



Virtual Wards

NHS Tayside

11 August 2009

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The Nuffield Trust, UK



Outline

- **Rationale**
- **Building a Predictive Model**
- **NHS Combined Predictive Model**
- *Predictive Models for Social Care*
- *Impactability Models*



Why Predictive Modelling?

BMJ in paper* in 2002 showed *Kaiser Permanente* in California seemed to provide **higher quality** healthcare than the NHS at a **lower cost**

Kaiser identify high risk people in their population and manage them intensively to **prevent admissions**

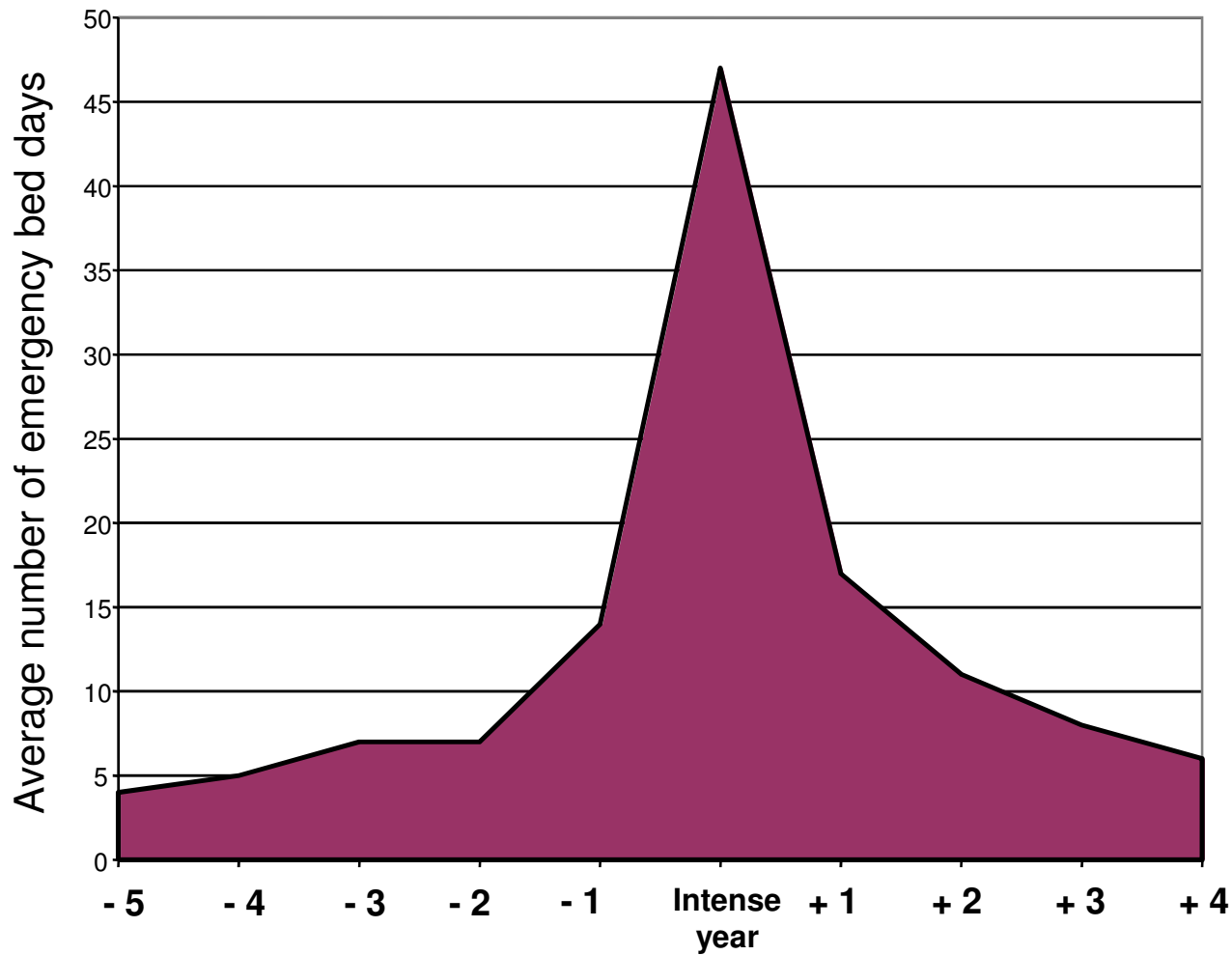
Inaccurate Identification:

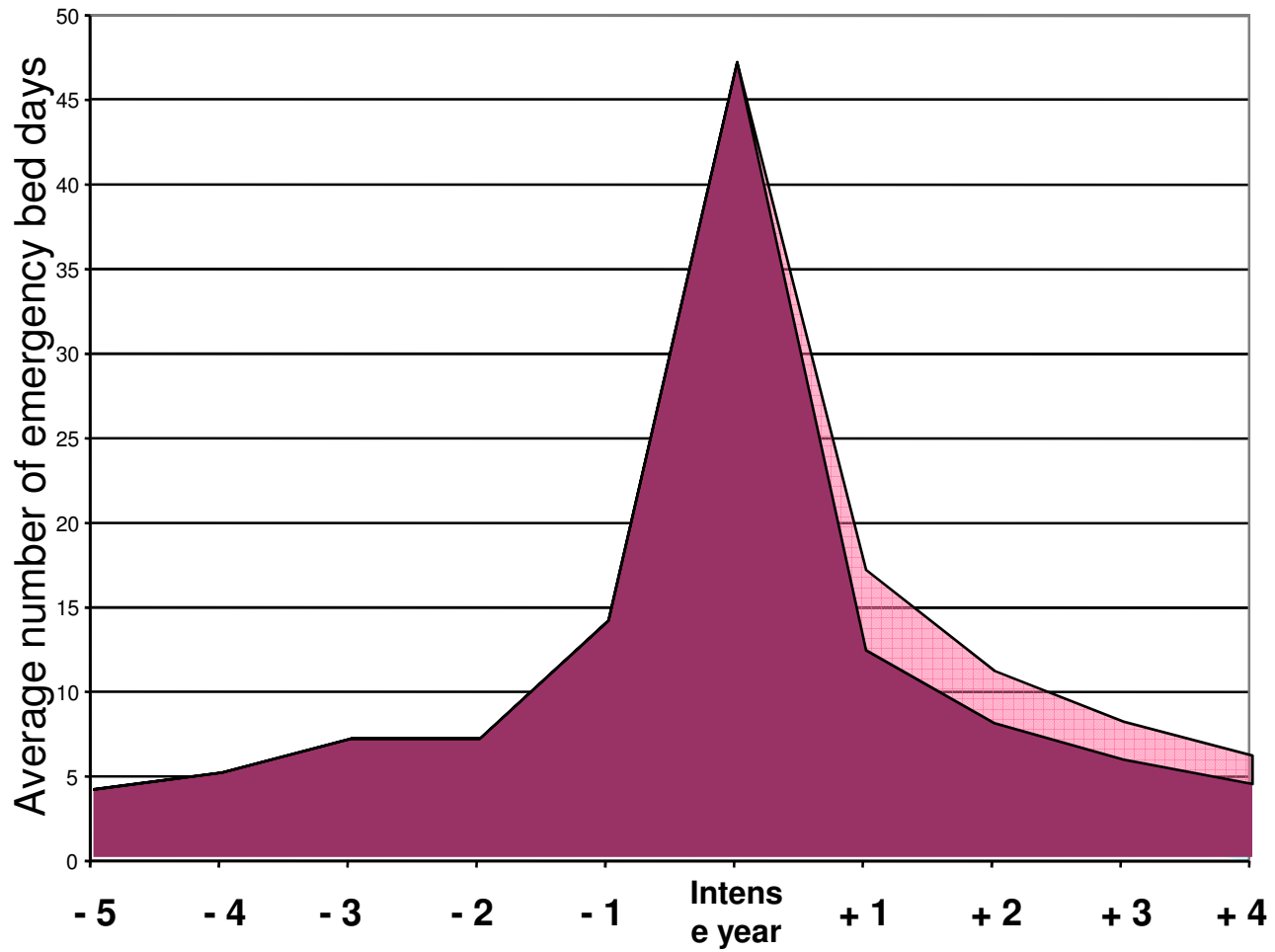
Clinician referrals

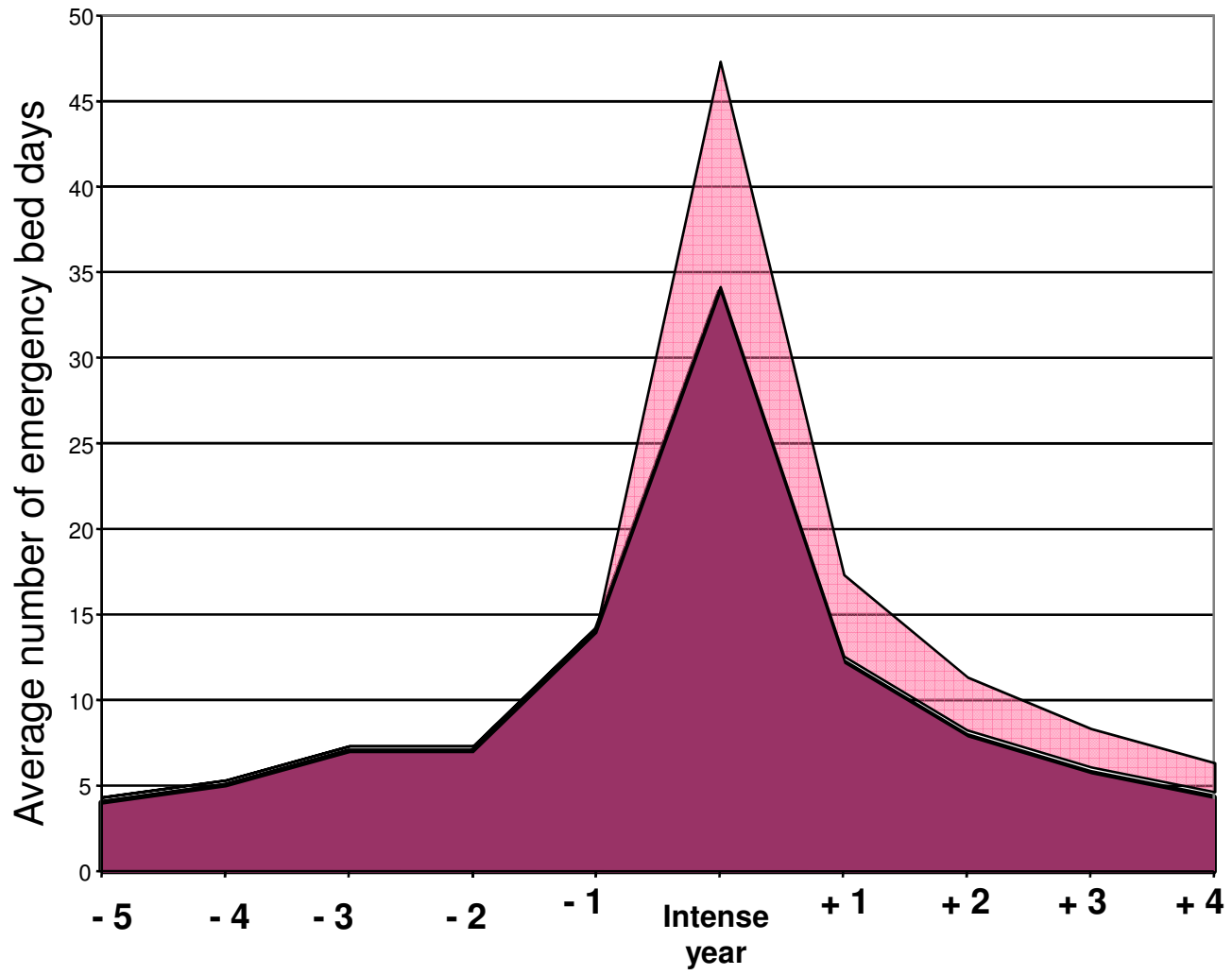
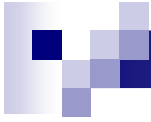
Referral criteria (e.g. all patients aged >65 with 2+ admissions)

*Feachem et al (2002) Getting more for their dollar: a comparison of the NHS with California's Kaiser Permanente
BMJ 2002;324:135-143

