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NHS
North of England Commissioning Support Unit

Guide to Admission Risk - Combined Predictive Model

This guide will take you through an explanation of the CPM / Admission Risk scoring rationale in the Primary Care dashboard.

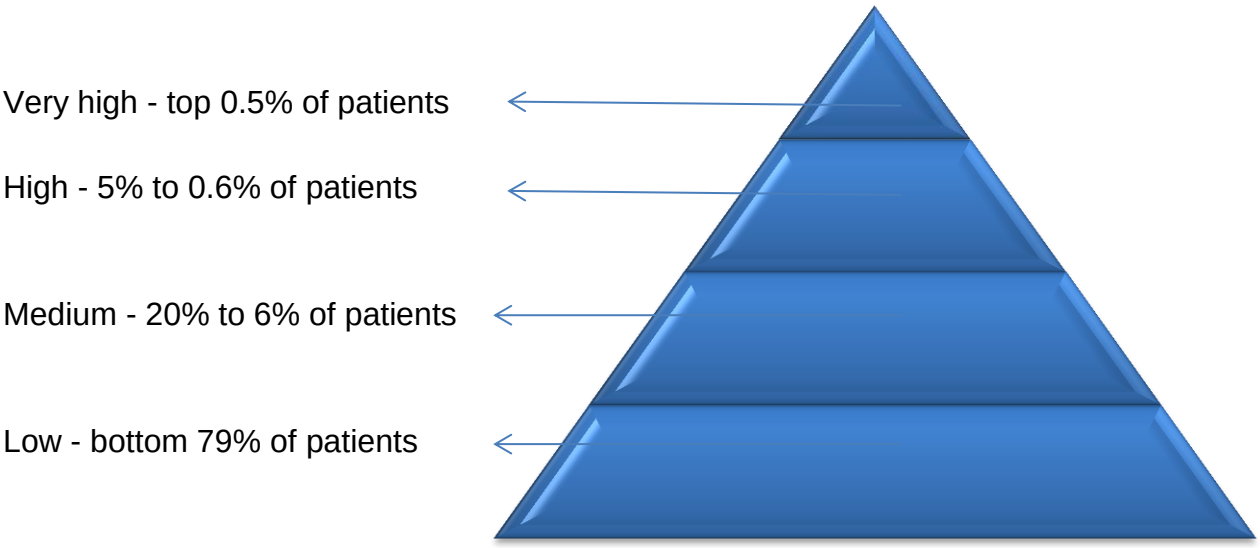
Open the Primary Care dashboard from the RAIDR portal and select the 'Admission Risk' tab.

Summary
The risk of having an emergency admission in the next year has been calculated for every patient in your practice using a methodology called the "Combined Predictive Model" or CPM. The model combines data from both secondary and primary care for each patient and uses it to work out a risk score. The risks are then grouped into very high, high, medium and low categories.

What is CPM?
The CPM model was developed by The King's Fund between 2005 and 2007 to help clinicians identify individuals at high-risk of admission to hospital. Croydon PCT piloted the practical use of CPM on behalf of the King's Fund in 2006. It developed 'virtual wards' offered solely to people at highest predicted risk. You can read the article at:
(http://tna.europarchive.org/20091005114006/http:/networks.nhs.uk/uploads/06/12/croydon_virtual_wards_case_study.pdf).
Research from Croydon has shown that CPM is approx. 85% accurate when predicted and actual admissions are compared.

The Combined Predictive Model (CPM) calculation is based on a comprehensive dataset of patient information, namely inpatient (IP), outpatient (OP), and accident & emergency (A&E) data from secondary care sources as well as GP electronic medical records. This data is used to calculate a score for each patient in the practice population, who has not dissented to share their information, and represents their risk of having an emergency admission in the next 12 months.

The scores are then grouped into the following categories using the population of the dashboard area (i.e. Tees, Durham and Darlington or Gateshead etc.) – *not* your practice population.



What affects the CPM score?

A total of 69 predictor variables (see Appendix 1) are flagged using 2 years of historical data, and a risk score between 0 and 100 is derived for each patient by combining these variables. A score of 100 indicates patients at highest risk of emergency admission in the next 12 months.

