How diabetes outcomes have changed over the past 30 years

Professor Philip Home
Newcastle University
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**Duality of interest:**
The speaker for himself or institutions with which he is associated receives funding for his research, advisory, and speaker activities from most manufacturers of diabetes medications, and some diagnostics companies

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An ambiguous title . . .

- 'How . . . something has changed'
  1. By what means? [How did I get to Keystone?]
  2. To what extent? [How did the USA do in the World Cup?]
Loss of vision in people with diabetes

1998-2000 (3 years), Newcastle upon Tyne

- 7 people registered blind, 11 partially sighted
- Incidence rates (due to diabetes)
  - blindness per year
    - 0.87/100 000 population
    - 0.35/1000 people with diabetes
- Screening
  - 84 %/yr (5588 of 6650)

Arun et al, Diabet Med, 2003
Changes in ketoacidosis hospitalizations over 21 years in the USA

Ketoacidosis discharges (n 1000⁻¹)

Ketoacidosis discharges (n 1000⁻¹-DM)

Changes in ketoacidosis hospitalizations over 21 years in the USA

Ketoacidosis discharges (n 1000⁻¹)

Deaths during ketoacidosis admission in Taipei
Lin et al, Chang Gung Med J, 2005

Deaths (% of admissions)

1982 2002

8.0 0.7
Changes in ketoacidosis hospitalizations over 21 years in the USA

Ketoacidosis discharges (n $1000^{-1}$)

Ketoacidosis discharges (n $1000^{-1}$-DM)

Understanding the numbers ('how' the numbers change)

- If the population with a condition increases, the numbers with a related condition (diabetes complication) should increase.
- But if the age-profile of the population of interest changes (e.g., becomes younger), and the related condition is age-related in the general population, then the rate with the related condition should decrease.
  - one would expect MI per person with DM to be falling.
- If the condition is diagnosed earlier, the same effect will apply.
- If a complication kills people, and is prevented, then the incidence of a later condition will rise.
  - as CV disease is ameliorated, the rate of visual impairment due to macular damage should increase.
Changes in renal failure therapy provision over 28 years in the USA

People entering end state renal therapy (n 1000^-1)

ESRF therapy (n 100,000^-1-people)

Hong Kong diabetes care
*Implementation of protocol + team driven care*

Death reduction 70%

So et al, *Am J Managed Care, 2003*
Changes in hyperglycaemic events and death over 29 years in the USA

Hyperglycaemic deaths (n)

Hyperglycaemic deaths (n 100,000^{-1}-DM)

Changes in hypoglycaemia emergency room visits 2006-2009 in the USA

Hypoglycaemia emergency room visits (n 1000⁻¹)

Hypoglycaemia ER visits (n 1000⁻¹-DM)

Changes in overall blood glucose control over ~15 years in the USA
Durability of glucose control in the ACCORD study

Post-trial changes in HbA\textsubscript{1c} in the UKPDS

<table>
<thead>
<tr>
<th>Year</th>
<th>Sulfonylurea/insulin</th>
<th>Conventional</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>p=0.008</td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td>p=0.14</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>p=0.82</td>
<td></td>
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<tr>
<td>2000</td>
<td>p=0.84</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>p=0.99</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>p=0.71</td>
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</table>

3-Step sustained retinopathy progression in the DCCT by randomised treatment group

Relation of CVD events to HbA$_{1c}$ in the follow-up period of the DCCT

DCCT (intervention period)  
EDIC (observational)

HbA$_{1c}$  
7.2 vs. 9.1 %

Conventional therapy group

Intensive therapy group

RR 42 (9-63) %

DCCT-EDIC study group, N Engl J Med, 2005
The intensity of the DCCT

- Multiple insulin injections or CSII
- Self-monitoring x4 day$^{-1}$ with dose adjustment
- Glucose and glycated haemoglobin targeting
- Further education of people with diabetes
- Physician/clinic visits monthly
- Telephone advice / use of nurse educators
- Study participant ‘ownership’ incentive

The Diabetes Control and Complications Trial

or

The Diabetes Professional and Patient Motivation, Patient and Professional Education, Intensive Self-monitoring, Effective Insulin Regimen, Audit and Target by Glycated Haemoglobin, Effect on Complications Trial

[ DCCT or DPPMPPEISMEIRATGHECT ]
What are the lessons of the DCCT?

**In people with Type 1 diabetes**

- Better blood glucose control prevents microvascular complications
- Intensive insulin treatment prevents microvascular complications
- Improved patient education prevents microvascular complications
- Some other aspect of improved metabolic control prevents microvascular complications
- Aspects of intensive diabetes management, combined in unknown proportions, prevent microvascular complications
How diabetes outcomes have been changed over the past 30 years

1970s
- artificial pancreas (concept)
- CSII
- blood glucose meters
- glycated haemoglobin
- radioimmunoassay
- effective blood pressure management
- laser photocoagulation

1980s
- glucose clamps for PK/PD
- ACE-inhibitors
- non-mydriatic retinal photography
- wearable artificial pancreas concept
- glucose sensors
- statins

1990 and since
- outcome studies
- metformin (USA)
- thiazolidinediones
- insulin analogues
- CGM
- incretin therapies
- SGLT2 blockers
- sensor pump control

Guidelines from 1989 (European NIDDM)
## Outcome of Podiatry-led Foot Care

*Freeman Diabetes Service – 1995/1996*

<table>
<thead>
<tr>
<th>Description</th>
<th>(n)</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background population</td>
<td>(n)</td>
<td>75 000</td>
</tr>
<tr>
<td>Managed population with diabetes</td>
<td>(n)</td>
<td>1 500</td>
</tr>
<tr>
<td>Incidence of foot ulceration (per 1000 pt-yr)</td>
<td></td>
<td>14.3</td>
</tr>
<tr>
<td>Incidence of toe amputation (per 1000 pt-yr)</td>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td>Incidence of limb amputation (per 1000 pt-yr)</td>
<td></td>
<td>0.6</td>
</tr>
</tbody>
</table>

*Robertshaw and Robertshaw, Newcastle Diabetes, 1998*
Changes in limb amputations over 21 years in the USA

Amputation discharge numbers (n 1000⁻¹)

Amputation discharge rate (n 1000⁻¹-DM)

Regional variation in first amputation rates in Finland 1988-2002

www.diabetes.fi
Changes in numbers of people with diabetes and cardiovascular disease in the USA

People with cardiovascular disease (n 1000,000⁻¹)

People with diabetes (n 1000 - 1)

Ketoacidosis discharges (n 1000 - 1) DM

CDC, 2014

Changes in numbers of people with diabetes and cardiovascular disease in the USA

Ketoacidosis discharges (n 1000 - 1 DM)  
CDC, 2014  
crude  
age-adjusted  

People with cardiovascular disease (n 1000,000⁻¹)  

People with cardiovascular events (n 1000⁻¹-DM)  

How diabetes outcomes have been changed over the past 30 years

- there is evidence of improvement in diabetes surrogate and actual outcomes over the last 30 years
- however, the increase in diabetes incidence/prevalence has overwhelmed the improvements to give increase in absolute numbers of adverse outcome
- the technology of diabetes care improved massively either side of 1980, but has taken decades to be implemented more widely
- more lately the number of therapeutic tools has increased remarkably – but it is too soon to see evidence of outcome from that, in particular in the face of the 'obesity' epidemic
- monitoring tools and educational approaches have probably paid a major part in allowing the implementation of management changes
- the guidelines 'epidemic' largely flowed from the technological introductions, and the need and ability to improve care
Thank you for listening