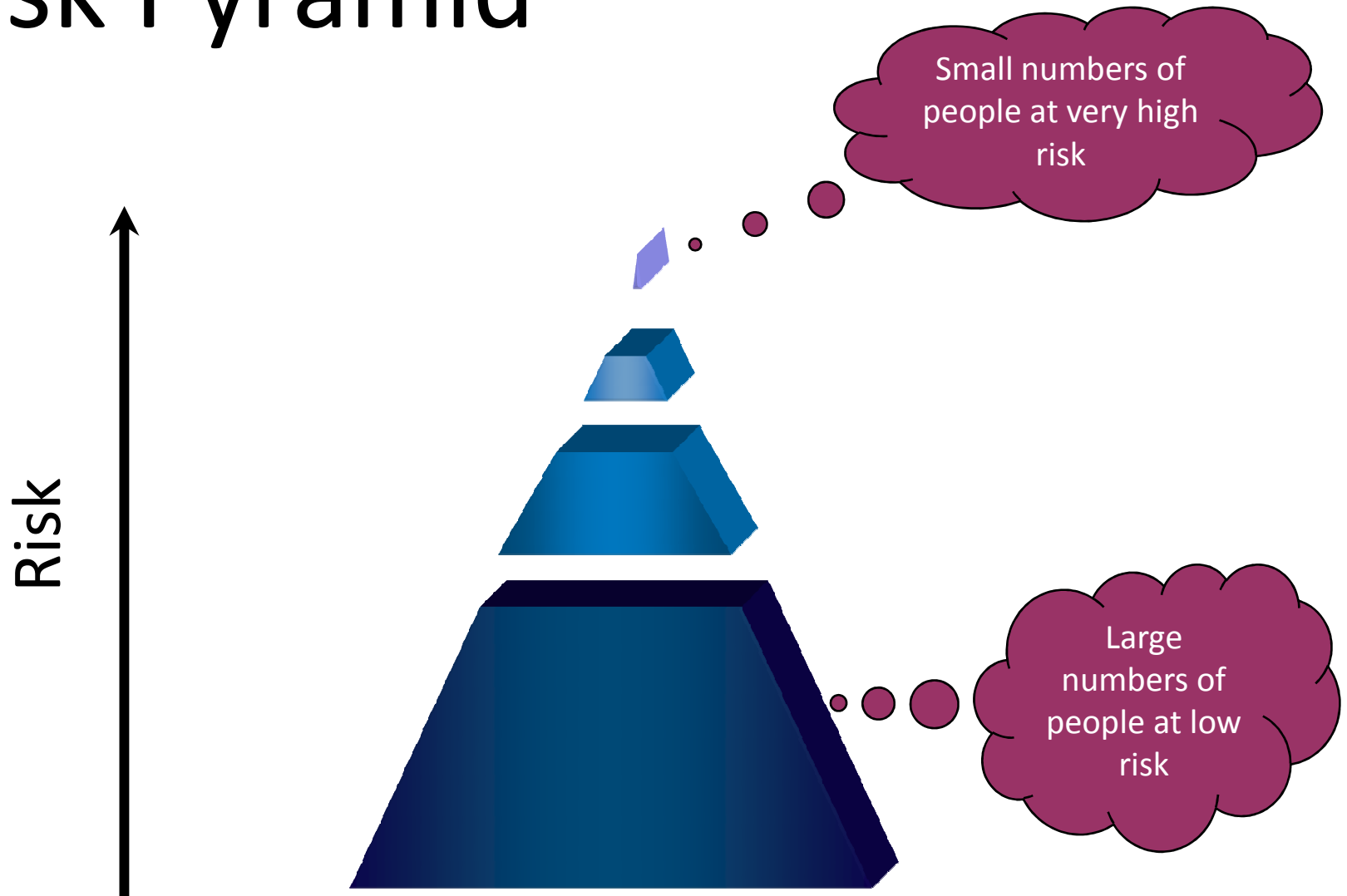
Frequently-admitted patients





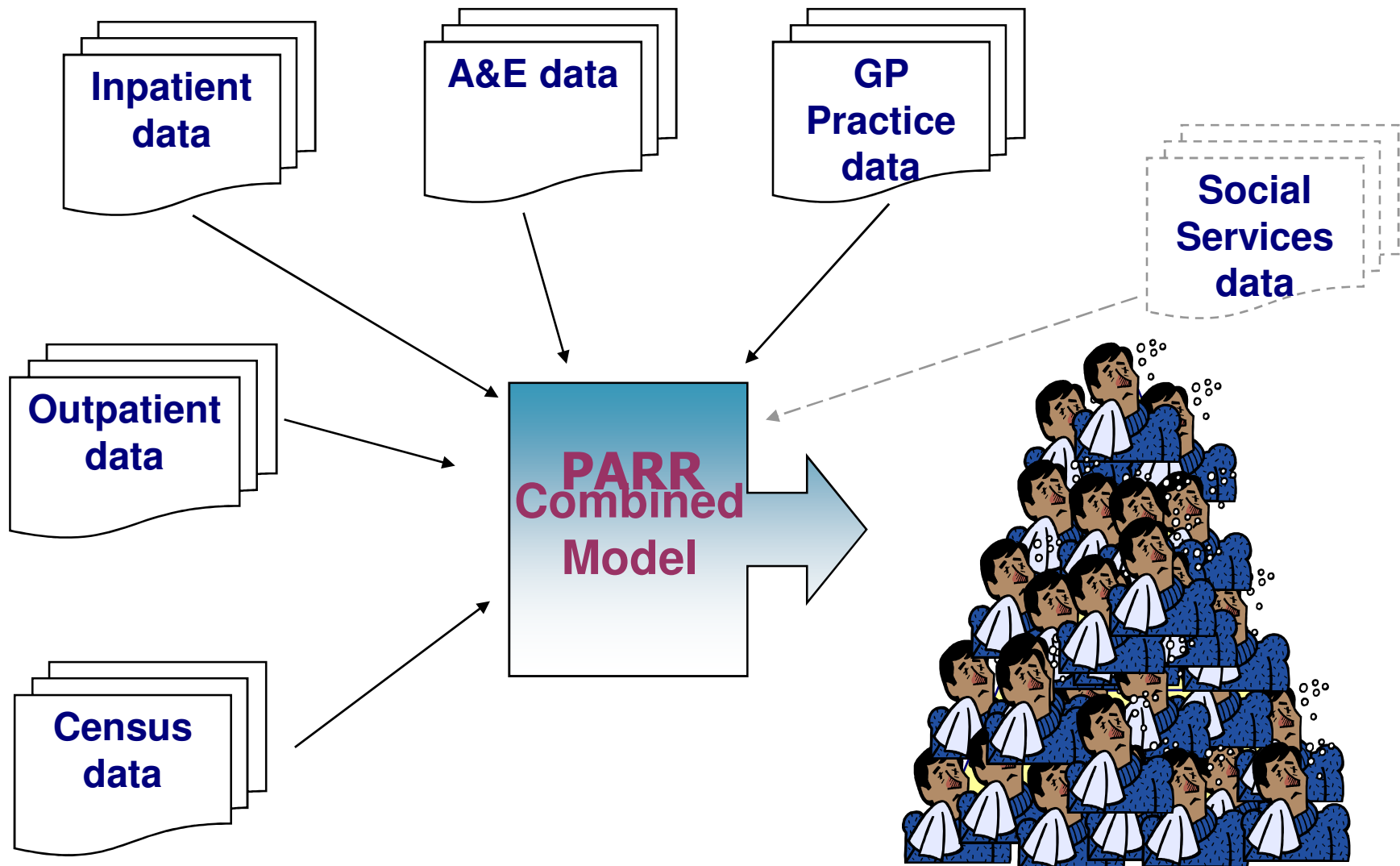


Risk Pyramid



Size of shape is proportional to number of patients

Patterns in routine data



Name, Address, DOB	131178	[Patterned]
--------------------	--------	-------------



J7KA42	[Patterned]
--------	-------------

Name, Address, DOB	131178	[Patterned]
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J7KA42	[Patterned]
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Name, Address, DOB	131178	[Patterned]
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J7KA42	[Patterned]
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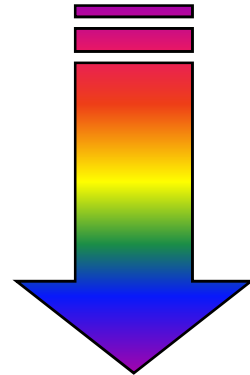
Name, Address, DOB	131178	[Patterned]
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J7KA42	[Patterned]
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J7KA42	[Patterned]
--------	-------------

- Inpatient
- Outpatient
- A&E
- GP



J7KA42	76.4
--------	------



Decrypted data with risk score attached

131178	76.4
--------	------

10 Million Patient-Years
of Data

Randomised

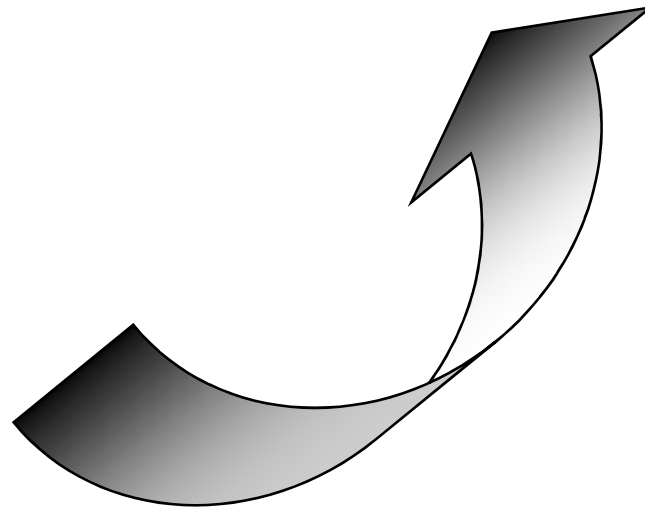
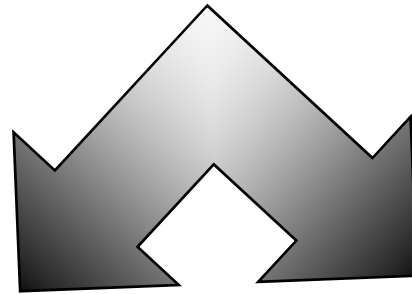
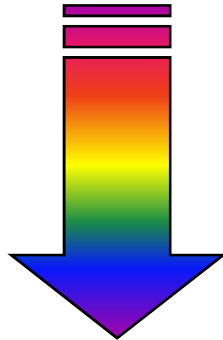
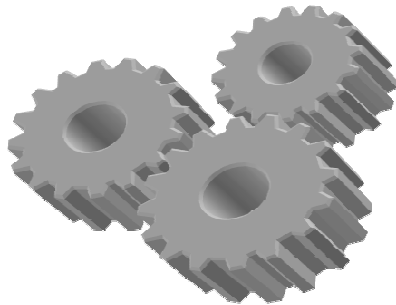
Development

