Development of a Computer Aided Risk Score (CARS) for use in hospital medicine

Dr Claire Marsh and Dr Judith Dyson

24th January 2019

Research & Project Team

- Statistics
  - Muhammad Faisal (UoB)
  - Andy Scally (UoB)
- Qualitative research
  - Judith Dyson (UoH)
- Patient & Public Involvement
  - Claire Marsh (BIHR)
- Project Management
  - Natalie Jackson (IA)
- Clinical lead
  - Donald Richardson (York)
- Principal Investigator
  - Mohammed A Mohammed (UoB & BIHR)
- Site specific clinical leads
  - Donald Richardson (York)
  - Kevin Speed (NLAG)
- Site specific project leads
  - Jeremy Daws (NLAG)
  - Chris Foster (York)
- Site specific IT leads
  - Robin Howes (NLAG)
  - Kevin Beaton (York)

Supported by the Health Foundation

Ethical approval from The Yorkshire & Humberside Leeds West Research Ethics Committee (ref. 173753)

2

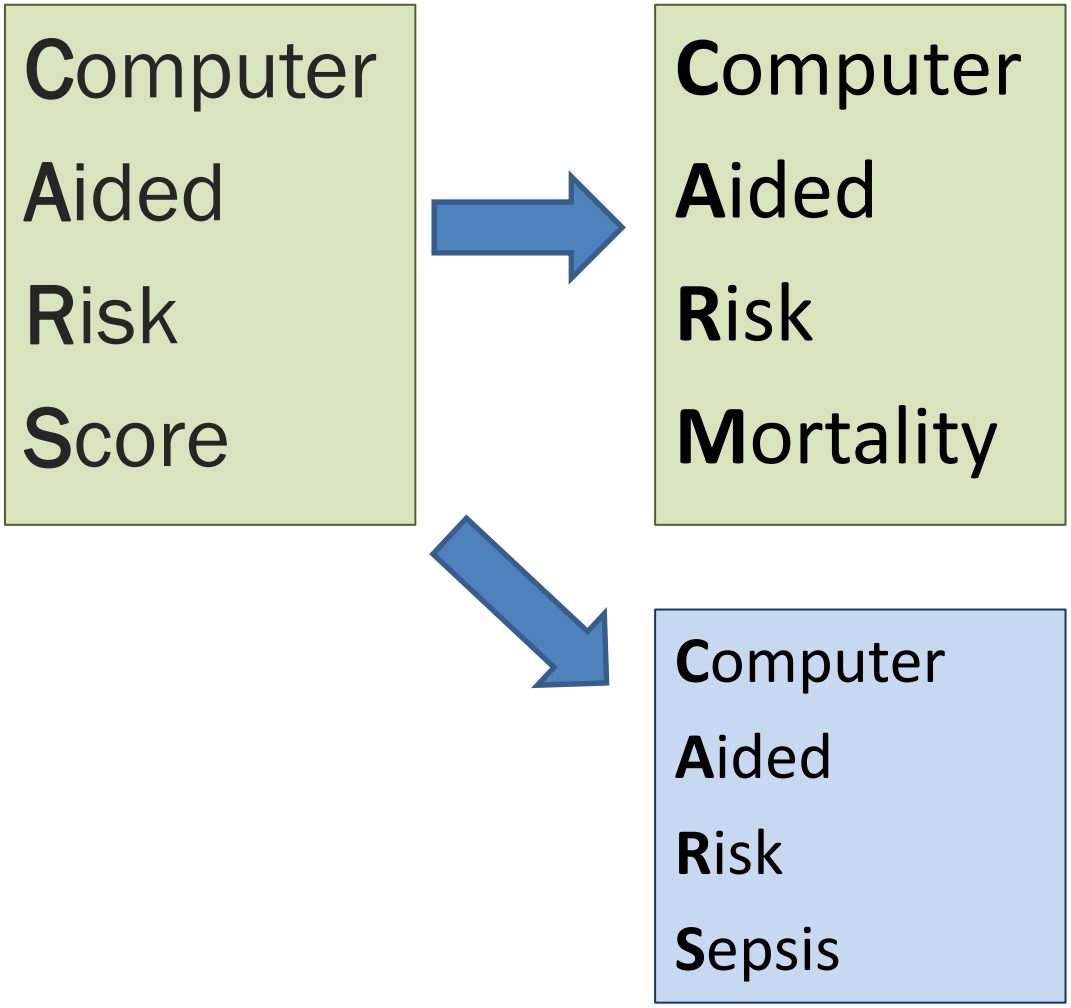
Papers

- Faisal, M., Scally, A., Richardson, D., Beatson, K., Howes, R., Speed, K. and Mohammed, M.A., 2018. Development and external validation of an automated computer-aided risk score for predicting sepsis in emergency medical admissions using the patient's first electronically recorded vital signs and blood test results. *Critical care medicine*, *46*(4), pp.612-618.
- Development and validation of a novel computer-aided score to predict the risk of in-hospital mortality for acutely ill medical admissions in two acute hospitals using their first electronically recorded blood test results and vital signs: a cross-sectional study. BMJ Open
