

Introducing Artificial Intelligence Technology to Risk Stratify Elective Waiting Lists across Cheshire & Merseyside

Update on project progress and next steps



Helping put the right patient, in the right environment, with the right team, at the right time.

NHS England and NHS Improvement



Data requirements from the Trust and system outputs

Patient co-morbidity/diagnosis data

- Some trusts collate co-morbidity data routinely based on previous admission coding
- In the absence of this, the co-morbidity data for waiting list patients can be extracted from a minimum of one year download of all coded data (HES data)
- If a patient has no preceding admission, an assumption will be made that there are no significant co-morbidities

Procedure data

- All patients are given an intended procedure code
- Can be accessed from NHS Portal or extracted from text if codes are not routinely recorded



System outputs

- Patient identifier (hospital number)
- Age
- Date first listed
- Current length of time on the waiting list
- Intended procedure
- Intended procedure code
- Suggested priority “P” code
- Overall risk of death
- Overall risk of complication
- List of all complications with a risk over 2.5% (this can be customised)
- Change in mortality risk if surgery delayed
- Change in overall complication risk if surgery delayed
- Change in complication profile if surgery delayed

How can Trusts use these data?

Improved Clinical Prioritisation

Site specific planning

Workforce planning

Prehabilitation

Health Inequalities

Reduced emergency admissions

Reduced administration burden

Emerging findings from Pilots

WL management / data cleansing

- 15% of P codes don't line up with AI system
- Ability to prioritise within P cohorts and waiting time brackets
- Duplicates on WL
- Cohort patients by site/IS/cold
- System view – PTL at system level, and cross referencing between trusts (NHS number enables enhanced risk management across sites)

Efficiencies & focussing resources

- Time taken to validate - 20k x 5 mins = 417 sessions (£187k)
 - Opportunity cost – lost activity
- Prehabilitation to be focussed on high risk patients (e.g. chest infections)

Quality / Outcomes

- Deterioration of patients increasing LOS and cost (5k patients found to have increased risk of complication over 6 month period. 2.5k x 1day increased LOS = 2.5k saved bed days)
- Conditions deteriorating and risk of ED presentation

Procedure	Mortality Risk (%)	Overall complication risk (%)	Dominant complication (%)	Mortality risk if delayed (%)	Complication risk if delayed %	Dominant complication if delayed (%)
Colectomy cancer	0.6	7.3	Chest infection 2.5	2.6	12.0	Chest infection 8.0
Colectomy benign	0.4	6.1	Chest infection 2.4	1.4	9.9	Chest infection 4.7
Appendectomy	0.3	5.3	Wound infection 3.3	0.4	6.1	Wound infection 5.0
Small bowel resection	0.5	7.0	Chest infection 2.4	1.2	9.4	Chest infection 4.6
Partial gastrectomy	0.5	7.0	Chest infection 6.0	1.5	10.7	Chest infection 7.0
Cholecystectomy Low risk	0.3	5.3	Chest infection 3.1	0.6	9.0	Chest infection 5.0
Cholecystectomy Moderate risk	0.7	11.3	Chest infection 4.0	2.1	16.7	Chest infection 7.4
AAA repair	2.3	11.4	Chest infection 5.0	36.0	39.0	Chest infection 16.7
Aorto-femoral bypass	1.2	9.4	Chest infection 5.0	4.6	24.0	Chest infection 6.3
Hernia	0.3	5.3	Wound infection 1.5	0.9	9.5	Wound infection 2.7
TURP	0.8	10.2	UTI 3.9	1.0	11.6	UTI 4.0
Cervical disc surgery	0.5	7.6	Chest infection 5.3	0.7	9.7	Chest infection 5.9





	STHK	WHH	LUFHT	Total	Percentage
Patients analysed	15846	10471	16265	42582	
minus: Endoscopies/ OP procedures	6199	4451	587	11237	26%
minus: No recorded procedure	216	236	51	503	1%
minus: Duplicate entries	21	156	1428	1605	4%
minus: Procedures not in COMPASS	4401	1423	2917	8741	21%
COMPASS procedures	5009	4205	11282	20496	48%

