes

In God we trust, all others bring data
William Denning

Life Cycle of New Technology

Expectations

AI Diabetes Control

FGM (=Flash Glucose Monitoring)

CGM (= Continuous Glucose Monitoring

New subtypes

GLP-1 (Glucagon Like Peptide 1 Agonist)

SGLT2 (Sodium-Glucose Cotransporter Inhibitors Type 2)

Google Contact Lens ✝

Apple Smell Sensor

Time

| Innovation Trigger | Peak of Inflated Expectations | Trough of Disillusionment | Slope of Enlightenment | Plateau of Productivity |

Source: R&D PartnerRE Life&Health

Diabetes Management by AI
May lead to breakthroughs (e.g. Artificial Pancreas)

Sensors to measure sleep, mood, activity, food image analytics

→

Data incorporated into electronic medical record

→

Database of similar glucose patterns of many diabetics

→

Algorithm to decide the best treatment option

Medical skin interface which changes colours with change in blood sugar levels

Optimization of Diabetes
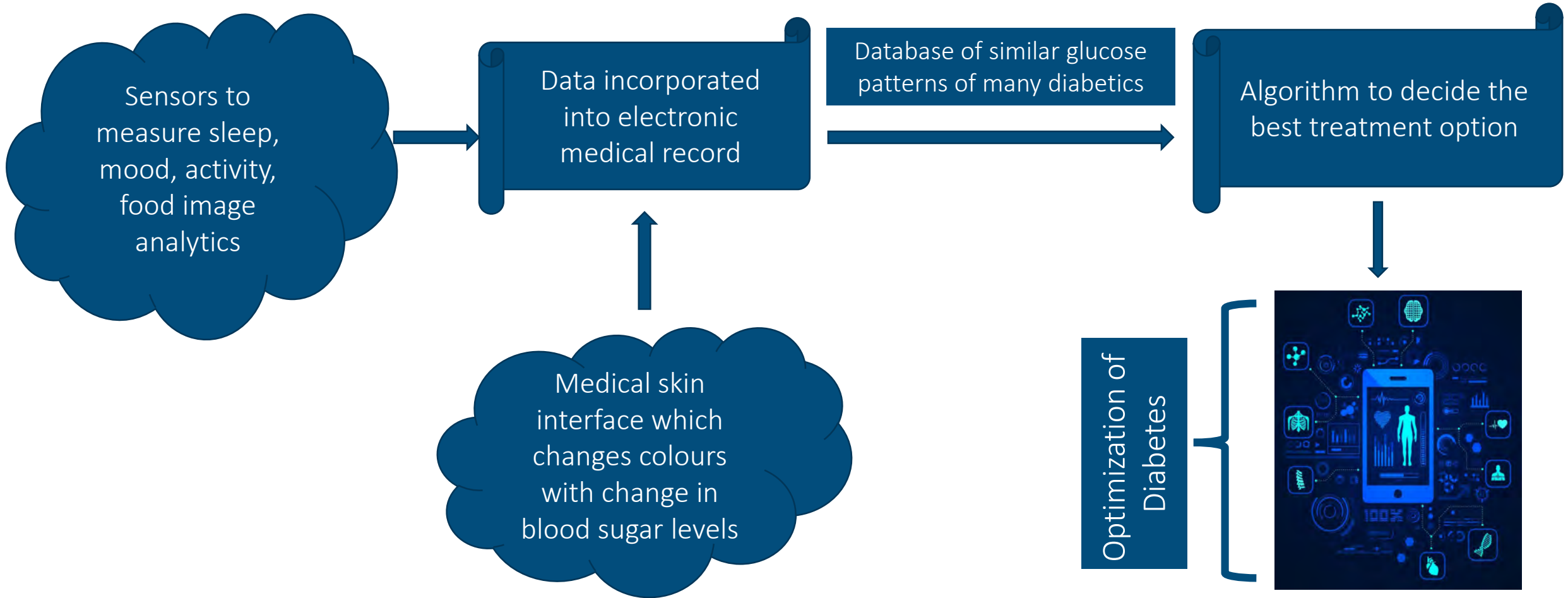
Use of AI in Diabetes Management

- Intelligent systems for glucose prediction and alarm generation

- Clinical decision support tools to deal with the avalanche of data gathered by sensors. Data mining approaches for risk prediction and prevention of diabetes comorbidities

- To build variety of solutions including closed loop systems

- Deliver value based health care

- Rrigorous understanding of the impact of a particular **drug, device** or **technology** to allow the evaluation of the potential impact of behaviours and treatments on cost

Kerr, D, Axelrod, C, Hoppe, C, Klonoff, D. Diabetes and technology 2030: a utopian or dystopian future? Diabet Med. 2018:35(4):498-503.