- Practitioner and patient involvement in the implementation of a novel automated Computer Aided Risk Score (CARS) predicting the risk of death following emergency medical admission to hospital: A qualitative study BMJ Open – in press
- A novel automated computer aided risk of mortality score compares favourably with medical judgements in predicting a patient's risk of mortality following emergency medical admission European Journal of Internal Medicine – under review

Development of CARS

- 5% of deaths preventable
- Of these 30% attributable to poor clinical monitoring
- NEWS is generally used to predict deterioration
- What if we combine with blood tests?

Evolving score set / names



NEWS

Chart 1: National Early Warning Score (NEWS)*

PHYSIOLOGICAL PARAMETERS	3	2	1	0	1	2	3
Respiration Rate	≤8		9 - 11	12 - 20		21 - 24	≥25
Oxygen Saturations	≤91	92 - 93	94 - 95	≥96			
Any Supplemental Oxygen		Yes		No			
Temperature	≤35.0		35.1 - 36.0	36.1 - 38.0	38.1 - 39.0	≥39.1	
Systolic BP	≤90	91 - 100	101 - 110	111 - 219			≥220
Heart Rate	≤40		41 - 50	51 - 90	91 - 110	111 - 130	≥131
Level of Consciousness				A			V, P, or U

*The NEWS initiative flowed from the Royal College of Physicians' NEWSDIG, and was jointly developed and funded in collaboration with the Royal College of Physicians, Royal College of Nursing, National Outreach Forum and NHS Training for Innovation.

Royal College of Physicians

NHS Training for Innovation

Paper based NEWS unreliable
Electronic NEWS reliable

"Patients die not from their disease but from the disordered physiology caused by the disease."
McGinley A, Pearse RM. A national early warning score for acutely ill patients. BMJ 2012;345:e5310