It is important to understand how certain factors affect the patient's CPM risk score. The example below shows a fictitious female patient, aged 44, and all of the relevant variables which have been flagged in her secondary & primary care records.

	Variable	Score
i	Female	0.01177781
ii	Age 44 (age group 40-59)	0.373238463
iii	A&E visit, disposal to Specialist in last 0-30days	0.632032184
iv	3+ A&E visits – last 180-365 days	0.507442635
v	1 out-patient specialty visit – last 0-30 days	0.116311541
vi	3+ out-patient visits – last 30-90 days	0.611030329
vii	11+ out-patient visits – last 365-730 days	0.364758425
viii	In-patient admission with diagnosis mental illness	0.282235541
ix	4+ distinct in-patient primary diagnosis – last 0-730 days	0.27788729
x	3+ emergency admissions – last 180-365 days	0.350301843
xi	3+ emergency admissions – last 365-730 days	0.483011573
xii	Rate of rehospitalisation of last admission	0.729074084
xiii	1 long term condition	0.119184904

The scores shown are then summed and fed into the calculation shown below:

Risk score = (1 / (1 + (exp(-1 x SUM)))) x 100

In the above example the patient has a calculated risk score of 73.8 (out of 100).

It can be seen in the example above that there are many things which affect the risk score:

- Timeliness of the data – this patient had 3+ A&E visits (variable iv) in the last 180-365 days giving a score of 0.5. As the timeline moves on and the visits are *more than* 365 days ago these visits will no longer count toward the score (although *new* A&E visits would affect future scoring).
- The variables look back over differing timelines with more recent attendances and admissions having a higher contributing score; variable iii looks at A&E visits in the last 0-30 days whereas variable xi looks at A&E visits in the last 365-730 days. Again as the timeline moves on these scores will change.
- Female patients have an extra contributing score.
- The model obviously relies on good data quality; spells, A&E attendances, OP and episodes must be coded correctly, as does Primary Care Read codes.

Long Term Conditions (LTC)

The patient in the above example has 1 LTC (from the list: Asthma, Diabetes, COPD, CAD, CHF, Hypertension, Depression and Cancer) giving a score of 0.1. Two+ LTCs from this list only raises the score to 0.2; more than 1 LTC is not a high contributing factor.

Age

The age of the patient has a significant impact on the score. For example:

- Age 0-4 scores 0.3 (note that this score is more than that for 2+ LTCs)
- Age 60-64 scores 0.6
- Age 80-84 scores 0.9

A&E attendances / non-elective admissions

More recent and more frequent A&E attendances and emergency admissions have a much higher contribution to the final risk score.

Polypharmacy

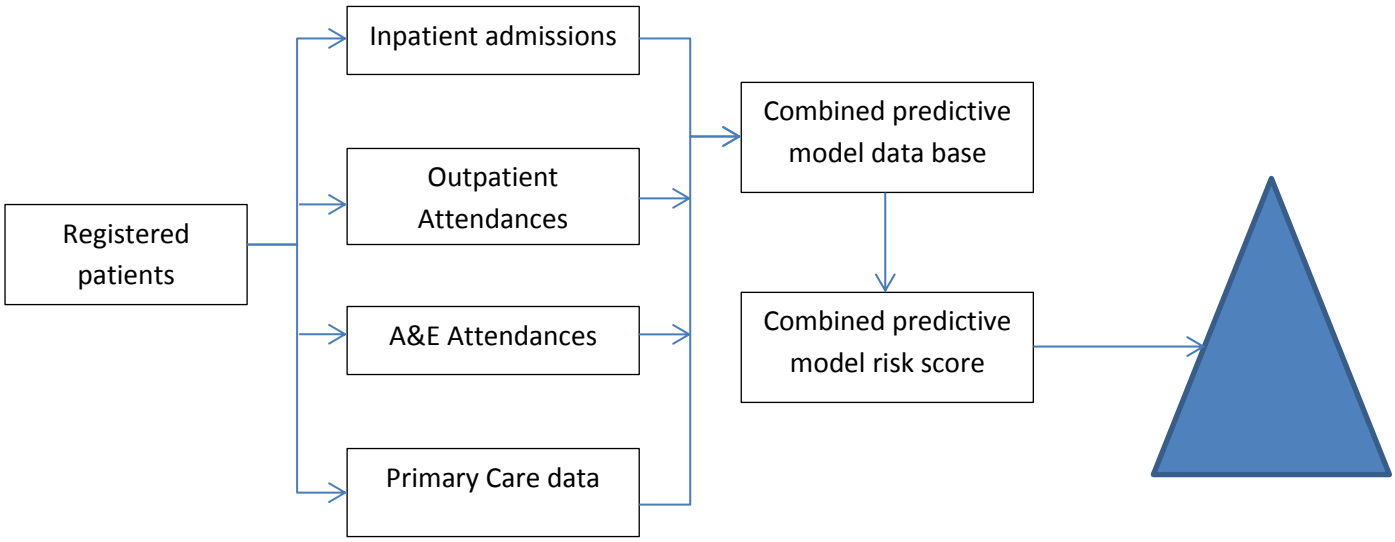
More drugs lead to a higher contributing factor:

- 1-4 unique drugs in any month (last 0-90days) scores 0.1
- 5-9 unique drugs in any month (last 0-90days) scores 0.4
- 10+ unique drugs in any month (last 0-90days) scores 0.5

Conclusion

1. These predictor variables can lead to a score for a patient who you might think should have a low risk of admission score, but they are calculated as having a high score. The explanation could be that this patient has had multiple A&E visits, for example.
2. Alternatively, you may think that a patient with COPD would have a high risk of admission but we have demonstrated that long term conditions are not, in themselves, associated with a high risk of admission.

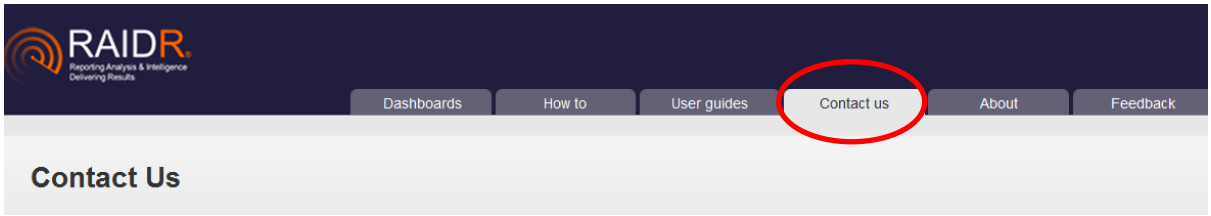
3. A patient's risk score can vary from month to month.
4. The model is very accurate; Croyden PCT found approximately 85% accuracy when their predicted and actual admissions are compared, when NHS North of Tyne ran the model on its data they found 88% accuracy when predicted and actual admissions were compared.
5. It is acknowledged that some interventions, although they may fail to reduce admissions, have other beneficial effects, such as reducing length of stay or improving patients' experience of care. CPM does not replace clinical judgement, suggest which intervention to make or take into account social circumstances.
6. The CPM can be summarised by the following flow diagram:



For more detailed information you can find the full Combined Predictive Model report and technical guide at:

http://tna.europarchive.org/20091005114006/http://networks.nhs.uk/uploads/06/12/combined_predictive_model_final_report_tech_doc.pdf

For general queries on using RAIDR please contact the RAIDR team using the details found in the 'Contact Us' menu option on the RAIDR web site.



Appendix 1 – List of variables included in the model and associated score.