Wearables

Leapfrog Technology on the way of everyday life

1. FGM (=Flash Glucose Monitoring): T1+T2 Diabetes

- FGM: scan sensor (on demand)
  - Backup
  - Suboptimal accuracy

2. CGM (= Continuous Glucose Monitoring): T1 Diabetes

- CGM: Real-time (always)
  - Good accuracy
  - Alerts for Hypos

Diabetes Management by AI

FDA Approves Medtronic's AI Powered Continuous Glucose Monitor

AVA MUTCHLER on March 26, 2018 at 1:20 pm

Earlier this month the Food and Drug Administration (FDA) approved Medtronic's Guardian Connect system. Guardian Connect is a continuous glucose monitoring (CGM) tool that uses artificial intelligence to aid diabetes patients who use multiple daily injections of insulin. The solution was approved for patients ages 14 to 75 years old.

The Guardian Connect system is the first CGM to take advantage of AI by using a predictive algorithm to prevent hyperglycemia and hypoglycemia in people who suffer from diabetes. The algorithm collects data from the Sugar.IQ diabetes assistant, powered by IBM Watson Health, which monitors how a patient's blood glucose levels respond to different elements, like food intake, insulin dosages and even their daily physical routines.

- Medtronic Guardian Connect CGM System predicts 98.5% accuracy
- App on Apple iOS devices
- "Personal Diabetes Assistant"
- Launch April 2019

Source: https://voicebot.ai/2018/03/26/fda-approves-medtronics-ai-powered-continuous-glucose-monitor/

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Diabetes Wellness
A Dynamic Underwriting and Pricing Approach

❑ Diabetes is a modifiable disease and morbidity and mortality is significantly dependent on:
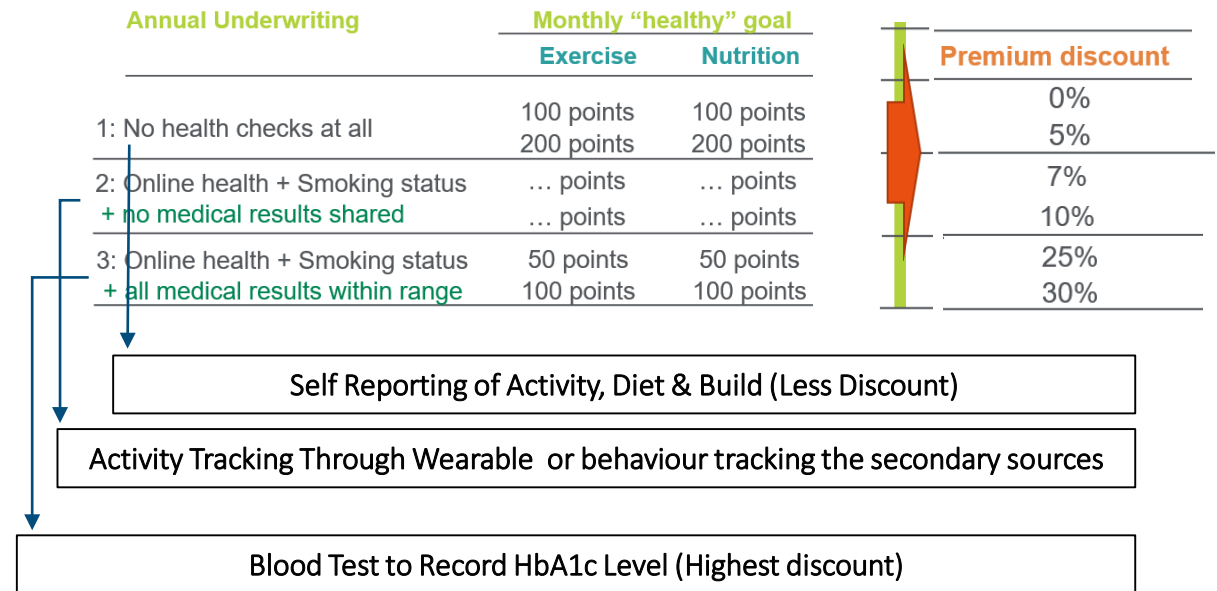
- Diet
- Exercise
- Medicine compliance

❑ Which ultimately leads to:

- Weight reduction
- Blood sugar control

❑ This creates opportunity for a dynamic product built around the concept of wellness.