Proposal

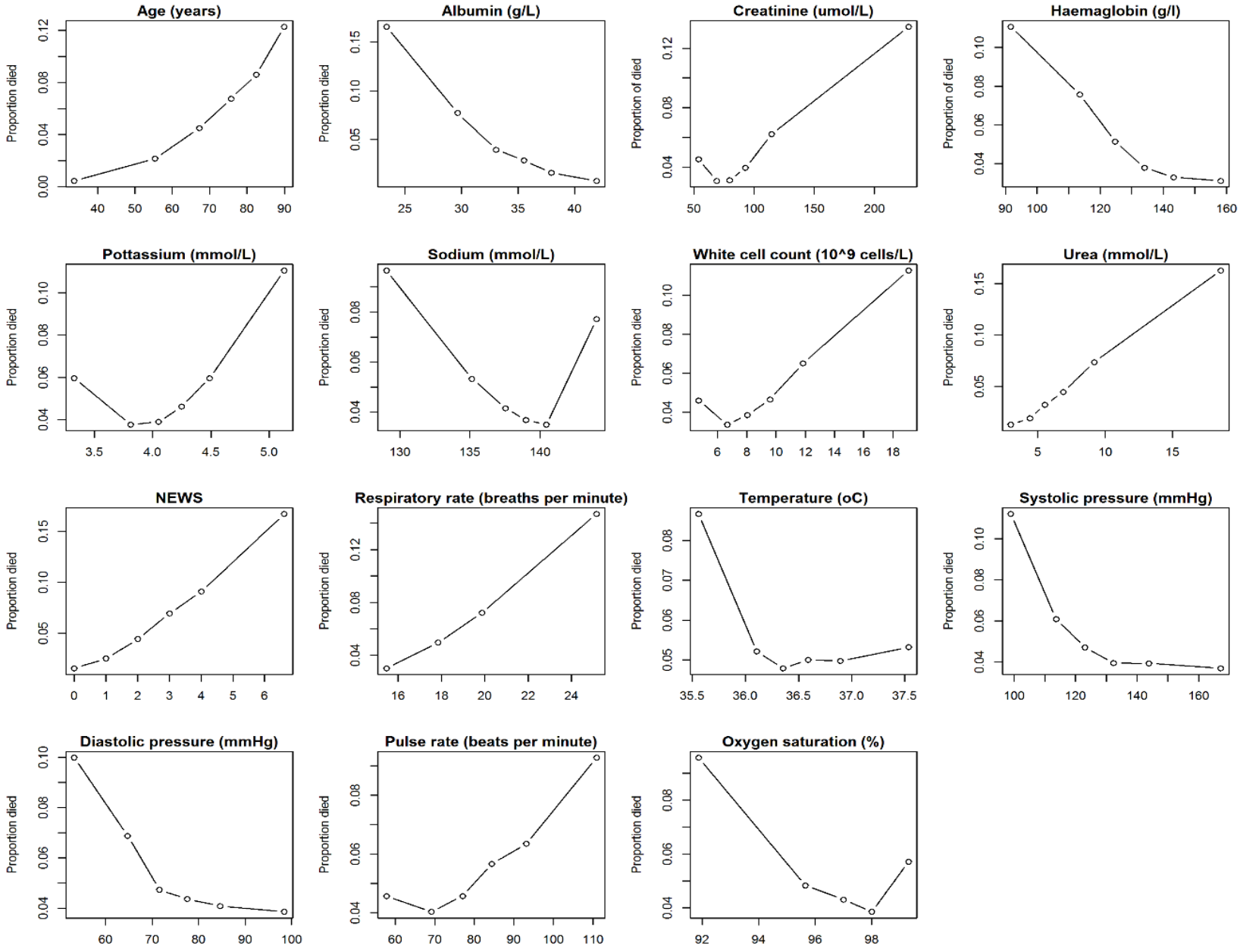
- For each emergency medical patient
- Automatically report the risk of mortality using
  - Risk equations based on NEWS (no blood tests)
  - If blood test results available, then use equation based on NEWS + Blood test results

Setting

- Acute hospitals
  - York Teaching Hospital NHS Foundation Trust
    - ICT Champion of the Year in the BT E-Health Insider Awards 2008
  - Northern Lincolnshire & Goole (NLAG) NHS Foundation Trust
    - Electronic NEWS
- Focus
  - Emergency medical admissions (aged 16+ years)

Data used to create score

- Age
- Sex
- First recorded
  - eNEWS (electronic National Early Warning Score including subcomponents)
  - AKI stage
  - Albumin
  - Creatinine
  - Haemoglobin
  - Potassium
  - Sodium
  - Urea
  - White cell count


Age (years)
Albumin (g/L)
Creatinine (umol/L)
Haemaglobin (g/l)
Pottassium (mmol/L)
Sodium (mmol/L)
White cell count (10^9 cells/L)
Urea (mmol/L)
NEWS
Respiratory rate (breaths per minute)
Temperature (oC)
Systolic pressure (mmHg)
Diastolic pressure (mmHg)
Pulse rate (beats per minute)
Oxygen saturation (%)
Proportion died
Proportion of died

CARM Equation

y ~ -0.084160939285938 3 + 0.272270268619721 * male + 0.061901476718729 4 * age - 0.095337294428103 9 * ALB + 20.415241403414 4 * log_CRE + 0.003064249646094 4 * HB + 0.079591659196525 9 * log_POT - 0.010710327681023 9 * SOD + 1.049509623075 * log_WBC + 0.996715670424129 * log_URE + 1.44909779844291 * AKI1 + 1.91817976736971 * AKI2 + 0.60888289905878 * AKI3 + 0.057193959602428 1 * NEWS + 0.642504494631563 * log_resp - 0.246217482730957 * temp + 0.176924987639937 * log_dias - 0.466876326689903 * log_syst + 0.426252285290785 * log_pulse - 0.022733748059009 * sat + 0.469824575364534 * sup + 1.27597597159774 * alert1 + 0.674577860317733 * alert2 + 1.75125534793613 * alert3 - 0.008157650889767 6 * age_log_wbc - 1.30709428996164 * log_cre_log_wbc + 12.7544970609909 * aki3_log_cre

Practitioner and Patient Involvement in the CARS project

Project Advisory Group

- Different staff groups from each Trust
  - IT
  - Medical leadership
  - Nursing leadership

- Patient advisors
  - 3 members of the Bradford Univ Faculty of Health Studies Service User & Carer Group.