5 Million Patient-Years
of Data

Validation

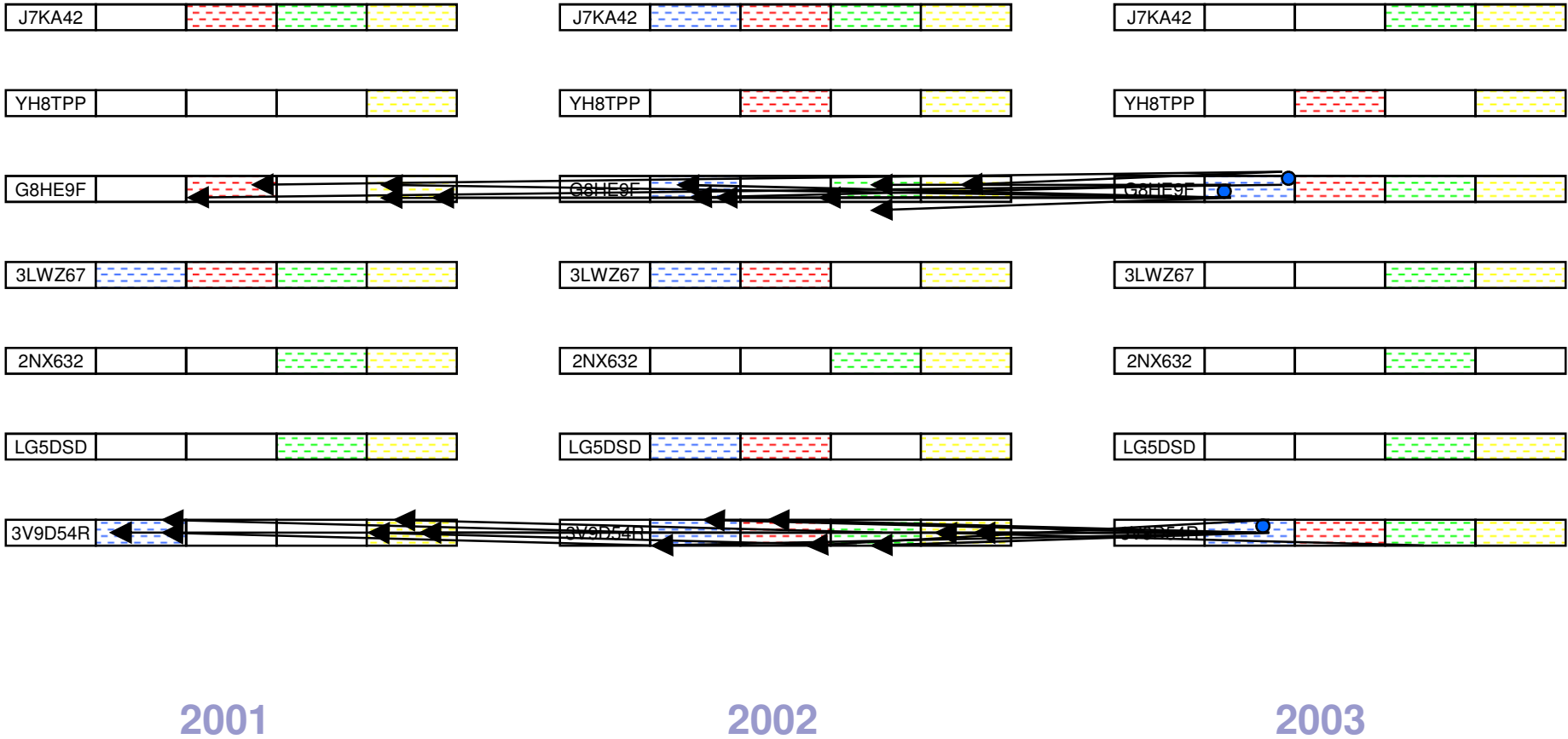
5 Million Patient-Years
of Data

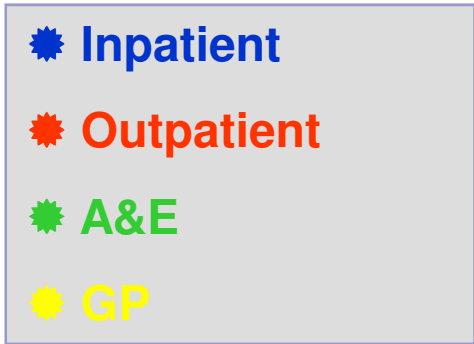
Predictive
Model



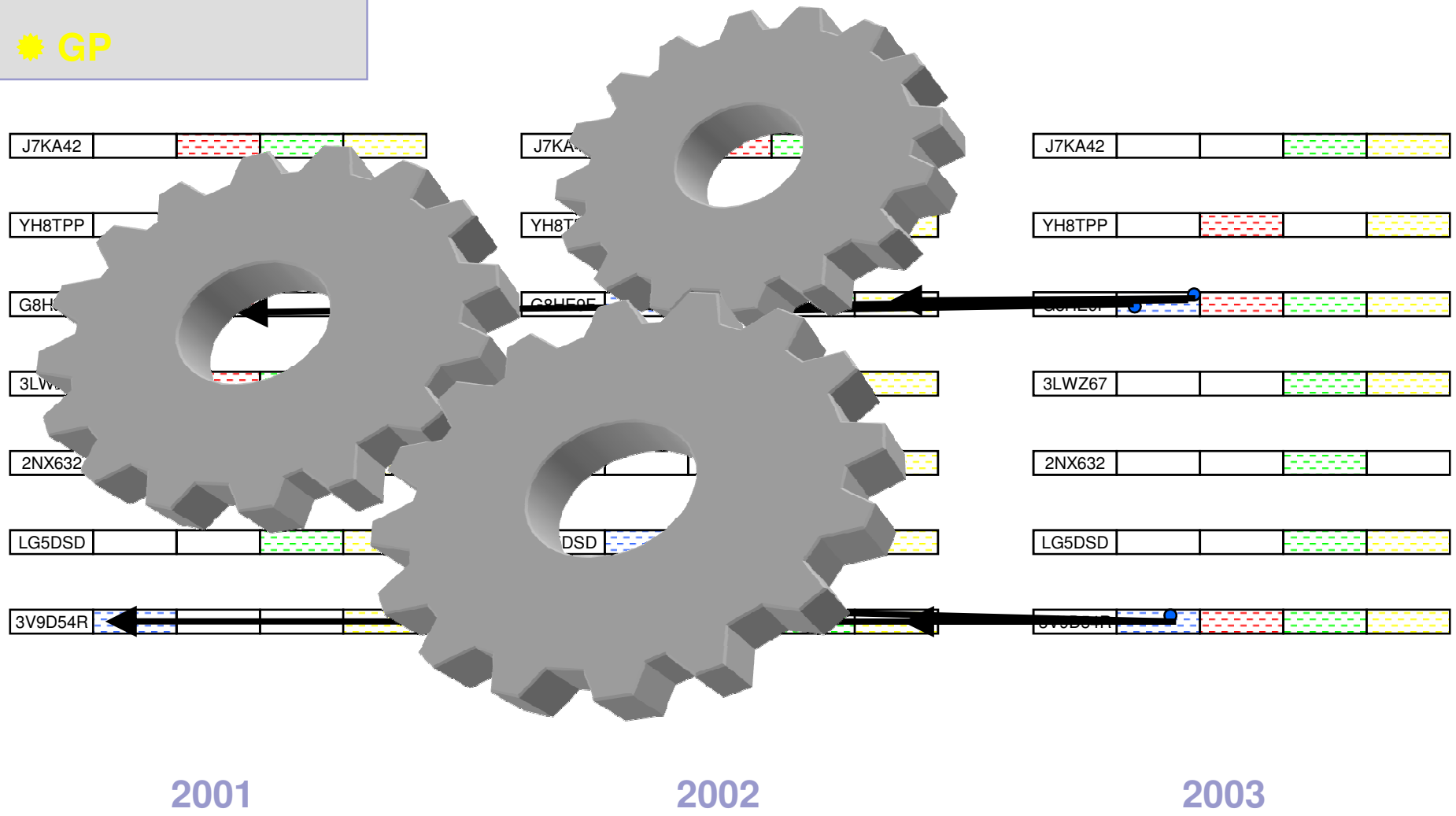
- ✱ Inpatient
- ✱ Outpatient
- ✱ A&E
- ✱ GP

Development Sample



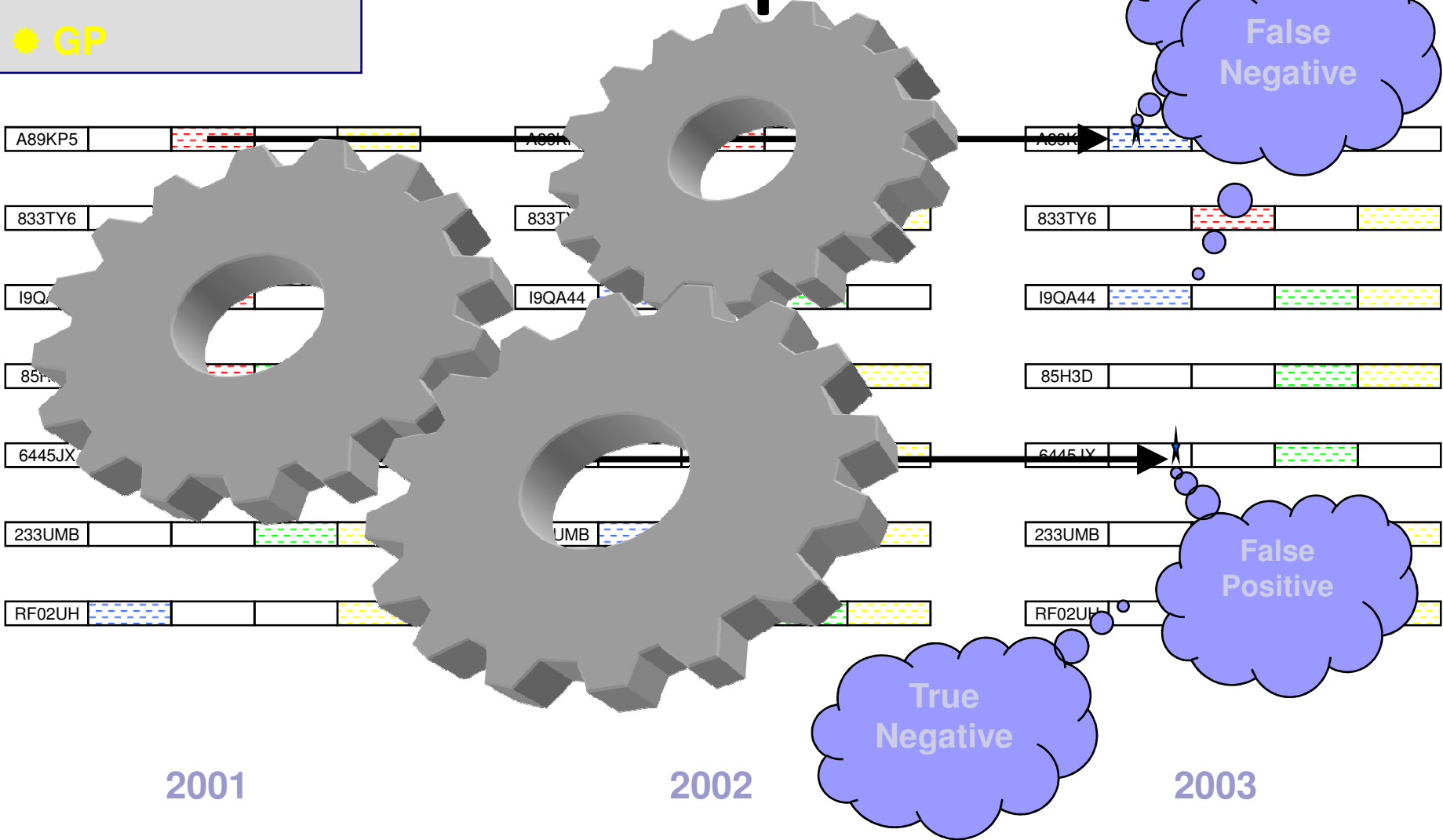


Development Sample







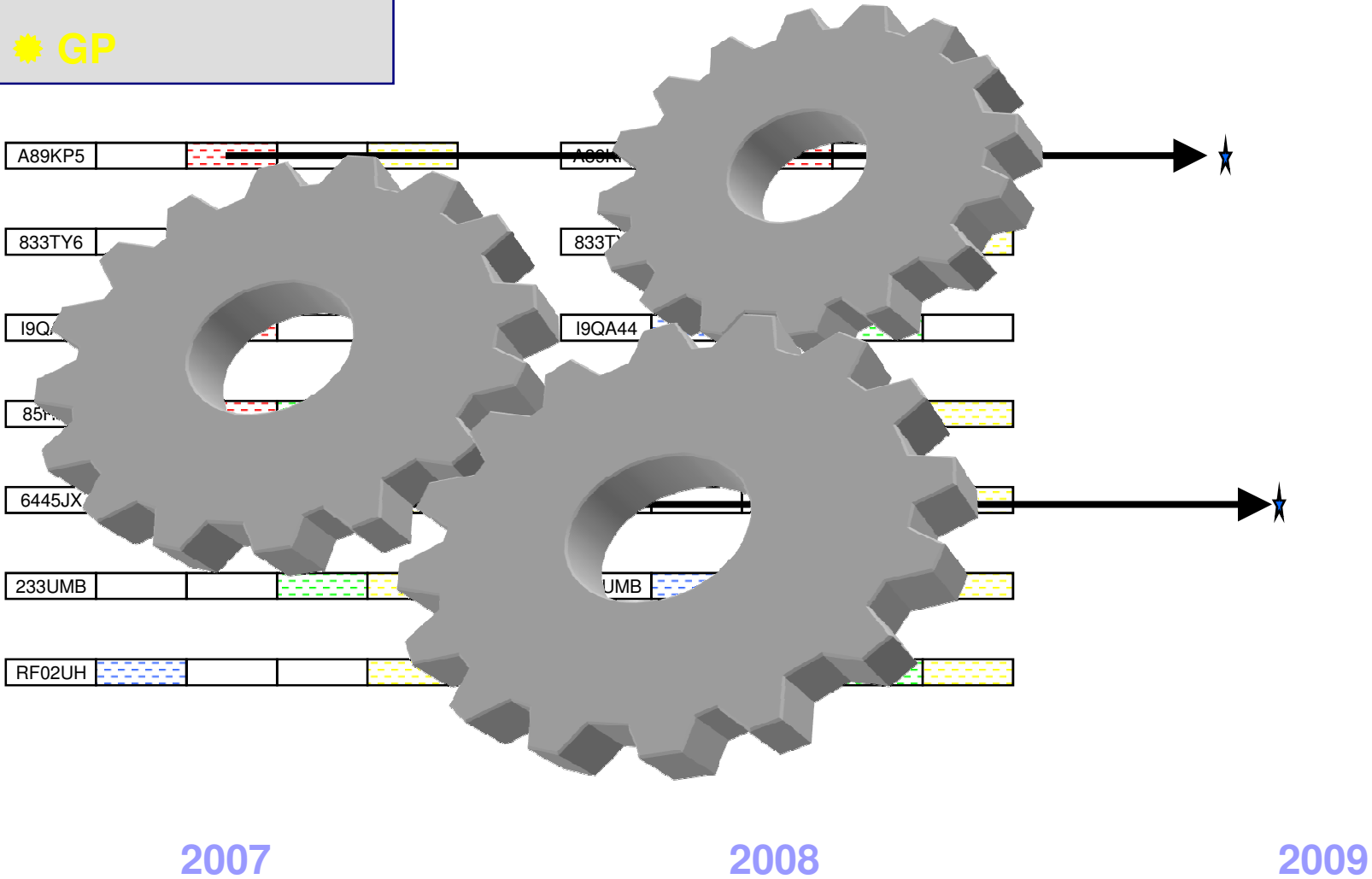
- ✱ Inpatient
- ✱ Outpatient
- ✱ A&E
- ✱ GP