Age 0-4	0.289313618
Age 15-39	0.385646264
Age 40-59	0.373238463
Age 60-64	0.630720996
Age 65-69	0.481813417
Age 70-74	0.507764968
Age 75-79	0.813038432
Age 80-84	0.959893138
Age 85-89	0.896645136
Age 90-94	1.289601194
Age 95+	1.416839346
Gender[10]	0.01177781
AE visit - Investigation X-ray - last 90 to 180 days	0.216051313
AE visit - Arrived by ambulance - last 30 to 90 days	0.187349103
AE visit - Disposal to Specialist - last 0 to 30 days	0.632032184
AE visit - Medical DX (non-injury) - last 30 to 90 days	0.223716412
AE visit - Medical DX (non-injury) - last 365 to 730 days	0.321316757
1 AE visit - last 180 to 365 days	0.042763882
2 AE visits - last 180 to 365 days	0.290049439
3+ AE visits - last 180 to 365 days	0.507442635
COPD (LTC)	0.171100735
Psychoactive substance misuse disorder	0.54193793
Psychotic disorder	0.528176075
Glomerular Filtration Rate Group 3	0.264393977
1 (from 8[11]) LTC	0.119184904
2+ (from 8) LTC	0.212972337
7+ distinct disorders (GP data)	0.096414136
1-4 unique drugs in any month - last 0 to 90 days	0.137302707
5-9 unique drugs in any month - last 0 to 90 days	0.388366204
10+ unique drugs in any month - last 0 to 90 days	0.490961533
Bronchodilator preparations - last 0 to 30 days	0.230925277
Bronchodilator preparations - last 30 to 90 days	0.397601369
Bronchodilator preparations - last 90 to 180 days	0.339967925
Bronchodilator preparations - last 180 to 365 days	-0.403051621
Bronchodilator preparations - last 365 to 730 days	-0.176615641
In-patient admission with diagnosis Mental illness - last 0 to 730 days	0.282235541
2 distinct in-patient primary diagnosis (any episode) - last 0 to 730 days	0.132210548
3 distinct in-patient primary diagnosis (any episode) - last 0 to 730 days	0.129497741
4+ distinct in-patient primary diagnosis (any episode) - last 0 to 730 days	0.27788729
Emergency admission for impactable condition (HRG code) - last 0 to 30 days	0.482474391

Emergency admission for impactable condition (HRG code) - last 30 to 90 days	0.265806985
Emergency admission for impactable condition (HRG code) - last 90 to 180 days	0.260367409
Emergency admission for impactable condition (HRG code) - last 180 to 365 days	0.336849464
1+ Emergency admission - last 0 to 30 days	0.948115234
1 Emergency admission - last 30 to 90 days	0.476647042
2+ Emergency admissions - last 30 to 90 days	1.11137369
1 Emergency admission - last 90 to 180 days	0.346261242
2+ Emergency admissions - last 90 to 180 days	0.567774763
1 Emergency admission - last 180 to 365 days	0.20977492
2 Emergency admissions - last 180 to 365 days	0.352014497
3+ Emergency admissions - last 180 to 365 days	0.350301843
1 Emergency admission - last 365 to 730 days	0.312027413
2 Emergency admissions - last 365 to 730 days	0.32371827
3+ Emergency admissions - last 365 to 730 days	0.483011573
Average number of episodes per Emergency admissions >=3	0.30864326
Observed/Expected ratio for rate of rehospitalisation for hospital of last admission	0.721855529
1 out-patient specialty visit - last 0 to 30 days	0.116311541
2 out-patient specialty visits - last 0 to 30 days	0.178716728
3+ out-patient specialty visits - last 0 to 30 days	0.291934635
1 out-patient specialty visit - last 30 to 90 days	0.150062538
2 out-patient specialty visits - last 30 to 90 days	0.151688397
3+ out-patient specialty visits - last 30 to 90 days	0.611030329
1-5 out-patient specialty visits - last 365 to 730 days	0.182179996
6-10 out-patient specialty visits - last 365 to 730 days	0.186734201
11+ out-patient specialty visits - last 365 to 730 days	0.364758425
OP visit - Source of referral not an Acc & Emergency - last 0 to 30 days	0.101656166
OP visit - Source of referral not an Acc & Emergency - last 30 to 90 days	0.322319293
Smoking status 'yes' last 0-365 days multiplied by Asthma (LTC)	0.355326713
11+ OP visits (last 0 to 730 days) multiplied by COPD (LTC)	-0.736470348