“using big data to improve vascular risk prediction and better targeted risk management”
VIEW2020
Rod Jackson
VIEW programme
School of Population Health
September 2016

Vascular Informatics using Epidemiology & the Web
Vascular risk Informatics using Epidemiology & the Web

Topic: Vascular risk prediction & risk management

Approach: Informatics – large-scale data linkage

Science: Epidemiology & Biostatistics

Data: Web-based clinical tools were developed to generate new clinical data that we link to regional & national routine health data collections

2020
VIEW team

Rod Jackson, Matire Harwood,
Sue Wells, Andrew Kerr, Dan Exeter,
Katrina Poppe, Roger Marshall, Patricia Metcalf,
Jim Warren, Jeff Harrison, Rob Doughty,
Romana Pylypchuk, Corina Grey, Josh Knight,
Suneela Mehta, Billy Wu
VIEW goals

• more accurate vascular risk prediction
• better vascular risk management
• reduced inequalities in vascular disease burden
more accurate vascular risk prediction
traditional approach to vascular risk prediction

relative risk of CVD by diastolic blood pressure

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PSC Lancet 1995;346:1647-53
relative stroke risk and usual Blood Pressure

(45 prospective studies: 450,000 people 13,000 events)

DBP > 80 mmHg
- 50% of 60 year olds

DBP > 90 mmHg
- 50% of 60 year olds

DBP > 95 mmHg

DBP > 100 mmHg
- 5% of 60 year olds

PSC Lancet 1995;346:1647-53
modern approach to vascular risk prediction
absolute (multivariable) risk of CVD by SBP

Absolute CVD risk (5-year %)

Systolic Blood Pressure (mmHg)

50 yr old woman

- Ideal risk profile
- & high TC
- & smoking
- & low HDL
modern approach to vascular risk prediction

absolute (multivariable) risk of CVD by SBP

50 yr old woman

Absolute CVD risk (5-year %)

Systolic Blood Pressure (mmHg)

- Ideal risk profile
- & high TC
- & smoking
- & low HDL
GUIDELINES FOR
THE MANAGEMENT OF MILDLY RAISED BLOOD PRESSURE
IN NEW ZEALAND

1992 & 1995

<table>
<thead>
<tr>
<th>MEN</th>
<th>Diabetes</th>
<th>No Diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nonsmoker</td>
<td>Nonsmoker</td>
</tr>
<tr>
<td></td>
<td>Smoker</td>
<td>Smoker</td>
</tr>
<tr>
<td>AGE 70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>180/105</td>
<td></td>
<td></td>
</tr>
<tr>
<td>160/95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>140/85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>120/75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| AGE 60 |  |  |
| 180/105 |  |  |
| 160/95  |  |  |
| 140/85  |  |  |
| 120/75  |  |  |

| AGE 50 |  |  |
| 180/105 |  |  |
| 160/95  |  |  |
| 140/85  |  |  |
| 120/75  |  |  |

| AGE 40 |  |  |
| 180/105 |  |  |
| 160/95  |  |  |
| 140/85  |  |  |
| 120/75  |  |  |

| AGE 30 |  |  |
| 180/105 |  |  |
| 160/95  |  |  |
| 140/85  |  |  |
| 120/75  |  |  |

Blood Pressure

<table>
<thead>
<tr>
<th>Total Chol. : HDL-Chol</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
</tr>
</tbody>
</table>

Risk Level

- Very High: >20%
- High: 15-20%
- Moderate: 10-15%
- Mild: 5-10%
- Low: 2.5-5%
- Very Low: <2.5%

How to use the Risk Tables:
1. To estimate a person's absolute 5-year risk of a cardiovascular event (newly diagnosed angina, MI, CHD death, stroke or TIA), identify the table relating to person's sex, diabetic status, smoking status and age.
2. Within the table find the cell nearest to the person's blood pressure and TC:HDL-C.
3. Compare cell color with risk level.
4. For patients with symptomatic CVD, or familial hypercholesterolemia, the level of risk should be increased by 1 or 2 categories.
## Risk Level for Women

<table>
<thead>
<tr>
<th>No Diabetes</th>
<th>Diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-smoker</td>
<td>Non-smoker</td>
</tr>
<tr>
<td>Smoker</td>
<td>Smoker</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>Systolic Blood Pressure (mm Hg)</th>
<th>Total Cholesterol: HDL Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>65-74</td>
<td>180</td>
<td>4</td>
</tr>
<tr>
<td>55-64</td>
<td>160</td>
<td>5</td>
</tr>
<tr>
<td>45-54</td>
<td>140</td>
<td>6</td>
</tr>
<tr>
<td>35-44</td>
<td>120</td>
<td>7</td>
</tr>
</tbody>
</table>