❑ Will require an engaging app and a follow up team

Annual Underwriting	Monthly "healthy" goal		Premium discount
	Exercise	Nutrition	
1: No health checks at all	100 points	100 points	0%
	200 points	200 points	5%
2: Online health + Smoking status	… points	… points	7%
+ no medical results shared	… points	… points	10%
3: Online health + Smoking status	50 points	50 points	25%
+ all medical results within range	100 points	100 points	30%

Self Reporting of Activity, Diet & Build (Less Discount)

Activity Tracking Through Wearable or behaviour tracking the secondary sources

Blood Test to Record HbA1c Level (Highest discount)

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Thank You

Technology Impact on Health Care Cost Trends

Innovation and Technology

PROGRAM OVERVIEW

Actuarial Innovation & Technology

Top Actuarial Technologies of 2019

https://www.soa.org/resources/research-reports/2019/actuarial-innovation-technology/
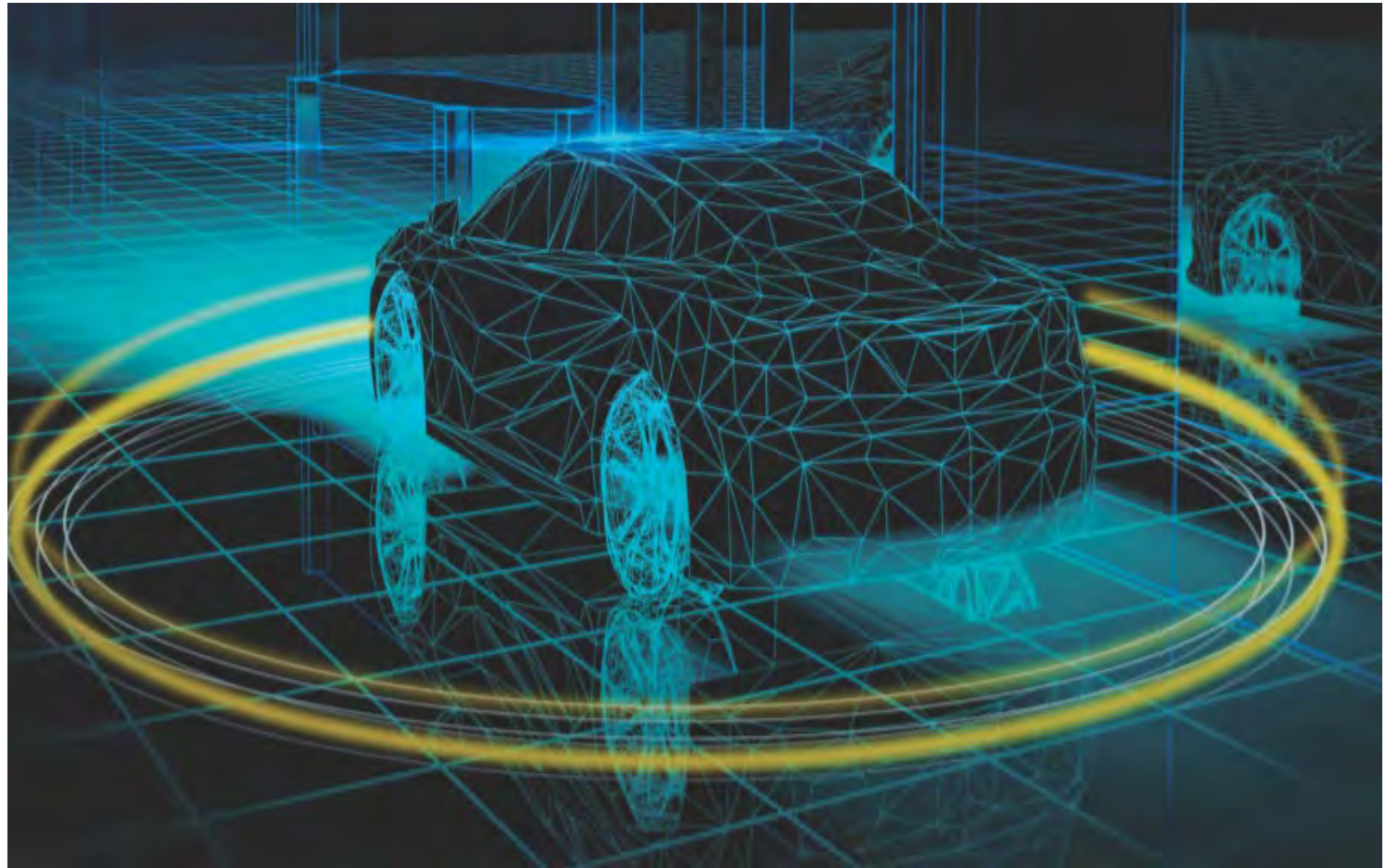
Actuarial Innovation & Technology