Current risk - complications	Total	Risk of complications in 6 months						Total Patients
		Risk of complications	5 to 10%	10 to 20%	20 to 40%	40 to 60%	60 to 80%	
5 to 10%	14290	5 to 10%	12992	1118	180			14290
10 to 20%	2907	10 to 20%		2332	531	32	12	2907
20 to 40%	1912	20 to 40%			1540	303	69	1912
40 to 60%	861	40 to 60%				665	196	861
60 to 80%	468	60 to 80%					468	468
Total Patients	20438	Total Patients	12992	3450	2251	1000	745	20438

Current risk of mortality	Total	Risk of mortality in 6 months							Total Patients
		Current risk of mortality	0 to 5%	5 to 10%	10 to 20%	20 to 40%	40 to 60%	60 to 80%	
0 to 5%	18657	0 to 5%	18034	381	196	34		12	18657
5 to 10%	903	5 to 10%		686	88	106	14	9	903
10 to 20%	480	10 to 20%			359	55	59	7	480
20 to 40%	279	20 to 40%				212	23	44	279
40 to 60%	83	40 to 60%					68	15	83
60 to 80%	36	60 to 80%						36	36
Total Patients	20438	Total Patients	18034	1067	643	407	164	123	20438

Vascular Surgery	Average mortality risk	Average overall complication risk	Chest infection risk	Myocardial infarction risk	Pulmonary embolus risk	Deep venous thrombosis risk
Current risk	7.3	28.7	4.6	1.3	1.2	2.3
Risk if delay occurs	20.3	42.3	7.3	2.3	1.8	2.9

Within the pilot trusts, the C2-AI data predicted that **5076** (24.8%) patients across the three trusts had an increased risk of mortality of between 0.1-89.9% if surgery was delayed by six months.

The data also showed predicted that **5200** patients (25.4%) had an increased risk of complication of between 0.8-72.1%) if surgery was delayed by six months.



Site Specific Planning – Orthopaedics Regional View



- The table below provides an example of a summarised view of the elective waiting lists for Hip and Knee replacements across the 2 pilot Trusts:

St Helens & Knowsley	Number	Av wait weeks	Av mortality risk %	Av complication risk %
Total	2146	29		
Hip replacement	248	29	2.6	15.8
Knee replacement	289	28	2.8	15
Warrington & Halton				
Total	2089	33		
Hip replacement	228	36	2.5	15.1
Knee replacement	257	37	1.3	12

St Helens & Knowsley	Chest infection <5%	Haemorrhage <2.5%	DVT <2.5%	PE <2.5%
Hip	37%	78%	42%	82%
Knee	43%	92%	53%	82%
Warrington & Halton				
Hip	72%	89%	86%	84%
Knee	79%	98%	83%	89%

Current risk of mortality	Total Patients
0 to 5%	4,700
5 to 10%	149
10 to 20%	69
20 to 40%	26
40 to 60%	6
60 to 80%	1
Total Patients	4,951

Risk of mortality in 6 months

0 to 5%	5 to 10%	10 to 20%	20 to 40%	40 to 60%	60 to 80%	Total Patients
4,652	37	11				4,700
	129	12	8			149
		62	7			69
			23	3		26
				5	1	6
					1	1
4,652	166	85	38	8	2	4,951



Current risk of complications	Total Patients
5 to 10%	3,842
10 to 20%	599
20 to 40%	303
40 to 60%	152
60 to 80%	55
Total Patients	4,951

Risk of complications in 6 months

5 to 10%	10 to 20%	20 to 40%	40 to 60%	60 to 80%	100%+	Total Patients
3,473	355	14				3,842
	529	69	1			599
		278	24	1		303
			134	18		152
				55		55
3,473	884	361	159	74	-	4,951



Of all 4951 patients, the mean average risk of mortality now is 1.3% but in 6 months this will increase to 1.5%.

M: Urinary currently has the biggest mean average mortality risk at 2.1%; in 6 months this is set to be J: Other Abdominal Organs-principally Digestive with a risk of 3.9%.

J: Other Abdominal Organs-principally Digestive is the OPCS category that sees the greatest increase in mortality with a 2.8% increase from 1.1%.

For complications, the risk increases from a mean average of 10.8% now to 12% in 6 months time.

M: Urinary currently has the biggest mean average complications risk at 14.4%; in 6 months this is set to be J: Other Abdominal Organs-principally Digestive with a risk of 22.4%.