Validation Sample

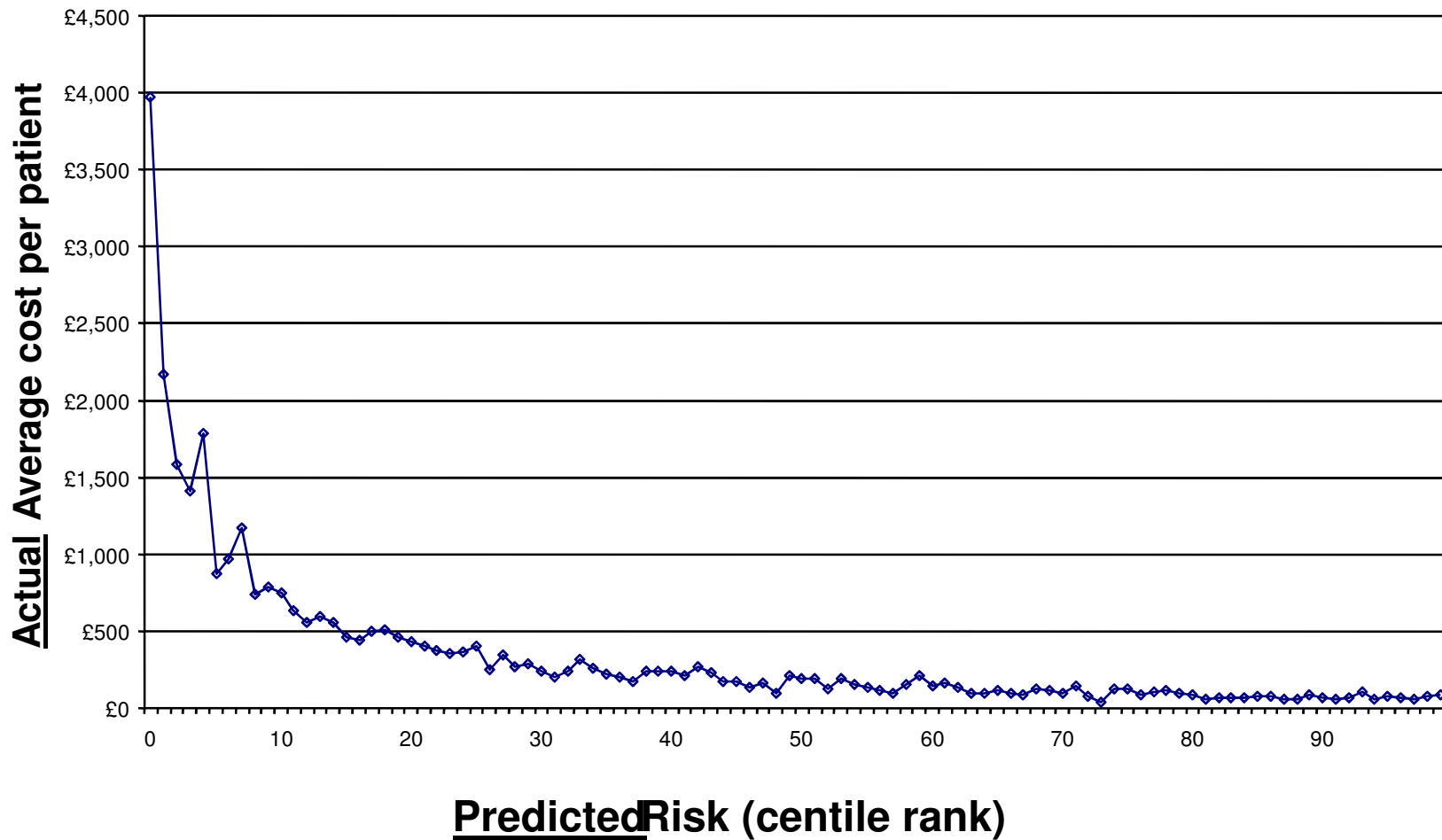


Using the Model

-  Inpatient
-  Outpatient
-  A&E
-  GP



Distribution of Future Utilisation



Risk Segmentation

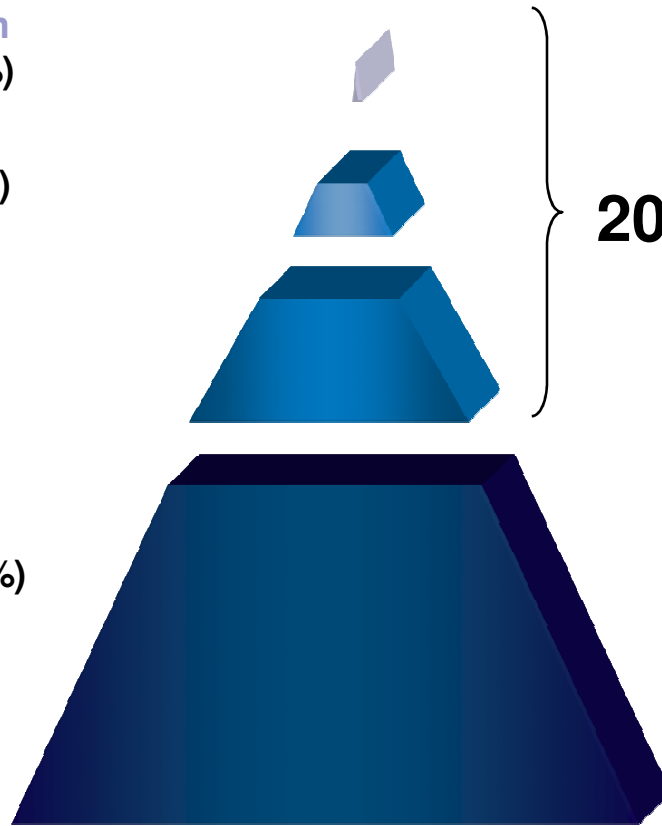
The Kaiser pyramid can be divided into four segments:

Very High
(0 – 0.5%)

High
(0.5 – 5%)

Moderate
(5 – 20%)

Low
(20 – 100%)

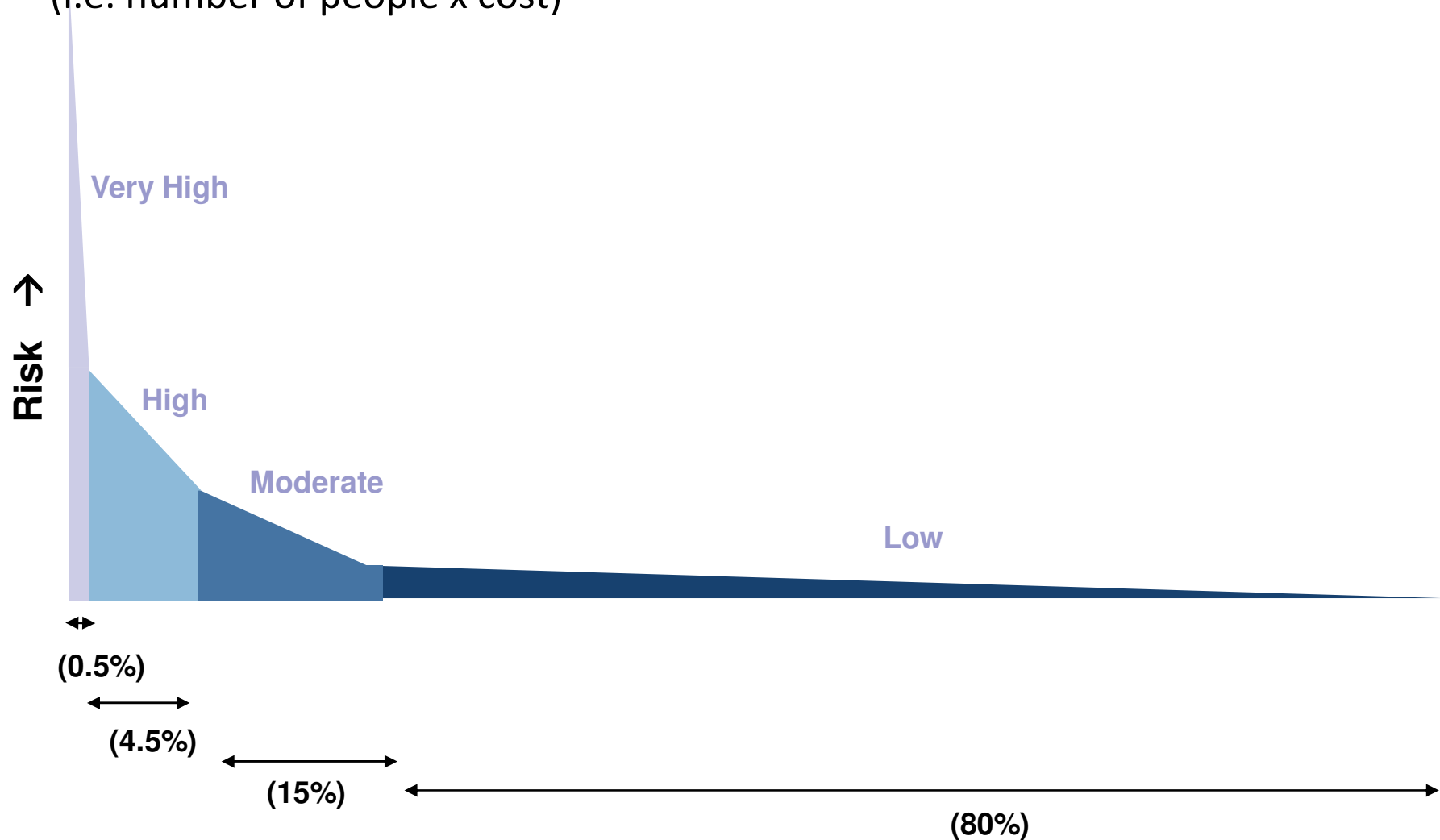


Top three segments
combined make up
the top quintile

Bottom
segment
represents
the bottom
four quintiles
combined

Burden of Future Utilisation is the Area Under the Curve

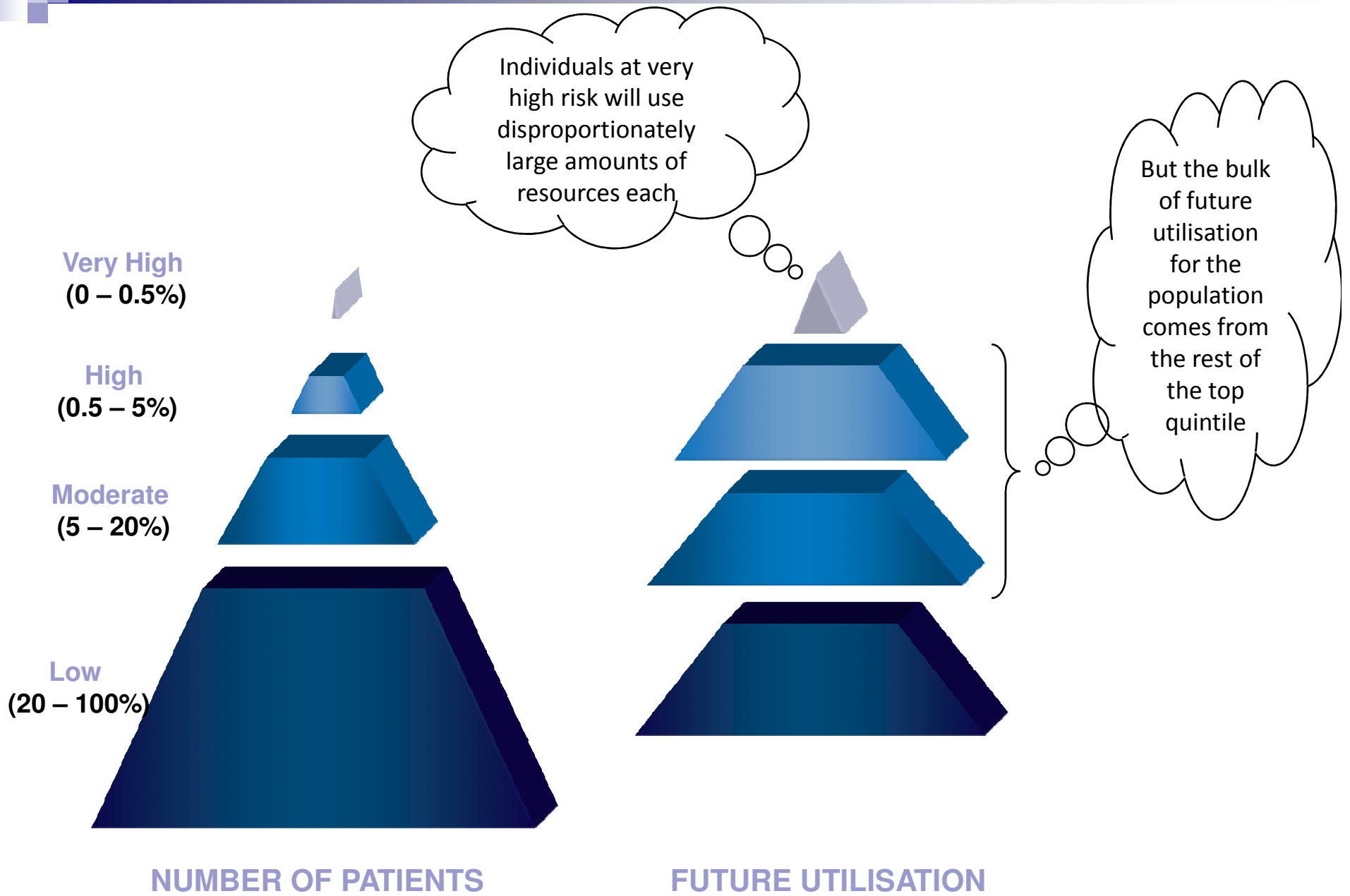
(i.e. number of people x cost)