### Risk Level (for Women and Men)

- **5-year Cardiovascular Disease (CVD) risk (fatal and non-fatal)**
  - **Very high**: >30%
  - **High**: 15-20%
  - **Moderate**: 10-15%
  - **Mild**: 5-10%
  - **<2.5%**
risk charts derived from 5573 men & women in Framingham Heart Study cohorts between 1968-1975 followed for 12 years
how relevant is a US CVD risk prediction study from the 1970s to a multiethnic NZ populations in the 21st century?

more accurate vascular risk prediction
better vascular risk management
better risk management: the higher the risk the greater the treatment benefit

cost-effective treatment depends on targeting higher risk patients
CVD events prevented per 1000 treated by baseline combined risk and extent of systolic blood pressure-lowering

CVD events avoided per 1000 treated

5 year CVD risk (%)

SBP reduction (mmHg)

BPLTTC. Lancet 2014; 384: 591–98
Cardiovascular medications in primary care: treatment gaps and targeting by absolute risk

Natasha Rafter, Jennie Connor, Jason Hall, Rod Jackson, Isobel Martin, Varsha Parag, Stephen Vander Hoorn, Anthony Rodgers

Methods Demographic, risk factor, and prescribing data from the Dunedin Royal New Zealand College of General Practitioners Research Unit database were analysed. The data set consisted of 25,384 individuals, men aged at least 45 years and women at least 55 years, who consulted a doctor in 2000 in a practice which supplied electronic clinical notes. People with congestive heart failure were excluded. Five-year risk of a cardiovascular event was estimated using a history of vascular disease or the Framingham risk equation, and correlated with prescribed medications.

better vascular risk management
**Results** Cardiovascular risk could be estimated for only one-third of the study population due to missing risk factor information. Data were largely unavailable on antiplatelet agents and so lipid lowering and blood pressure lowering medications were used to assess the “treatment gap”. This combination was prescribed to only 28% of those with documented cardiovascular disease. For the remainder without a history of disease and for whom 5-year absolute risk of cardiovascular disease could be estimated, prescription of combination therapy ranged from 8% in the lowest risk group (<5% 5-year risk) to 14-16% in the other risk categories.
vascular risk management: Auckland 2006-9

reducing inequalities in vascular disease burden
inequalities in vascular risk burden: comparison of least/most deprived* Māori & Pakeha

* socioeconomic deprivation based on NZdep

Chan et al. NZMJ 2008. 121:1285/3341
reducing inequalities by better targeting of high vascular risk individuals & populations
using big data to improve CVD risk prediction
PREDICT in PHOs: electronic decision support for CVD risk prediction & management
Risk Assessment:
This page was made specifically for Joe Bloggs (ABC1235): 09-Aug-2006 10:37 hrs

Estimated risk of having a CVD event in the next 5 years: 18%

<table>
<thead>
<tr>
<th>Estimated risk level:</th>
<th>Estimated Benefits: NNT for 5 years to prevent one event</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-year CV risk</td>
<td>(CVD events prevented per 100 people treated for 5 years)</td>
</tr>
<tr>
<td>(fatal and non-fatal)</td>
<td></td>
</tr>
<tr>
<td>18%</td>
<td>1 intervention (25% risk reduction)</td>
</tr>
<tr>
<td></td>
<td>2 interventions (45% risk reduction)</td>
</tr>
<tr>
<td></td>
<td>3 interventions (55% risk reduction)</td>
</tr>
<tr>
<td></td>
<td>22 (4.5 per 100)</td>
</tr>
<tr>
<td></td>
<td>12 (8.1 per 100)</td>
</tr>
<tr>
<td></td>
<td>10 (9.9 per 100)</td>
</tr>
</tbody>
</table>

Based on the conservative estimate that each intervention: aspirin, blood pressure treatment (lowering systolic blood pressure by 10 mm Hg) or lipid modification (lowering LDL-C by 20%) reduces CV risk by about 25% over 5 years.

CVD risk has been moved up one risk category (5%), as cardiovascular risk may be underestimated in the Framingham risk equation; based on:
- family history of premature coronary heart disease or ischaemic stroke in a first-degree male relative before the age of 55 years or a first-degree female relative before the age of 65 years
- Maori or Pacific ethnicity or people from the Indian subcontinent
- metabolic syndrome

Cardiovascular Disease: Baseline Risk and Treatment Benefit

**NO DIABETES**
(With a 5% upward risk adjustment applied)

<table>
<thead>
<tr>
<th>Ratio of Total Cholesterol:HDL</th>
<th>Nonsmoker</th>
<th>Smoker</th>
</tr>
</thead>
<tbody>
<tr>
<td>180/105</td>
<td></td>
<td></td>
</tr>
<tr>
<td>160/95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>140/85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>120/75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Risk Level
5 year CVD risk (non-fatal and fatal)