J: Other Abdominal Organs-principally Digestive is the OPCS category that sees the greatest increase in complications with a 11.5% increase from 10.9%.

* OPCS categories with less than 30 patients have been excluded from the OPCS mean calculations

Waiting List by OPCS category	Total Patients	Number of Duplicates
A: Nervous System	-	2
B: Endocrine System and Breast	407	-
C: Eye	1,069	6
D: Ear	85	-
E: Respiratory Tract	195	2
F: Mouth	114	-
G: Upper Digestive Tract	32	-
H: Lower Digestive Tract	198	-
J: Other Abdominal Organs-principally Digestive	142	2
K: Heart	-	-
L: Arteries and Veins	71	4
M: Urinary	521	4
N: Male Genital Organs	312	9
P: Lower Female genital Tract	59	-
Q: Upper Female Genital Tract	113	-
R: Female Genital Tract associated with Pregnancy, Childbirth and Puerperium	-	-
S: Skin	-	14
T: Soft Tissue	608	-
U: Diagnostic Imaging, Testing and Rehabilitation	-	-
V: Bones and Joints of Skull and Spine	1	-
W: Other Bones and Joints	1,016	-
X: Miscellaneous Operations	8	-
Y: Subsidiary Classification of Methods of Operation	-	-
Z: Subsidiary Classification of Sites of Operation	-	-
Total Patients	4,951	43



Hospital Assigned Priority	Total Patients
P1	-
P2	-
P3	-
P4	-
Routine	3,968
Urgent	976
Two week wait	7
No priority assigned	-
Total Patients	4,951



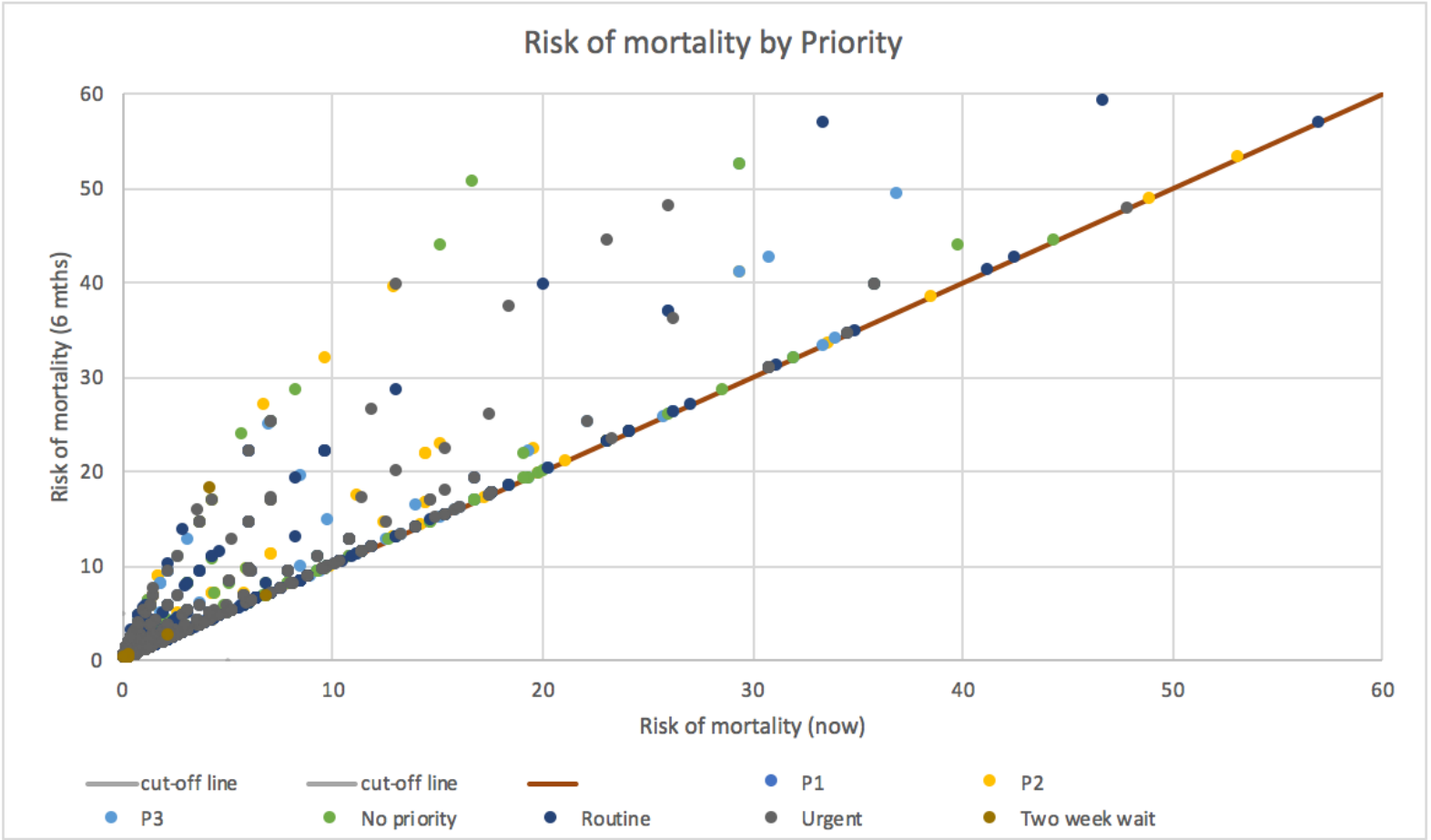
Waiting List by Time Band	Total Patients
0 to 18	2,664
18 to 26	713
26 to 40	435
40 to 52	199
52+	940
Total Patients	4,951