Size of Shape is Proportional to Future Utilisation



SIZE OF SHAPE IS
PROPORTIONAL
TO FUTURE UTILISATION



NHS Combined Model

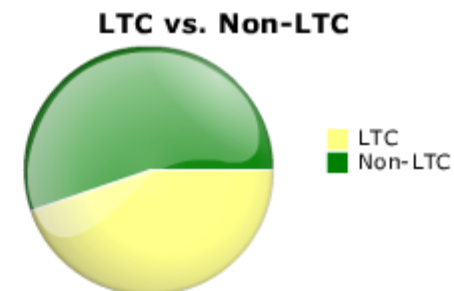
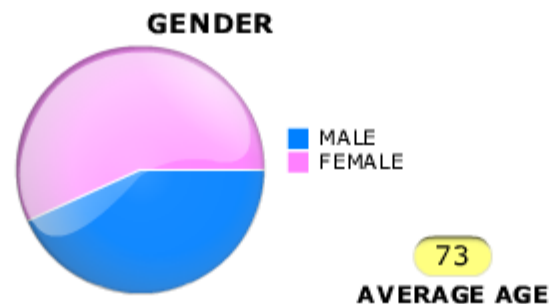
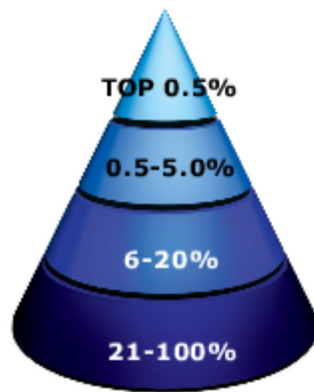
PATIENTS

TOTAL POPULATION	322518
RISK SEGMENT POPULATION	1612

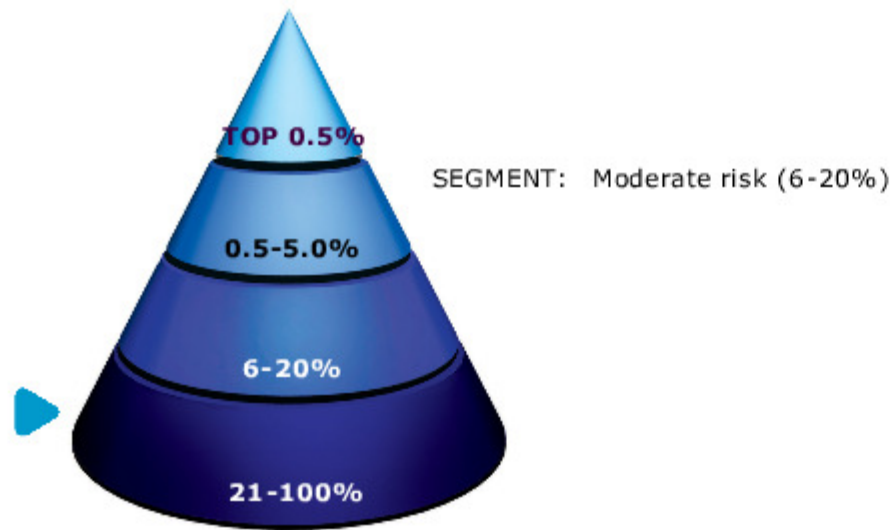


UTILISATION RATES PER 1000

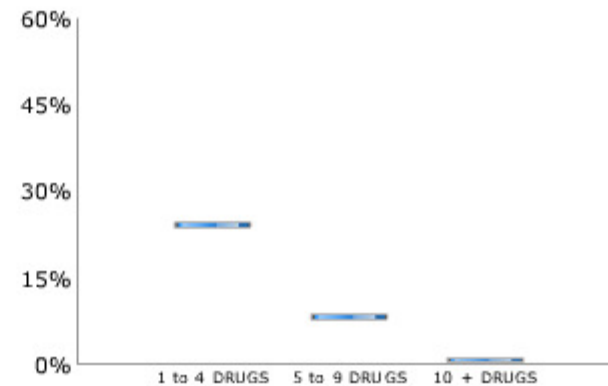
	Any IP admissions	Emergency IP admissions	OP visits	AE visits
OVERALL RATE	101	57	710	197
RISK SEGMENT RATE	1402	1094	5292	1563
INDEXED RATE(X OVERALL RATE)	13.9 X	19.3 X	7.5 X	7.9 X