- Impact of Genetic Testing on Life Insurance Mortality

- https://www.soa.org/resources/research-reports/2018/impact-genetic-testing/

Projected Model New Business Claim Cash Flows and GT Positive New Business Claims as a % of Baseline New Business Claims, Assuming WL Policies

Innovation and Technology
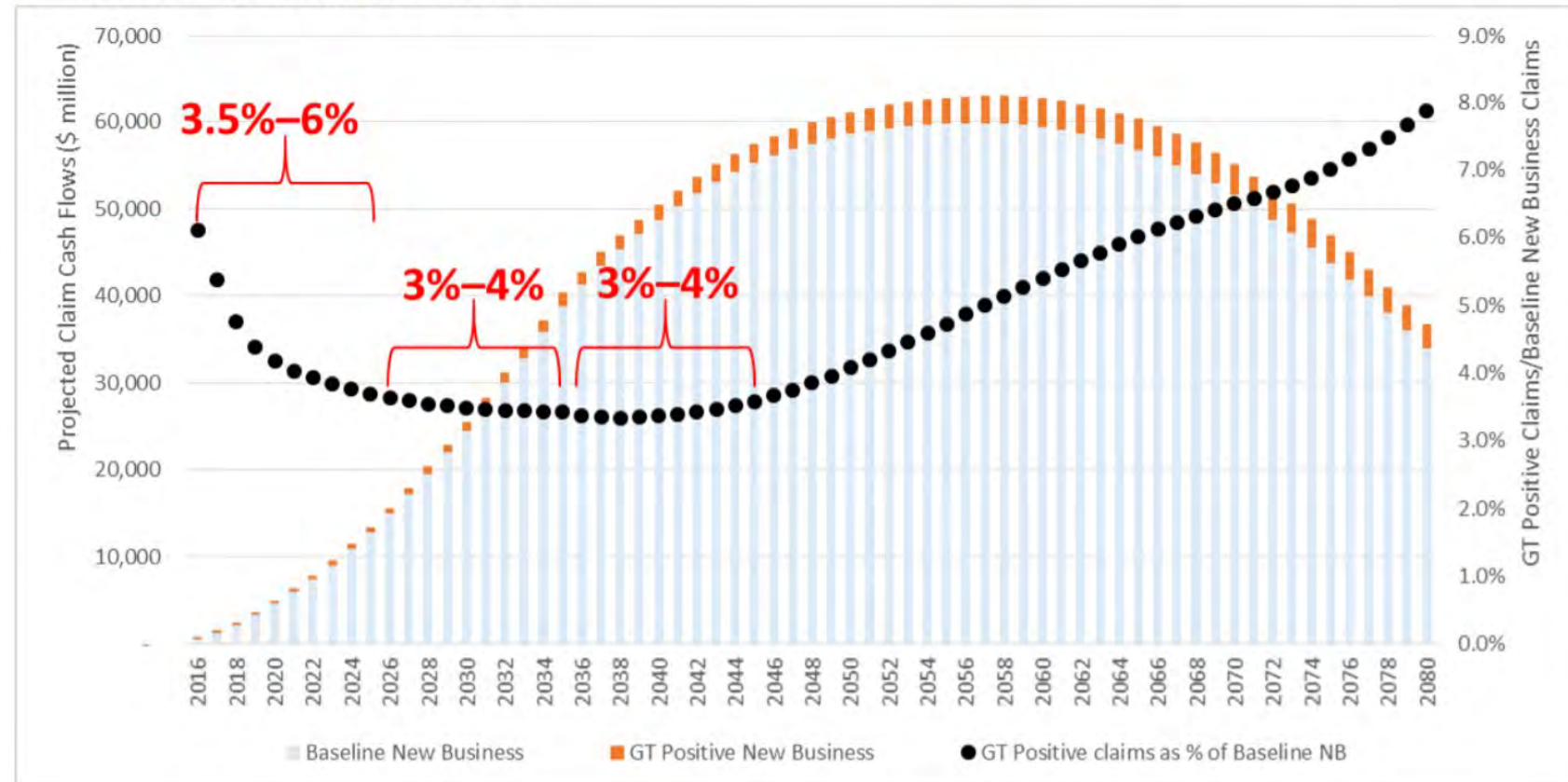
Actuarial Innovation & Technology