Patients on the surgical waiting list by quadrant



5	← change to amend the grey cut-off lines (mortality)
30	← change to amend the grey cut-off lines (complications)
Priority	← Select Priority or Time bands to display as coloured markers on the graphs



Select one or more options from the slicers to amend the pivot tables and automated text:

Select hospital priority

- P1
- P2

Select time band

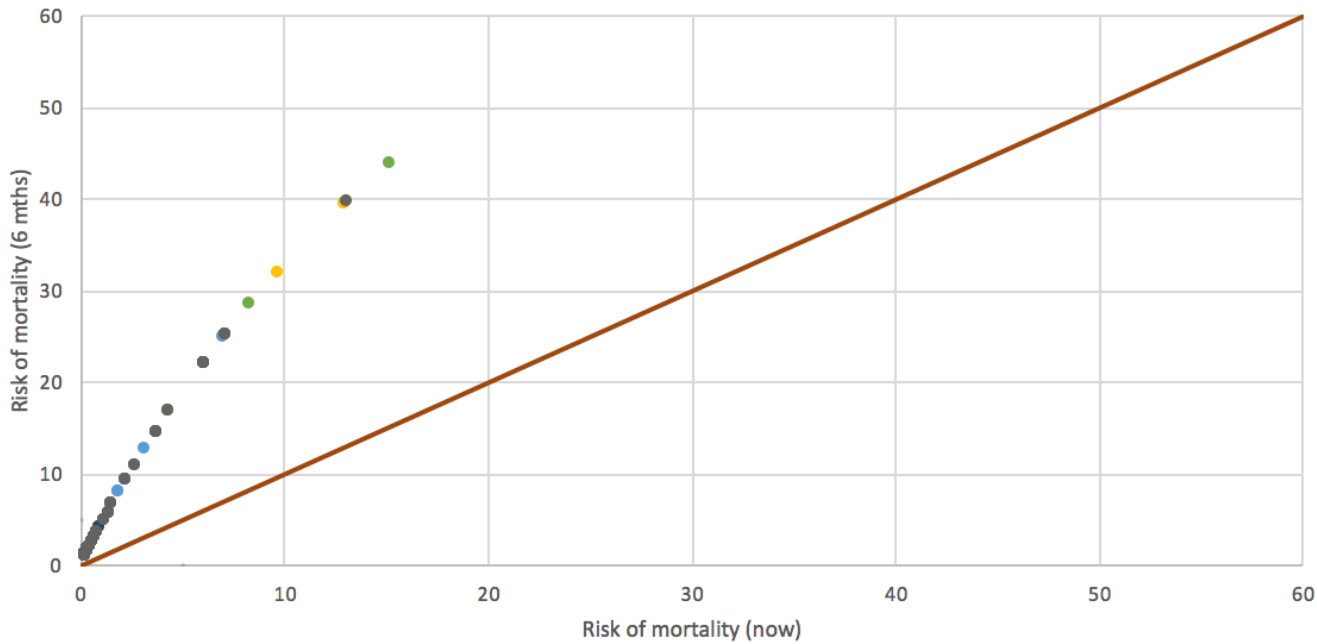
- 0 to 18
- 18 to 36

Select OPCS category

- B: Endocrine System and Breast
- D: For

- 5** ← change to amend the grey cut-off lines (mortality)
- 30** ← change to amend the grey cut-off lines (complications)
- Priority** ← Select Priority or Time bands to display as coloured markers on the graphs