- **Very High** >30%
- **High** 15-20%
- **Moderate** 10-15%
- **Mild** 5-10%
- **<2.5%** 2.5-5%
PREDICT was designed to:

- Get current best evidence on risk & management into clinical practice

Electronic medical record in primary care

Electronic decision support

Patient population
& to simultaneously generate new evidence from clinical practice

Electronic medical record
in primary care

Patient population

NHI

PREDICT:
electronic decision support
& to simultaneously generate new evidence from clinical practice

patient-specific outcomes: hospital admissions, deaths

patient-specific CVD risk factor profiles

encrypted NHI
PREDICT recruitment 2002-14

Updated from Wells et al. IJE 2015
PREDICT recruitment 2002-14

Updated from Wells et al. IJE 2015

now 500,000
National mortality database

National hospitalisation database

Regional laboratory (TestSafe) database

National virtual diabetes register

National drug dispensing database

National PHO enrolment database

linked

PREDICT in PHOs
web-based platform in primary care

by e-NHI
PREDICT 1° Care

- PREDICT integrated into electronic health record systems of ≈ 35% NZ GPs
• link cohort to national hospitalisations & mortality databases biannually
• from 2006 linked national drug dispensing and laboratory database (1° care risk management)
CVD events during follow-up in PREDICT population 30-74 years, by clinical history

- With prior CVD: 13% events during follow-up, 46% population
- With diabetes: 14% events during follow-up, 17% population
- No CVD or diabetes: 73% events during follow-up, 37% population

2002-2012
new 1° prevention risk scores
Romana Pylypchuk (PhD), Sue Wells & Rod Jackson
1° prevention cohort by ethnicity aged 30-74 years: 2002-2012

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total (205,274)</td>
<td>114,463</td>
<td>90,811</td>
</tr>
<tr>
<td>European/other</td>
<td>74,002</td>
<td>57,757</td>
</tr>
<tr>
<td>Maori</td>
<td>14,142</td>
<td>12,583</td>
</tr>
<tr>
<td>Pacific</td>
<td>16,372</td>
<td>13,490</td>
</tr>
<tr>
<td>Indian</td>
<td>9,947</td>
<td>6,981</td>
</tr>
</tbody>
</table>

with no hx of CVD, renal disease or AF
observed vs predicted risk: Framingham score

Predicted event rate: Framingham

1° prevention score
observed vs predicted risk: PREDICT score

![Graph showing observed vs predicted risk](image)
ANZACS-QI

All NZ Acute Coronary Syndrome - Quality Improvement Programme

Andrew Kerr, Corina Grey
National mortality database

National hospitalisation database

Regional laboratory (TestSafe) database

National drug dispensing database

National PHO enrolment database

linked

web-based platform in hospitals

ANZACS-QI

by e-NHI
ANZACS-QI: All NZ Acute Coronary Syndrome-Quality Improvement

- web-based CVD risk factor/diagnostic/management/patient flow data collection system in hospitals
- started in 2004 in MMH as ‘Acute PREDICT’, expanded to Waikato in 2005
- ‘morphed’ into ANZACS in 2012
- now includes acute coronary hospitalisations in every NZ hospital & all coronary procedures in NZ
- copies of patients’ data are recorded on a secure web server
- ≈ 30,000 patients risk assessed 2007-2015

Acute PREDICT 2° Care ➔ 2012: ANZACS-QI
ANZACS-QI recruitment 2002-15

Kerr et al. NZMJ (accepted)
developing low information vascular risk scores for informing national policy
Suneela Mehta (PhD)
National mortality database

National hospitalisation database

Regional laboratory (TestSafe) database

National PHO enrolment database

National Virtual diabetes register

National drug dispensing database

linked by e-NHI
≈ total NZ adult population

linked by e-NHI

National mortality database
National hospitalisation database

National Virtual diabetes register
Regional laboratory (TestSafe) database

National drug dispensing database
National PHO enrolment database
VARIANZ (VAascular Risk In Adult NZ’ders) linked by e-NHI:

- National mortality database
- National hospitalisation database
- Regional laboratory (TestSafe) database
- National Virtual diabetes register
- National drug dispensing database
- National PHO enrolment database
VARIANZ-2006: Vascular Risk In Adult New Zealanders-2006 Cohort

- includes: mortality, hospitalisations, drugs dispensed, community lab tests performed, Virtual diabetes register, PHO enrolments
- NHI linked records considered sufficiently complete since 2006
- Can be compared to 2006 Census
VARIANZ-2006: for 5 year risk prediction