Qualitative research aims

To establish

i) health care practitioner (staff) and service user/carer (SU/C) views on the potential value, unintended consequences and concerns associated with the development of the CARs and

ii) staff views on how CARs should be adopted in practice/implementation needs.

Method

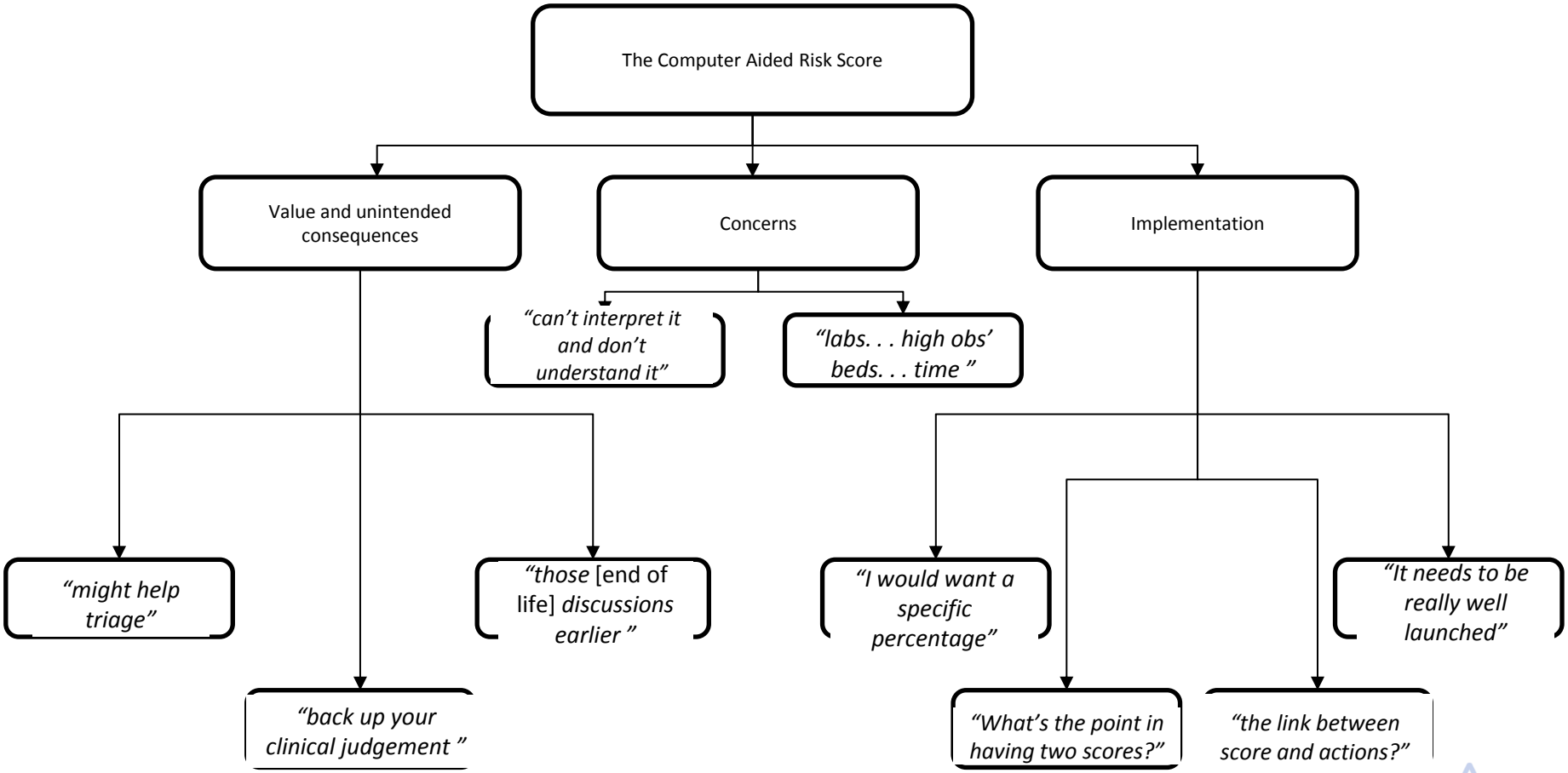
- Focus Groups in two rounds
- Round one – Staff (n=17, 2FGs) and SU/C (n=11, 2FGs):
  - Presentation about CARS (rationale and development)
  - Discussion relating to potential value, unintended consequences and concerns
- Round two – Staff (n=28, 6 FGs):
  - Vignettes to “try” the score
  - Discussion relating to implementation needs