- Market Framework and Outlook for Automated Vehicle Systems

- https://www.soa.org/resources/research-reports/2018/market-framework-automated-vehicle/

Actuarial Innovation & Technology Resources

- https://www.soa.org/programs/act-innov-tech/act-innov-tech-library/

- Curated set of papers that can assist in getting up to speed quickly on topics

Home | **Resources** | Committee

Actuarial Innovation & Technology Resources

Self-learners on how technology impacts the actuarial landscape can find below a list of curated articles on various technology aspects. These documents were selected by volunteers for their learning content, in order to collectively cover the desired topic. Please contact research@soa.org for comments or suggestions.

Artificial Intelligence - Introduction
Artificial Intelligence - Insurance Industry
Autonomous Vehicles
Big Data Solutions
Blockchain
Cloud Computing
Cyber Risk / Cyber Insurance
Data Analytic Tools
InsurTech Financing
Internet of Things
Machine Learning
Personal Health Monitoring / Wearable Devices
Predictive Analytics
Telematics
Usage Based Insurance
Virtual Reality

Innovation and Technology

Impact of Technology on Health Care Cost Trends

Cancer Genomics

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Cancer Genomics

https://www.soa.org/resources/research-reports/2019/cancer-genomics/

- Author: Breakthrough Development

- Cancer incidence and mortality rates high in North America and Europe; Trends in Asia-Pacific

- Important to understand health care cost trends

Innovation and Technology

Cancer Genomics

Cost Effectiveness of Tumor Genomic Analysis and Immunotherapy

May 2019

- Past / Current pillars of cancer treatment:
  - Surgery
  - Radiation
  - Chemotherapy
- Sequencing of hundreds of cancer genes at once for cost-effective and fast actionable diagnosis
- Studied: Lung Cancer; Melanoma; Head-neck Cancer

Innovation and Technology

Cancer Genomics

Cost Effectiveness of Tumor Genomic Analysis and Immunotherapy

May 2019

- New approaches
- Immunotherapy ("IO", PD/L1 Testing)
  - Tumors resist the immune system by causing suppression of Thymus (T) cells
  - Cell surface marker PD/L1: when blocked allows the T cells to avoid suppression and attack cancer
  - Immunotherapy is the use of synthesized antibodies that bind to PD/L1 stop suppression
  - Awakened immune system shrinks or eliminates tumor cells exposed to activated T cells

Innovation and Technology

Cancer Genomics

Cost Effectiveness of Tumor Genomic Analysis and Immunotherapy

May 2019

- New approaches
- Tumor Mutational Burden (TMB) Testing
  - Genomics allows sequencing of hundreds of cancer genes at once
  - Counting mutational and then combining with immunotherapy enhances therapy benefit
  - Genomic price ranges now increase economic benefit
  - Social insurance systems beginning to utilize

Innovation and Technology

Cancer Genomics

Cost Effectiveness of Tumor Genomic Analysis and Immunotherapy

May 2019

- Estimates of IO and TMB screening benefits emerging through clinical studies
- Actuaries in health care beginning to understand trend implications
- Melanoma: Potential 10-20% reduction in overall healthcare costs

- Hospice Care: Focus on quality of life for people and their caregivers who are experiencing an advanced, life-limiting illness

- Palliative Care: Specialized medical care for people living with a serious illness. Focused on relief from the symptoms and stress of a serious illness.