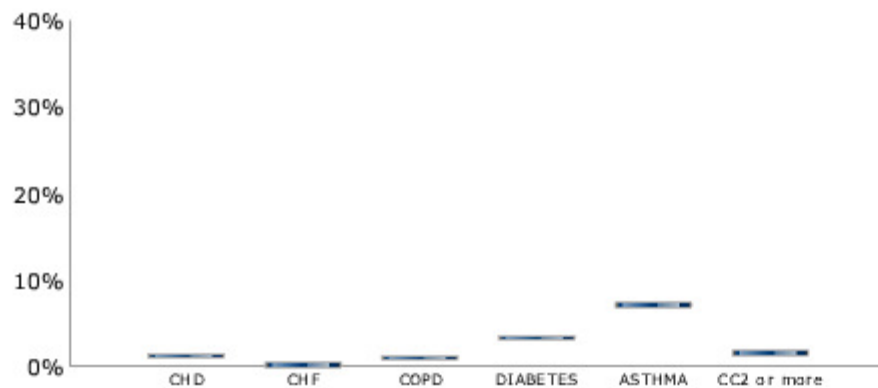
Clinical profiles



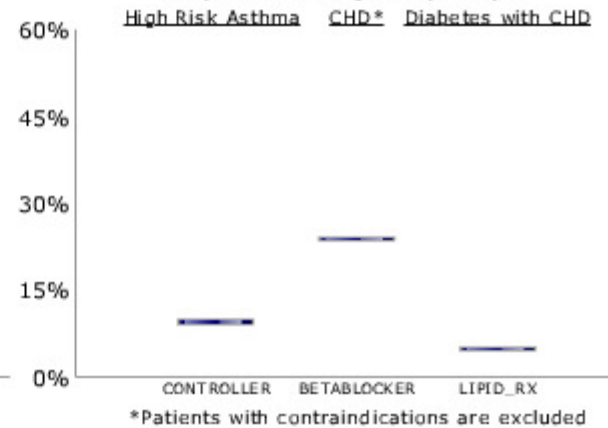
Polypharmacy in any One Month



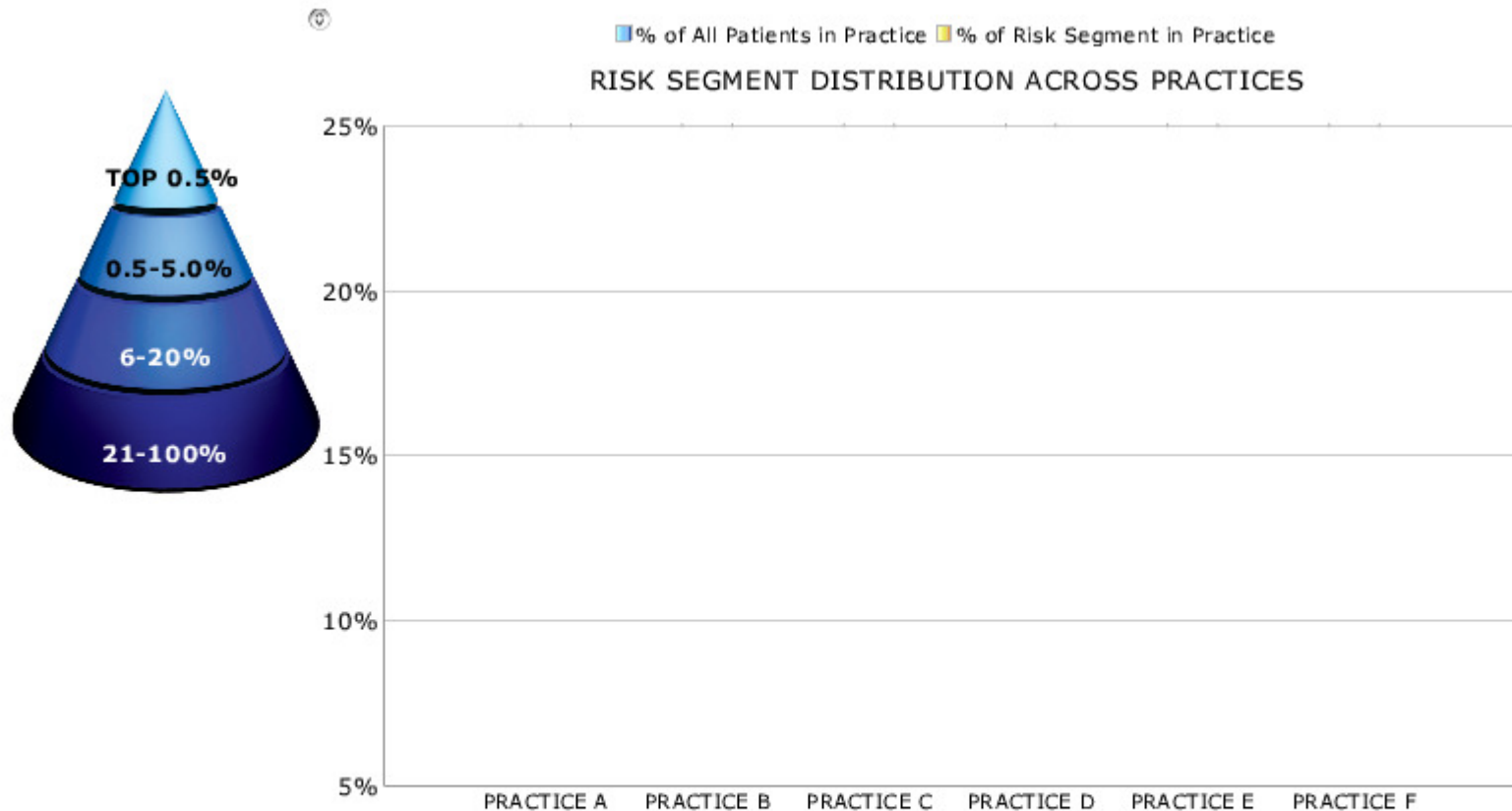
LTC Prevalence



Key Clinical Quality Gaps



Tackling the *Inverse Care Law*

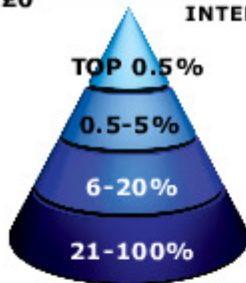
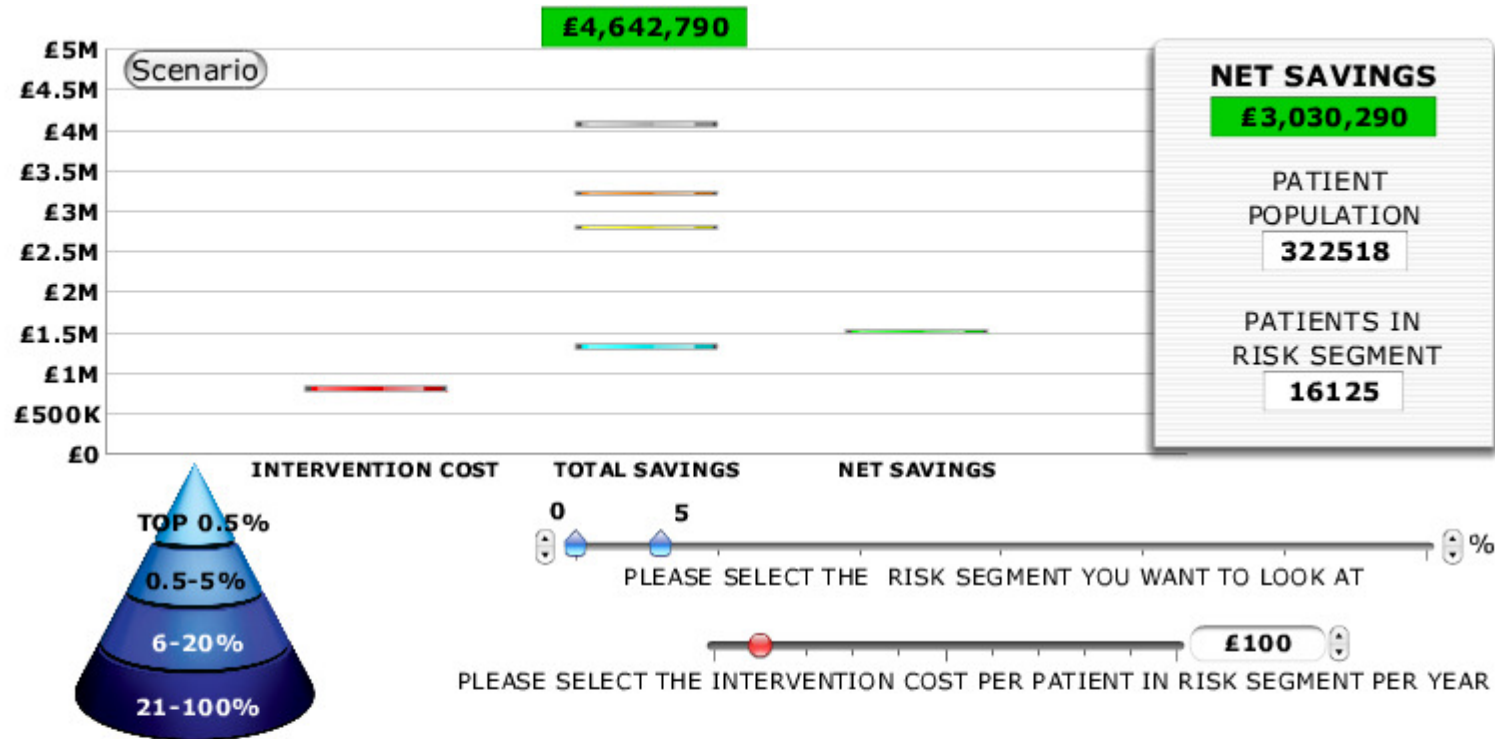


IP EMERGENCY ADMITS / 1000

	PRACTICE A	PRACTICE B	PRACTICE C	PRACTICE D	PRACTICE E	PRACTICE F	TOTAL
PATIENTS IN RISK SEGMENT	2777	2650	2556	2294	1978	2334	14589
ALL PATIENTS	15660	13751	11676	11154	10917	10747	73905



Developing Business Cases



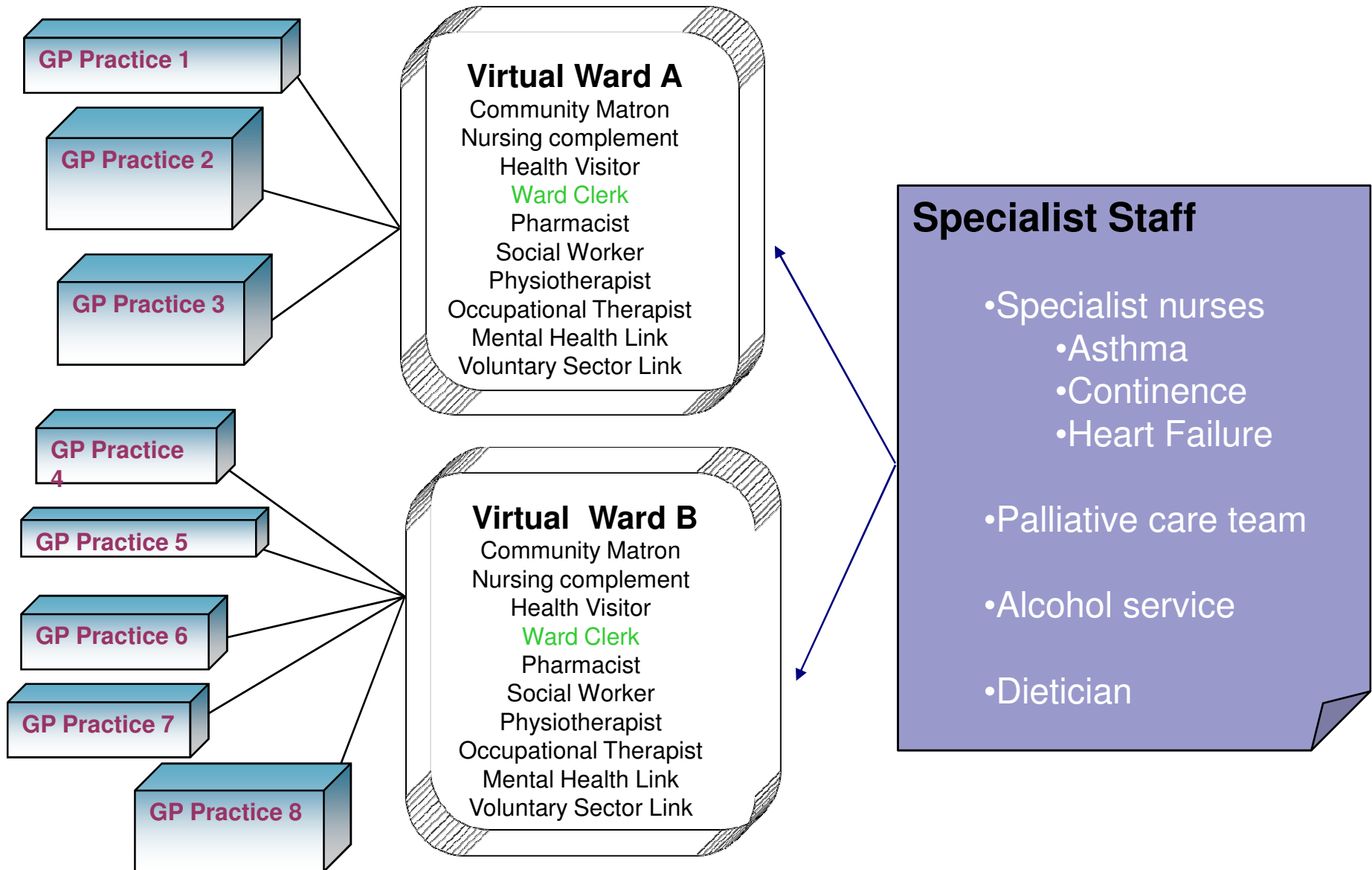
IP Emergency Admissions	6304	Intervention impact rate	0.20	Estimated cost of admission	£2,100
IP Other Admissions	3337	Intervention impact rate	0.10	Estimated cost of admission	£900
AE Visits	11152	Intervention impact rate	0.20	Estimated cost of visit	£250
OP Visits	56859	Intervention impact rate	0.20	Estimated cost of visit	£100

Note: Utilisation rates are for year following prediction

Virtual Wards

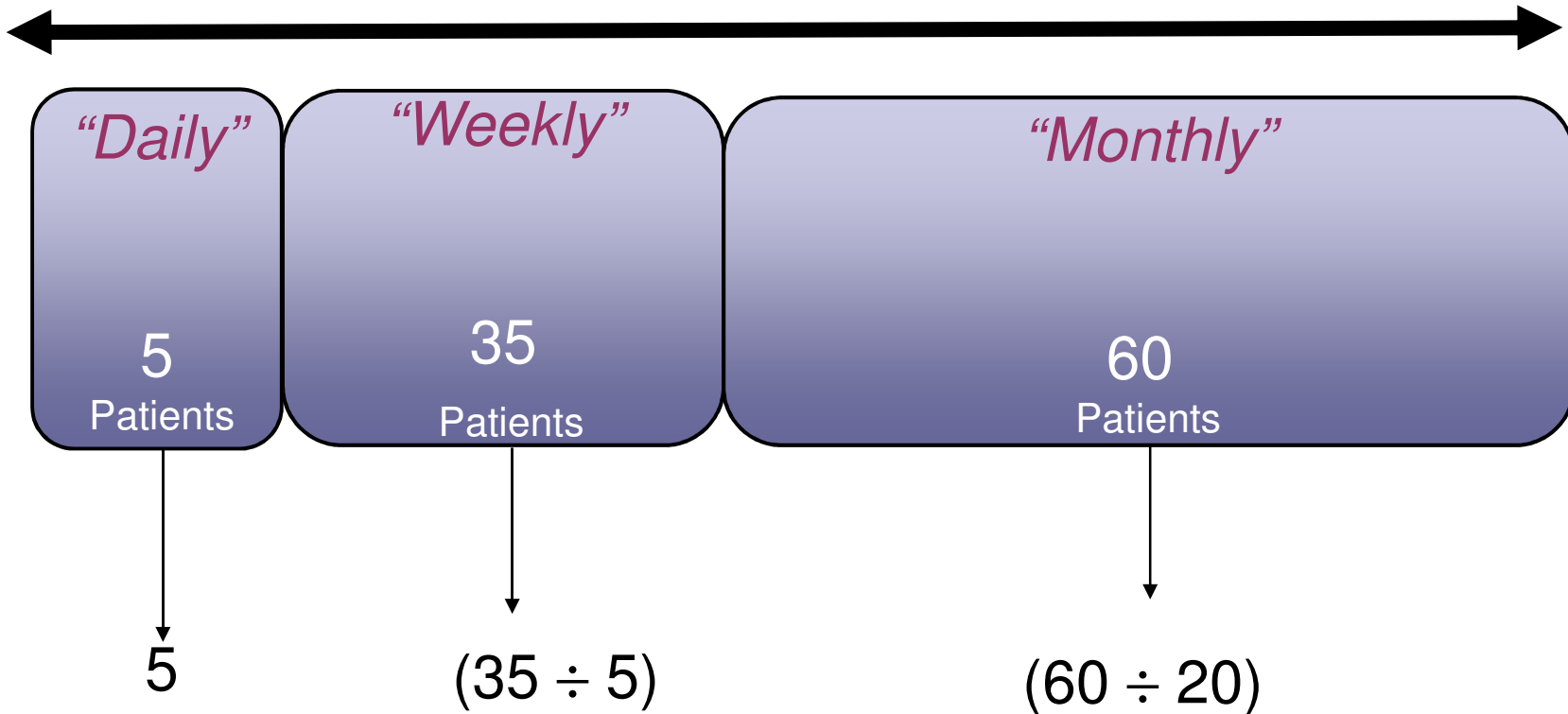
- Multidisciplinary team who meet daily
- Single set of notes
- Ward clerk and one telephone number





“Bed” Capacity

100 patients per ward



$$= 5 + 7 + 3$$

= **15** patients for discussion each day



Admission

- Combined Model only
- Memorandum of Understanding
- Consent
- Electronic notes



Initial assessment at
home
Screening
Patient-focused



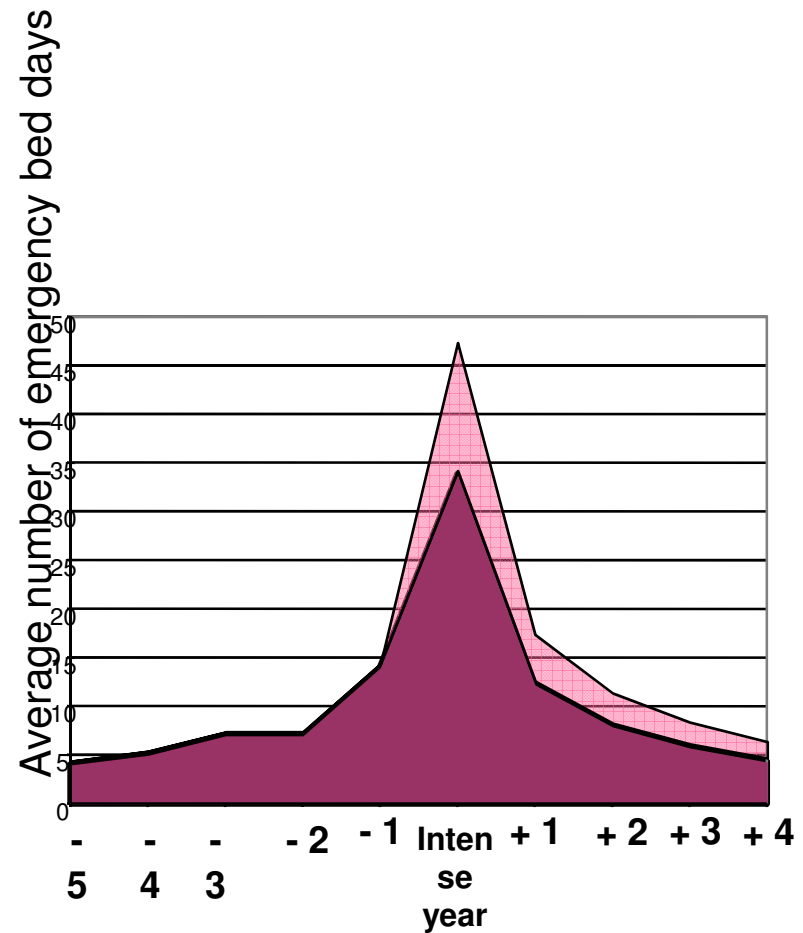
Daily Ward Rounds

- 20 minutes
- PCT offices or GP practice meeting rooms
- Tele-conferencing facility