*co-designed (content, planning and execution) researchers and SURG

Analysis

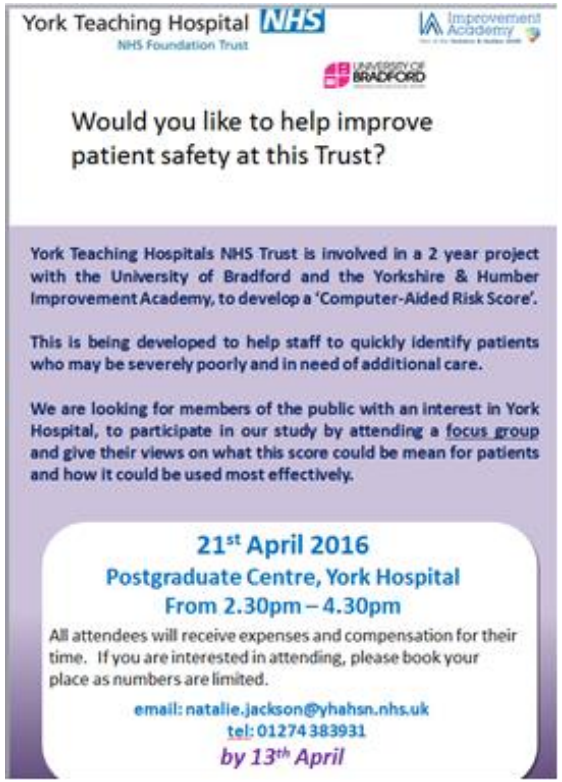
- Audio recorded, transcribed verbatim, NVIVO
- All data, thematic analysis according to the aims

Themes resulting from data analysis according to the study aims



Accessing service users/carers

- Focus group advisory session with Bradford University Service User/Carer group
- Recruitment to focus groups via Patient Experience Teams at the two Trusts



Useful alert BUT should not over-rule judgement

As long as it's another helpful factor in deciding what to do as opposed to being the determining factor because that would frighten me a lot if it was the determining factor

Anything to improve patient outcome…

There's a good deal of suspicion in the general public of 'computer says'….I'd rather a doctor exercise clinical judgement

The score could be an aid to communication?

You need to feel confident as a relative that if there is a change in score there is an agreement it would be discussed with you….

If he had the score – today this is how bad she actually is it's likely to be soon - that would have helped him deal with the situation better

I'm not persuaded that the population in its entirety actually can take in the detail, so if you start bombarding them with figures – some people just shut down

I think if the family are told they are gravely ill that would be more human than giving them a score of say 8.4