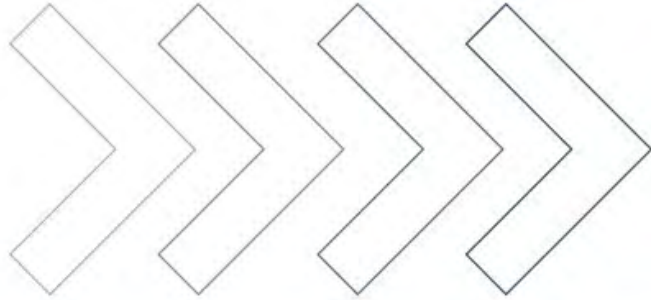- Increasing growth of care in US, and increasing in Asia Pacific

Hospice Care Research

An Analysis of End-of-Life Costs for Terminally Ill Medicare Fee-for-Service (FFS) Cancer Patients

Podcast

RESEARCH INSIGHTS, A SOCIETY OF ACTUARIES PODCAST
Hospice Care Research

30↺   00:00:00   ↻30

- World Health Organization: Strengthening palliative care as a component of integrated treatment throughout the life course and recommended that evidence-based, cost-effective, and equitable palliative care services be universally available.

- Advanced Palliative Integration: Hong Kong, Singapore

- Preliminary Integration: Malaysia, Macau

- Growing in many other Asia-Pacific markets

- https://www.who.int/nmh/Global_Atlas_of_Palliative_Care.pdf

Hospice Care:

https://www.soa.org/resources/research-reports/2018/hospice-care-research/
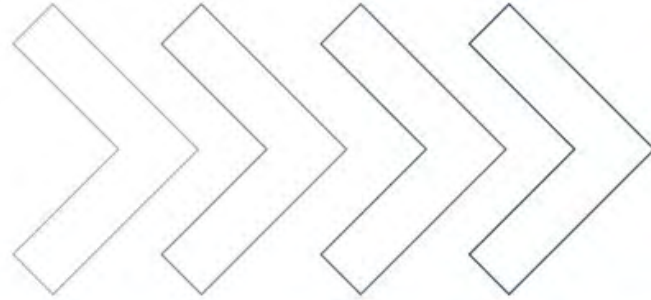
- Author: Axene Health Partners

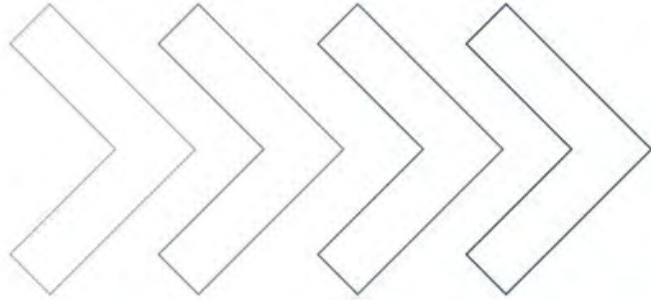- Comparison of costs for patient cohorts who utilize hospice care as compared to other services

Hospice Care Research
An Analysis of End-of-Life Costs for Terminally Ill
Medicare Fee-for-Service (FFS) Cancer Patients

- Key Results
- Focus was on patients who had Malignancies under Active Treatment
- 33% of Medicare-eligible enrolled in Fee For Service programs not enrolled in the hospice program prior to their deaths
- On average, the non-hospice patients had 25% higher medical costs (excluding prescription drugs) than their hospice-enrolled counterparts over their last six months of life.
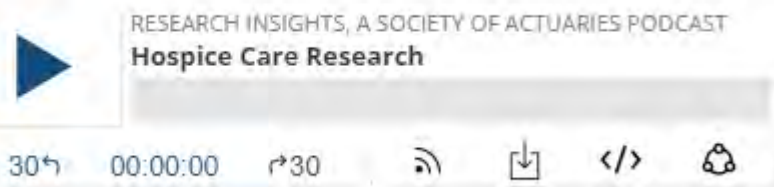
- Additional opportunities