Risk of mortality by Priority



- cut-off line
- cut-off line
- cut-off line
- P1
- P2
- P3
- No priority
- Routine
- Urgent
- Two week wait

Select one or more options from the slicers to amend the pivot tables and automated text:

Select hospital priority

P2

Select time band

0 to 18

Select OPCS category

B: Endocrine System and Breast

Select trust

St H&K WHH

Current risk of mortality	Risk of mortality	Total	Risk of mortality in 6 months						Total Patients
			0 to 5%	5 to 10%	10 to 20%	20 to 40%	40 to 60%	60 to 80%	
	0 to 5%	8671	8574	77	20				8671
	5 to 10%	277		239	21	17			277
	10 to 20%	137			121	14	2		137
	20 to 40%	61				51	10		61
	40 to 60%	9					8	1	9
	60 to 80%	1						1	1
	Total Patients	9156	8574	316	162	82	20	2	9156

Current risk of complications	Risk of complications	Total	Risk of complications in 6 months					Total Patients
			5 to 10%	10 to 20%	20 to 40%	40 to 60%	60 to 80%	
	5 to 10%	7176	6514	630	32			7176
	10 to 20%	992		862	129	1		992
	20 to 40%	572			510	57	5	572
	40 to 60%	291				258	33	291
	60 to 80%	125					125	125
	Total Patients	9156	6514	1492	671	316	163	9156

There are currently 61 patients on the waiting list with a mortality rate of 20-40% and 9 patients with a mortality risk between 40 and 60%.



If the same patients remain on the waiting list, in 6 months time, there will be 82 patients on the waiting list with a mortality rate of 20-40% and 20 patients with a mortality risk between 40 and 60%.

Currently there are 416 patients who have at least a 40% risk of complications but in 6 months if the patients are not treated there will be 479 patients with a 40% risk of complications.

Select hospital assigned priority

P1 P2 P3 P4

Select WL time band

0 to 18 18 to 26 26 to 40 40 to 52 52+

Select OPCS category

B: Endocri C: Eye D: Ear E: Respirat F: Mouth G: Upper L H: Lower L J: Other Al L: Arteries M: Urinary N: Male G

Further slicers to narrow down the data based on the risk of mortal

Mortality (now)

0 to 5% 10 to 20% 20 to 40% 40 to 60% 5 to 10% 60 to 80%

Mortality (6 mths)

0 to 5% 10 to 20% 20 to 40% 40 to 60% 5 to 10% 60 to 80%

Procedures by number of patients

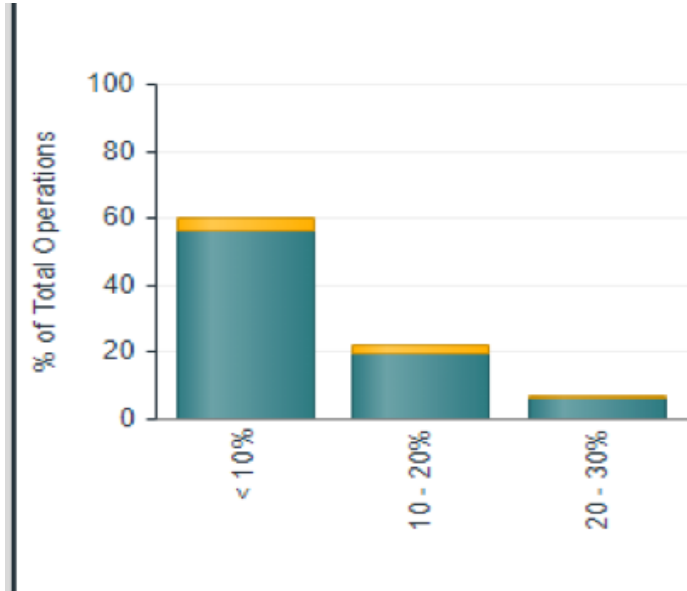
Sorted by number of patients waiting for each procedure