Discharge

- Important due to *Regression to the Mean*
- Prompted by Risk Score
- Twin discharge letters
- GP Follow-up





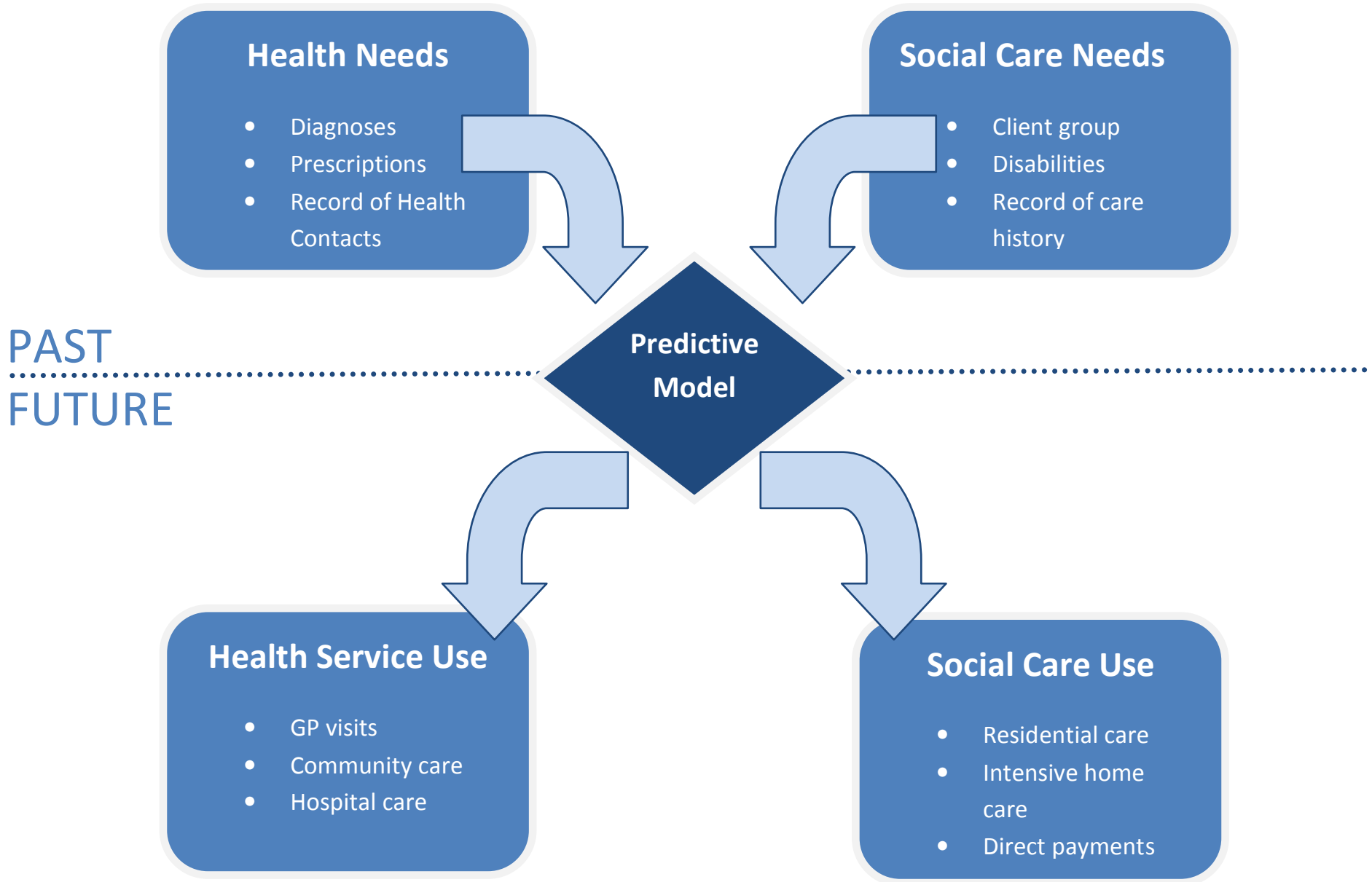
Variants

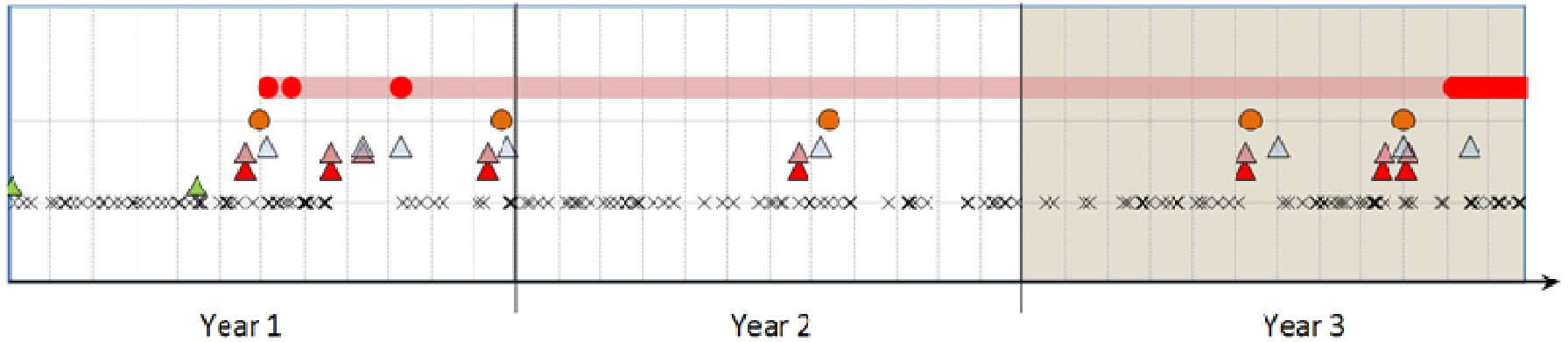
Existing Variants

- Wandsworth – *VWGPs*
- New York City – *BlackBerry Ward Rounds*
- Devon – *GP based*

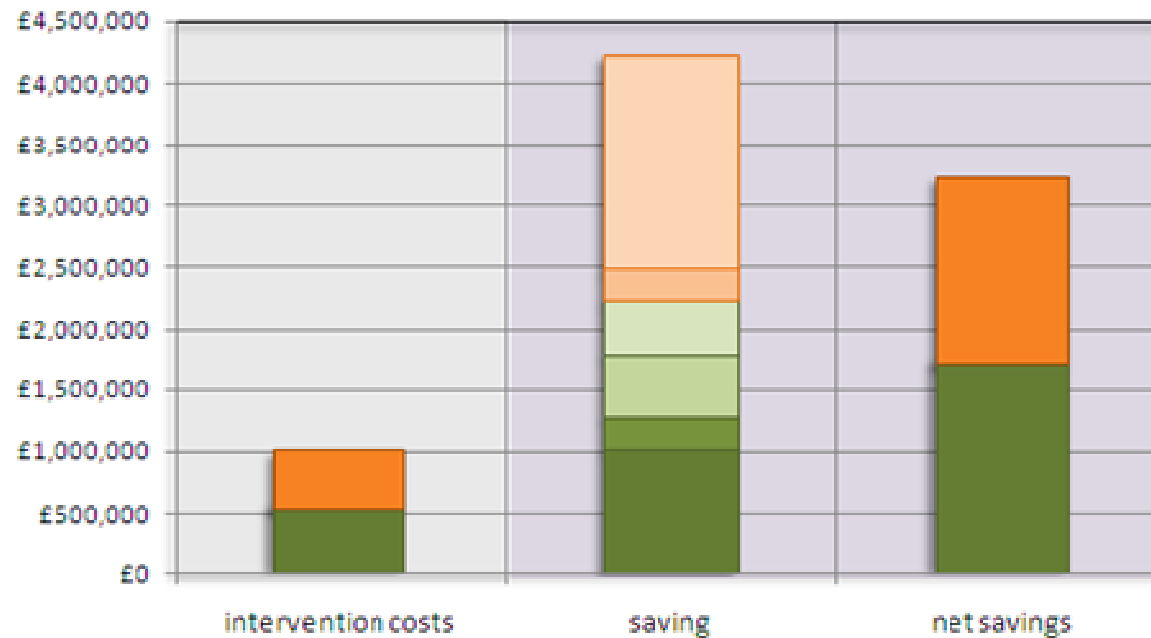
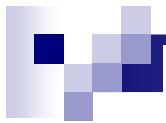
Planned Variants

- British Columbia – *Reactive & Proactive beds*
- Shetland – *Virtual Hospice*
- Toronto – *Virtual Discharge Ward*
- Machynlleth – *Virtual & Real beds*





- High intensity social care service
- Other social care service
- Social care assessment
- △ Inpatient - discharge
- △ Inpatient - admission
- ▲ A&E visit
- ▲ Outpatient visit
- × GP visit



Enter intervention cost per patient in risk segment per year

Select risk segment (0 to 5)

		number of events	estimated cost of event	impact of intervention (percentage)
NHS	IP emergency admissions	5,000	£2,000	10%
	IP elective admissions	3,000	£900	10%
	AE visits	10,000	£250	20%
	CP visits	45,000	£100	10%
LA	Intensive home care weeks	8,500	£200	15%
	Care home weeks	35,000	£500	10%



Welsh Predictive Risk Service



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Welsh Predictive Risk Service

Together with health professionals and data analysis experts, Informing Healthcare has developed a web based information tool – The Welsh Predictive Risk Service (WPRS). WPRS classifies GP Practice populations according to their risk of emergency hospital admission.

WPRS is now available to those GP Practices who have agreed to participate in the pilot implementation. Click the 'Sign In' button and follow the 'Sign Up' procedure to get started.

The first step is for the GP practice's Caldicott Guardian to 'Sign Up'. When access is granted, the Caldicott Guardian can approve 'Sign Up' requests from other members of staff.

At this stage, access to the tool is limited to GP practice staff only. Access by any other groups, for example case managers, is subject to agreement with GP practices.

As part of this pilot implementation, Swansea University shall be seeking opinions based on your experience of using the tool.

If you experience any difficulties in using the web-tool, please call the Support Team at Health Solutions Wales on 02920 502374.

WPRS System Messages

Service Information **05/02/2009**

WPRS is released.

Currently, only **IE 7.0** and **Windows XP** support full website functionality. For best results view using **IE 7.0**.

Further Services



[My User Profile](#)



[My local Caldicott Representatives](#)



Welsh Predictive Risk Service



Sign In

Sign in to the Welsh Predictive Risk Service

Username

Password

Sign In

[Forgotten your password?](#)

New to Welsh Predictive Risk Service?

WPRS is available to users who have registered using their NHS Email as a UserID.

If you want to use WPRS follow the simple steps and sign up using the button below.

Sign Up Now

Confidential

The Data Protection Act (1998) and Computer Misuse Act (1990) cover data in this system. You must not pass the data to anyone who does not have a proper business need to use it.

This is a private NHS site used only under authorised access. Unauthorised access to this system or any of the services provided is unlawful under UK law and is considered an offence under the Computer Misuse Act 1990. Unauthorised access attempts to this site and services provided will be investigated and the offenders prosecuted.