- Regional Analysis in larger markets

- International comparisons

- Focus on additional conditions
  - Kidney Dialysis
  - Dementia
  - Chronic combinations:
    - Congestive Heart Failure
    - Diabetes
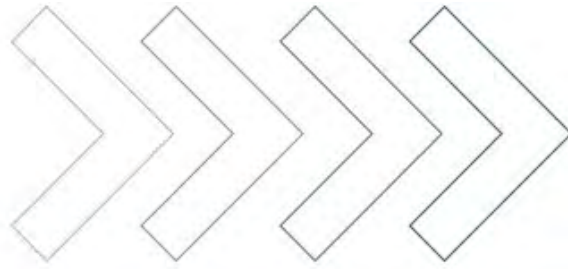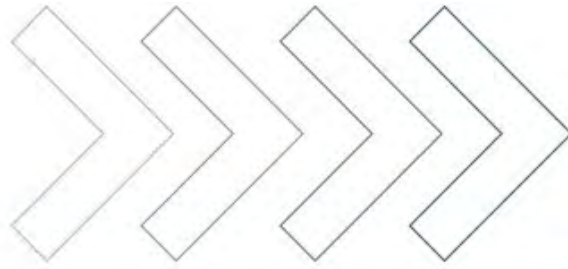   - Chronic Obstructive Pulmonary Disease

Evaluating Payment Models for High-Cost Curative Therapies

Single and Multipayer System Perspectives in England and the U.S.

- Complex Health Care insurer decision: How to consider expensive but potentially curative therapies

- Growing trends of examples and "pipeline" worldwide
  - Hepatitis C
  - Hemophilia
  - CAR-T cell / gene therapies
  - Others

- Single-payer versus Multipayer health care systems

Podcast

RESEARCH INSIGHTS, A SOCIETY OF ACTUARIES PODCAST
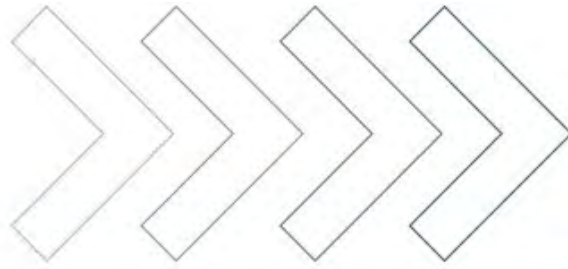**Evaluating Payment Models for High-Cost Cu...**

30↰ 00:00:00 ↱30

Evaluating Payment Models for High-Cost Curative Therapies:

https://www.soa.org/resources/research-reports/2018/high-cost-curative-therapies/

- Author: Milliman

- Framework, Options, Evaluation of different payment models

Evaluating Payment Models for High-Cost Curative Therapies

Single and Multipayer System Perspectives in England and the U.S.

- Examples from UK and US health care insurance systems

- Health currency model:
  - Payer funds therapy up front
  - "Health currency" is created upon administration of the therapy
  - If the treated patient changes insurers, the initial payer is paid a predetermined percentage of the forgone future financial savings related to the therapy.
  - Most effective when
    - Initial funding is large
    - Big differences between annual care costs in pre/post-cure scenarios.
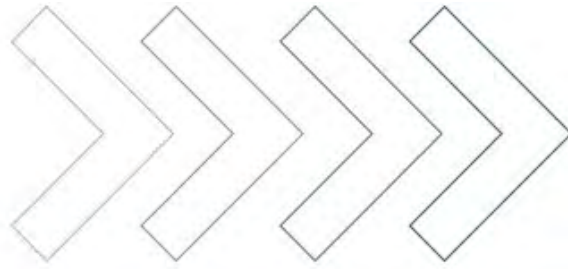   - Larger potential for insured turnover

Podcast

RESEARCH INSIGHTS, A SOCIETY OF ACTUARIES PODCAST
Evaluating Payment Models for High-Cost Cu...

30 00:00:00 30

Evaluating Payment Models for High-Cost Curative Therapies

Single and Multipayer System Perspectives in England and the U.S.

- Examples from UK and US health care insurance systems

- Industry Pooling
  - Reduces impact of membership turnover
  - Fares better for less expensive pre-cure treatments, such as cystic fibrosis

- "Effectiveness Guarantees" in a single-payer system: Provides protection to insurer for making large payments to medical therapy providers

Podcast

RESEARCH INSIGHTS, A SOCIETY OF ACTUARIES PODCAST

Evaluating Payment Models for High-Cost Cu...

30 00:00:00 30

Technology impacting actuarial work everyday…

- Intersection of technology and actuarial science always in motion
  - Wellness / Quantifiable self
  - Electronic Health Records
  - Epigenetics in selection and underwriting
  - Others…

Society of Actuaries®