1993 - 2006

2006 - 2011

deaths & hospitalisations
VARIANZ-2006: for 5 year risk prediction & risk management

- deaths & hospitalisations
- dispensed drugs + labs

1993 to 2011
## VARIANZ-2006 and the 2006 Census

<table>
<thead>
<tr>
<th>Demographic</th>
<th>VARIANZ 2006 Population n(%)</th>
<th>2006 NZ Census Population n(%)</th>
<th>Difference n(%) Census</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2 543 577</td>
<td>2 982 720</td>
<td>439 143 (15%)</td>
</tr>
<tr>
<td>Male</td>
<td>1 140 283 (45%)</td>
<td>1 433 980 (48%)</td>
<td>293 697 (20%)</td>
</tr>
<tr>
<td>Female</td>
<td>1 403 155 (55%)</td>
<td>1 548 760 (52%)</td>
<td>145 605 (9%)</td>
</tr>
<tr>
<td><strong>Age:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-34 years</td>
<td>652 170 (26%)</td>
<td>837 560 (28%)</td>
<td>185 390 (22%)</td>
</tr>
<tr>
<td>35-44 years</td>
<td>521 108 (20%)</td>
<td>635 050 (21%)</td>
<td>113 942 (18%)</td>
</tr>
<tr>
<td>45-54 years</td>
<td>486 247 (19%)</td>
<td>568 810 (19%)</td>
<td>82 563 (15%)</td>
</tr>
<tr>
<td>55-64 years</td>
<td>389 470 (15%)</td>
<td>429 670 (14%)</td>
<td>40 200 (9%)</td>
</tr>
<tr>
<td>65-74 years</td>
<td>263 268 (10%)</td>
<td>275 700 (9%)</td>
<td>12 432 (5%)</td>
</tr>
<tr>
<td>75-84 years</td>
<td>172 720 (7%)</td>
<td>177 780 (6%)</td>
<td>5 060 (3%)</td>
</tr>
<tr>
<td>85 years and over</td>
<td>58 594 (2%)</td>
<td>58 140 (2%)</td>
<td>-454 (0%)</td>
</tr>
<tr>
<td><strong>Ethnicity:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Māori</td>
<td>260 871 (10%)</td>
<td>343 050 (12%)</td>
<td>82 765 (24%)</td>
</tr>
<tr>
<td>Pacific</td>
<td>127 141 (5%)</td>
<td>147 740 (5%)</td>
<td>23 400 (16%)</td>
</tr>
<tr>
<td>Asian</td>
<td>160 188 (6%)</td>
<td>278 265 (9%)</td>
<td>121 483 (44%)</td>
</tr>
<tr>
<td>Chinese</td>
<td>56 325 (2%)</td>
<td>121 110 (4%)</td>
<td>65 783 (54%)</td>
</tr>
<tr>
<td>Indian</td>
<td>55 115 (2%)</td>
<td>80 609 (3%)</td>
<td>26 484 (33%)</td>
</tr>
<tr>
<td>Other</td>
<td>1 995 377 (79%)</td>
<td>2 213 280 (74%)</td>
<td>224 757 (10%)</td>
</tr>
</tbody>
</table>
## 2006 VARIANZ cohort by CVD history

### 35-74 years

<table>
<thead>
<tr>
<th></th>
<th>No hx CVD</th>
<th>Hx CVD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total (1,878,994)</td>
<td>1,758,572</td>
<td>120,422</td>
</tr>
<tr>
<td>AF</td>
<td>13,358 (1%)</td>
<td>17,172 (14%)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>86,750 (5%)</td>
<td>26,161 (22%)</td>
</tr>
<tr>
<td>Lipid Lowering Rx</td>
<td>165,875 (9%)</td>
<td>72,254 (60%)</td>
</tr>
<tr>
<td>BP Lowering Rx</td>
<td>299,676 (17%)</td>
<td>86,285 (72%)</td>
</tr>
<tr>
<td>CVD events:5y f/u</td>
<td>65,239 (4%)</td>
<td>41,913 (35%)</td>
</tr>
</tbody>
</table>
applying the VARIANZ-2006-11 risk score
give every adult NZ’der a vascular risk score
only using routinely collected data
proposed VARIANZ IDI (Integrated Data Infrastructure) 2013/2018

- deaths & hospitalisations
- dispensed drugs + labs

1993

- Census
- Justice
- Migration
- Benefits
- Education
- Tax
- ACC
- Households

2020
ANZACS-QI in hospitals

2006
VARIANZ

2004

1993

dispensed drugs

2006

2002

2013
VARIANZ - IDI

2016

PREDICT in 1° Care

VIEW 2020: routinely collected data