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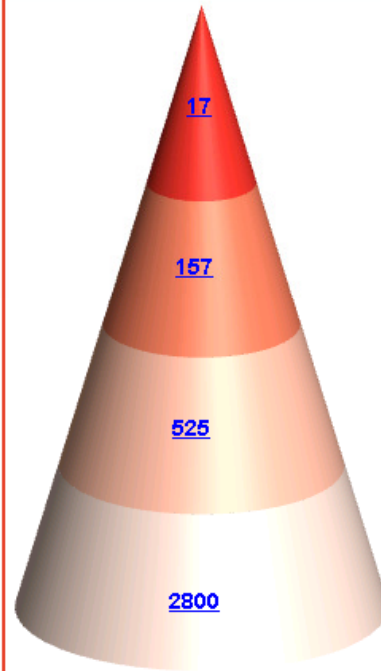
Organisation : **Dummy**

Please select the criteria and press 'Recalculate' below:

Age Group

Gender

No. of Chronic Conditions



Level 4: High Risk
(0.00 % - 0.50 %)

Level 3: Moderate Risk
(0.50 % - 5.00 %)

Level 2: Low Risk
(5.00 % - 20.00 %)

Level 1: Very Low Risk
(20.00 % - 100.00 %)

Total : 3499



Welsh Predictive Risk Service



Define Risk Threshold

Please fill in the new Risk Threshold values:

	From :	To :
Level 4: High Risk	0.00 %	<input type="text" value="0.50"/> %
Level 3: Moderate Risk	0.50 %	<input type="text" value="5.00"/> %
Level 2: Low Risk	5.00 %	<input type="text" value="20.00"/> %
Level 1: Very Low Risk	20.00 %	100.00 %

Patient Lists - Microsoft Internet Explorer

Address <https://krytendemo.hsw.wales.nhs.uk/PRISM/PatientList.aspx?Level=4&PatientCount=17>

Welsh Predictive Risk Service

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Organisation : **Dummy**

Risk Level	Age Group	Gender	Number of Chronic Conditions			
4 - High Risk	All	All	All			

NHS Number	Forename	Surname	Gender	Date of Birth	Post Code	Risk Score
4765904368	LILY	PRISM	Female	01 Jul 1964	PR99 1SM	99.94 %
6806831141	JAMES	PRISM	Male	01 May 1915	PR99 1SM	94.19 %
4192178206	RUBY	PRISM	Female	01 Apr 1958	PR99 1SM	88.80 %
6083101141	GRACE	PRISM	Female	01 Feb 1937	PR99 1SM	87.13 %
6178301141	RUBY	PRISM	Female	01 Apr 1925	PR99 1SM	80.74 %
6462198041	HARRY	PRISM	Male	01 Oct 1930	PR99 1SM	69.35 %
6664745802	CHLOE	PRISM	Female	01 Jan 1917	PR99 1SM	66.29 %
6812693561	DANIEL	PRISM	Male	01 Apr 1942	PR99 1SM	64.88 %
4559918468	CHARLIE	PRISM	Male	01 May 1958	PR99 1SM	63.05 %
6490268041	HARRY	PRISM	Male	01 Sep 1920	PR99 1SM	60.37 %
6293688041	OLIVIA	PRISM	Female	01 Mar 1928	PR99 1SM	59.25 %
6784401141	LILY	PRISM	Female	01 Jul 1937	PR99 1SM	58.79 %
6163338041	THOMAS	PRISM	Male	01 Jun 1910	PR99 1SM	57.81 %
4210669206	OLIVER	PRISM	Male	01 Nov 1957	PR99 1SM	57.07 %
6394151141	EMILY	PRISM	Female	01 Feb 1926	PR99 1SM	55.00 %
6754001141	LILY	PRISM	Female	01 Aug 1925	PR99 1SM	54.99 %
6163187041	RUBY	PRISM	Female	01 Mar 1920	PR99 1SM	54.67 %

First (Page 1 of 1) << Previous Next >>


■ Risk score unchanged since last month
 ▲ Risk score increased since last month
 ▼ Risk score decreased since last month

Done Local intranet


Risk History with Risk Variables - Microsoft Internet Explorer

File Edit View Favorites Tools Help


Address <https://krytendemo.hsw.wales.nhs.uk/PRISM/RiskHistoryVariable.aspx>



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Nhs Number	Name	Date Of Birth	Gender	Post Code	Predictive Risk Score
4765904368	PRISM, LILY	01 Jul 1964	Female	PR99 1SM	99.94

Demographic Variables in Risk History

Risk Variable	Value
Age	44
Gender	Female
Deprivation	58.60

GP Variables in Risk History

Hospital Admission Variables in Risk History

Outpatient Variables in Risk History

Chronic Conditions in Risk History


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Nhs Number	Name	Date Of Birth	Gender	Post Code	Predictive Risk Score
4765904368	PRISM, LILY	01 Jul 1964	Female	PR99 1SM	99.94

Demographic Variables in Risk History

GP Variables in Risk History

Risk Variable	Value
Neurotic, personality and other nonpsychotic disorders	Yes
Poisoning	No
Sprains and strains of joints and adjacent muscles	No
Mental and behavioural disorders	No
GI disorders	Yes
Corticosteroid Clinical Use	Yes
Loop Diuretics	Yes
Narcotic Analgesics	Yes
Other Antidepressant Drugs	Yes
Penicillinase Res Penicillins	2
Sulphonamides & Trimethoprim	No
Ulcer-Healing Drugs	Yes
Vitamin B Group	No
Polypharmacy	18
Patient has stated that they are a current smoker	No
Number of chronic conditions (PRISM model)	1

Hospital Admission Variables in Risk History

Outpatient Variables in Risk History


Chronic Conditions in Risk History

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Nhs Number	Name	Date Of Birth	Gender	Post Code	Predictive Risk Score
4765904368	PRISM, LILY	01 Jul 1964	Female	PR99 1SM	99.94

Demographic Variables in Risk History

GP Variables in Risk History

Hospital Admission Variables in Risk History

Risk Variable	Value
Inpatient admission with diagnosis Cerebral Palsy and other paralytic syndromes	No
Inpatient admission with diagnosis Symptoms and signs involving the circulatory and respiratory systems	No
Inpatient admission with diagnosis Symptoms and signs involving the digestive system and abdomen	Yes
Inpatient admission with diagnosis Abnormal findings on examination of urine, without diagnosis	No
Inpatient admission with Alcohol related diagnosis	No
Emergency admissions in last 12 months of history period	17
Non-emergency admission	Yes
Inpatient day & night cases	No

Outpatient Variables in Risk History

Chronic Conditions in Risk History


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Nhs Number	Name	Date Of Birth	Gender	Post Code	Predictive Risk Score
4765904368	PRISM, LILY	01 Jul 1964	Female	PR99 1SM	99.94

Demographic Variables in Risk History

GP Variables in Risk History

Hospital Admission Variables in Risk History

Outpatient Variables in Risk History

Risk Variable	Value
OP visit following an emergency admission	Yes
OP visit with referral from a GP	Yes
OP visit with outcome - Another appointment given	Yes

Chronic Conditions in Risk History


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Nhs Number	Name	Date Of Birth	Gender	Post Code	Predictive Risk Score
4765904368	PRISM, LILY	01 Jul 1964	Female	PR99 1SM	99.94

Demographic Variables in Risk History

GP Variables in Risk History

Hospital Admission Variables in Risk History

Outpatient Variables in Risk History

Chronic Conditions in Risk History

Risk Variable	Value
Asthma	Yes
Coronary Heart Disease	No
Diabetes	No
CHF (LTC)	No
COPD (LTC)	No
Epilepsy (LTC)	Yes

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Patient Risk History - Microsoft Internet Explorer

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Welsh Predictive Risk Service

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Go To: 1 of 1 Find:

Historic Risk Scores for NHS Number : 4765904368

Month	Risk Score
Jan	5
Feb	5
Mar	5
Apr	5
May	5
Jun	100

Key
Risk Score

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Done Local intranet



Trend

Model predicts:					
Details					
Examples					



Trend

Model predicts:	Cost				
Details	Model predicts which patients will <i>become</i> high-cost over next 6 or 12 months				
Examples	Low-cost patient this year will become high-cost next year				



Trend

Model predicts:	Cost	Event			
Details	Model predicts which patients will <i>become</i> high-cost over next 6 or 12 months	Model predicts which patients will have an event that can be avoided			
Examples	Low-cost patient this year will become high-cost next year	Patient will be hospitalized Patient will have diabetic ketoacidosis			



Trend

Model predicts:	Cost	Event	Actionability		
Details	Model predicts which patients will <i>become</i> high-cost over next 6 or 12 months	Model predicts which patients will have an event that can be avoided	Model predicts which patients have features that can readily be changed		
Examples	Low-cost patient this year will become high-cost next year	<p>Patient will be hospitalized</p> <p>Patient will have diabetic ketoacidosis</p>	<p>Patient has angina but is not taking aspirin</p> <p>Patient does not have pancreatic cancer (Ambulatory Care Sensitive)</p>		



Trend

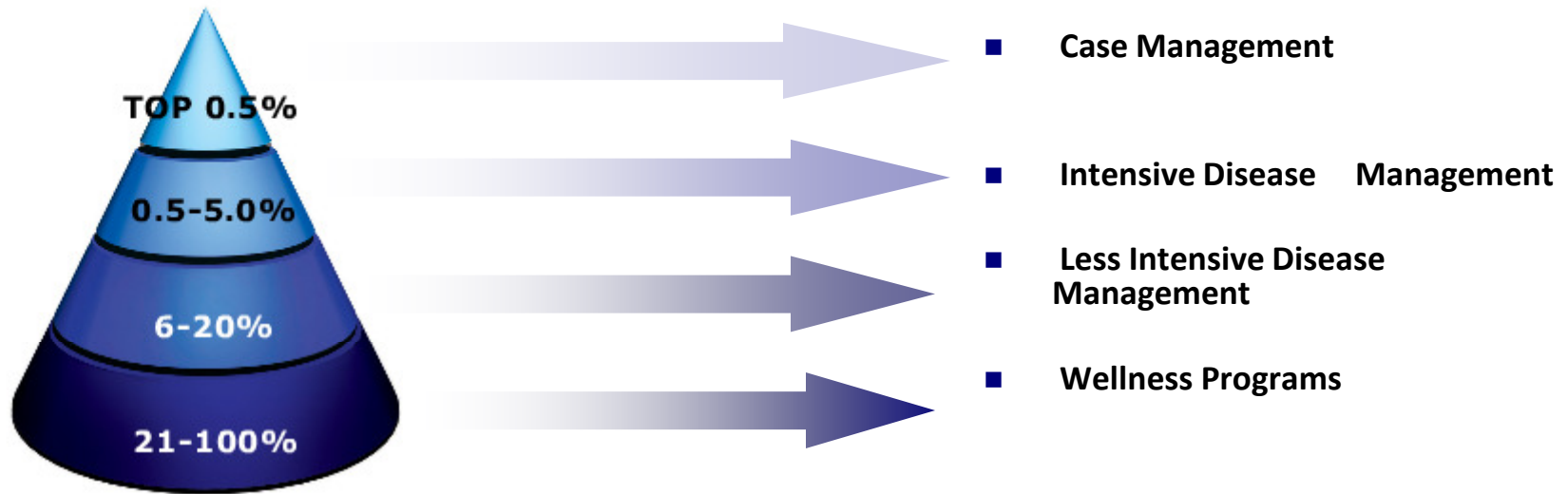
Model predicts:	Cost	Event	Actionability	Readiness to engage	
Details	Model predicts which patients will <i>become</i> high-cost over next 6 or 12 months	Model predicts which patients will have an event that can be avoided	Model predicts which patients have features that can readily be changed	Model predicts which patients are most likely to engage in upstream care	
Examples	Low-cost patient this year will become high-cost next year	<p>Patient will be hospitalized</p> <p>Patient will have diabetic ketoacidosis</p>	<p>Patient has angina but is not taking aspirin</p> <p>Patient does not have pancreatic cancer (Ambulatory Care Sensitive)</p>	<p>Patient does not abuse alcohol</p> <p>Patient has no mental illness</p> <p>Patient previously compliant</p>	



Trend

Model predicts:	Cost	Event	Actionability	Readiness to engage	Receptivity
Details	Model predicts which patients will <i>become</i> high-cost over next 6 or 12 months	Model predicts which patients will have an event that can be avoided	Model predicts which patients have features that can readily be changed	Model predicts which patients are most likely to engage in upstream care	Model predicts what mode and form of intervention will be most successful for each patient
Examples	Low-cost patient this year will become high-cost next year	<p>Patient will be hospitalized</p> <p>Patient will have diabetic ketoacidosis</p>	<p>Patient has angina but is not taking aspirin</p> <p>Patient does not have pancreatic cancer (Ambulatory Care Sensitive)</p>	<p>Patient does not abuse alcohol</p> <p>Patient has no mental illness</p> <p>Patient previously compliant</p>	<p>Patient prefers email rather than telephone</p> <p>Patient prefers male voice rather than female</p> <p>Readiness to change</p>

How the output of predictive models are used



Potential Misuses



- Dumping
- Cream-skimming
- Skimping

Policy implications: **United Kingdom**

- All four Home Nations have invested in national predictive tools to identify people at risk of unplanned hospital admissions.
- These administrations should now look at investing in new generations of predictive tools that take account of
 - Quality gaps
 - Motivation
 - Receptivity
- There are serious implications for tackling healthcare inequalities here: the most disadvantaged in society are typically the least likely to be motivated and the most difficult to engage.





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