Record level data

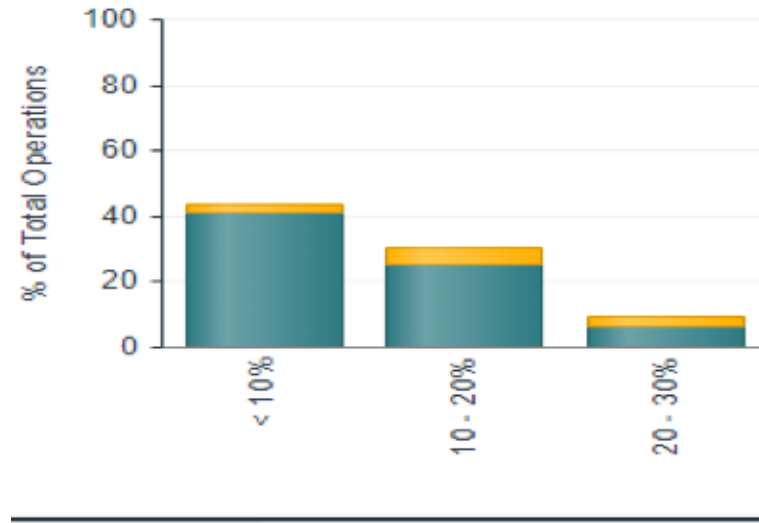
Sorted by Hospital Assigned Priority

How can Trusts use this data?

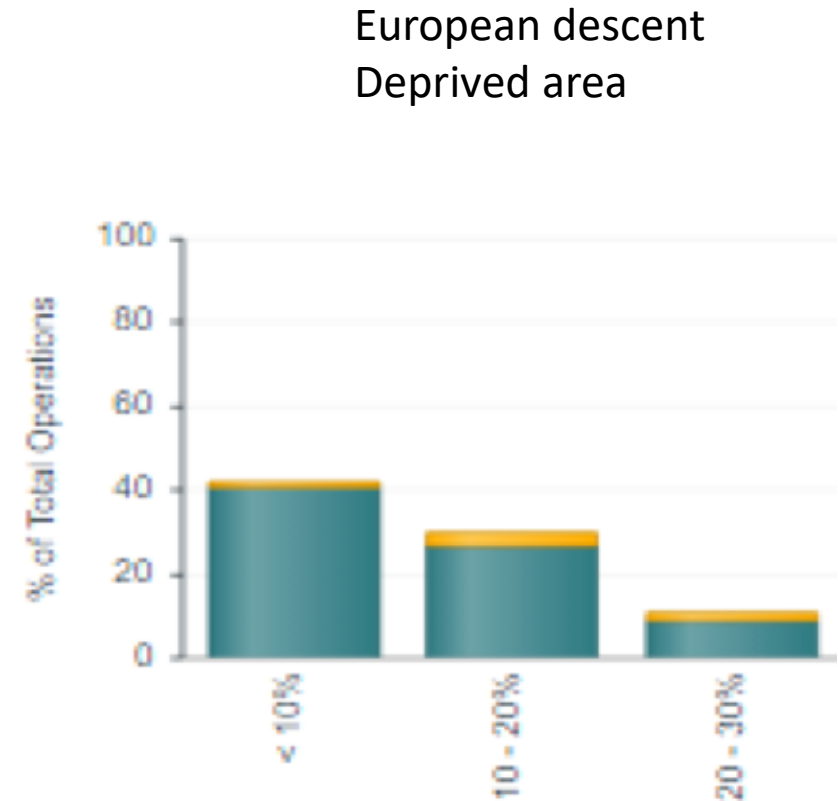
- Deprivation or Ethnicity



European descent
Affluent area



Afro Caribbean descent
Affluent area



Next Steps



- C2-AI to develop “best practice” guidance on requirements for Trusts involved in further rollout
- Clinically-led discussion about application of scoring matrix
- C&M recommendation from 3 Pilot Trusts – evaluation for national elective programme
- Prioritised roll out across remaining Cheshire & Merseyside Trusts
- Potential opportunity to pilot in large paediatric hospitals
- Note: interest from neighbouring regions (GM & L&SC) to pilot in other areas