Impact on project team

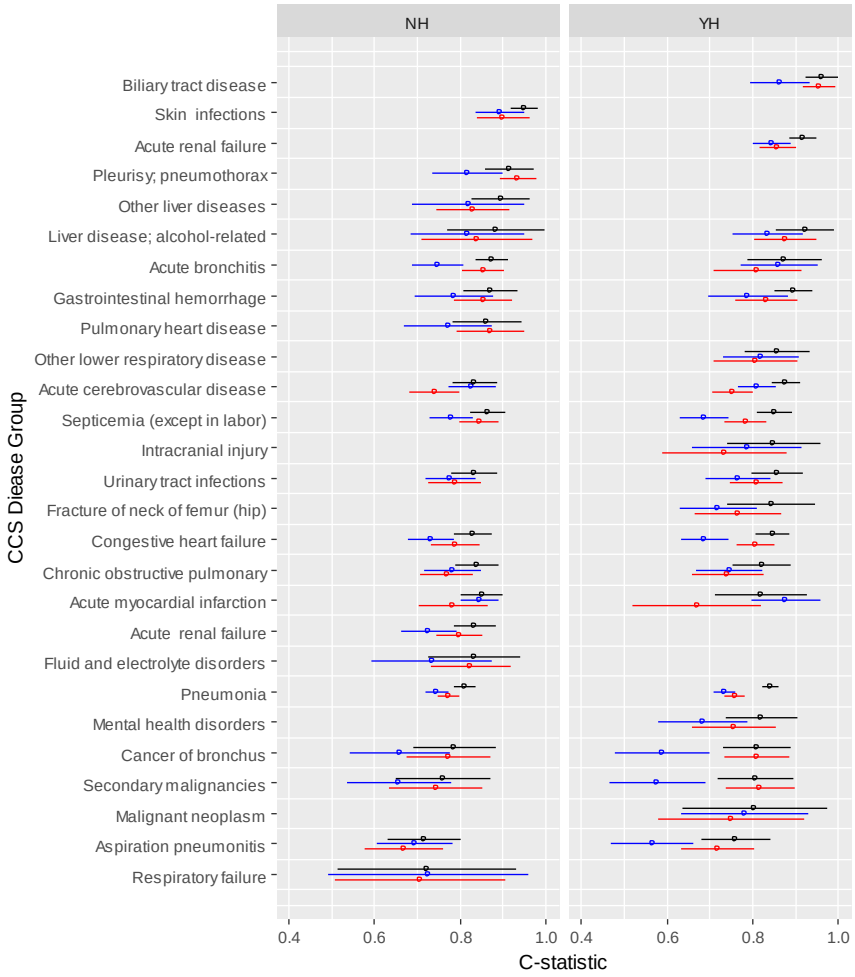
At the beginning we were focused on the score being used to spot deterioration so we could heroically step in and save people more often, but as we reflected on what others were saying, we realised it could also be used to highlight the need for improved communication/decision-making around end of life care.

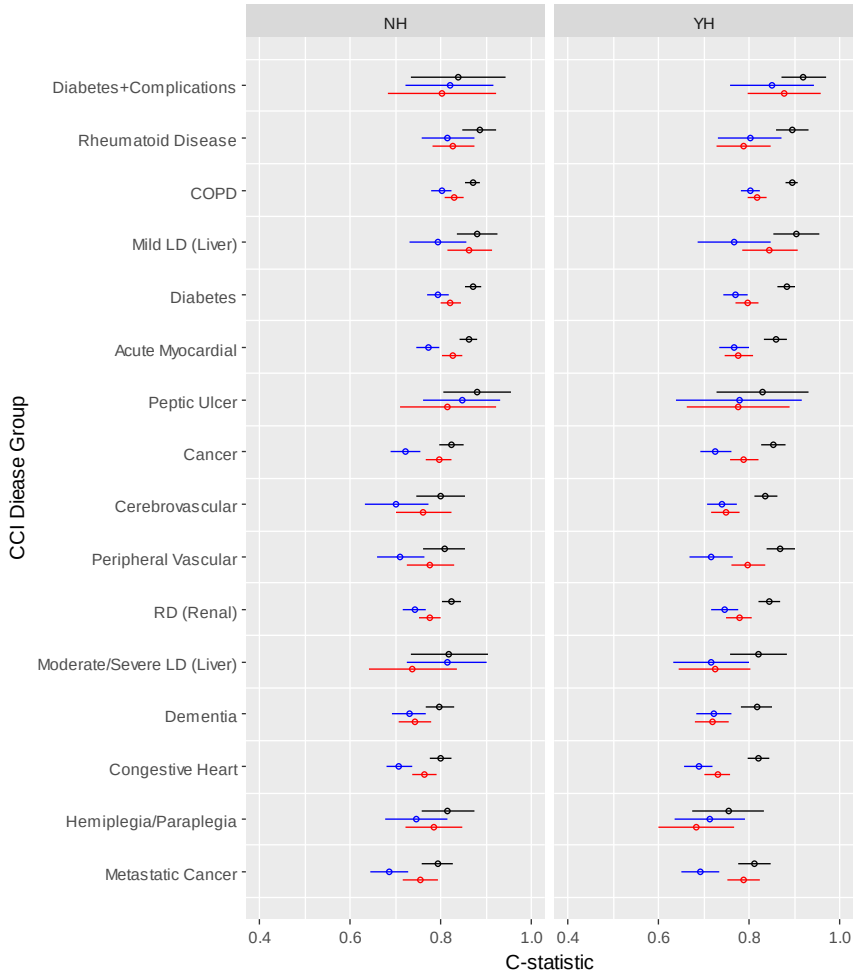
Dr. Donald Richardson - Consultant Physician, York Teaching Hospital NHS Foundation Trust

They said, we did……

Further Development of CARS; needs according to FG participants	Actions taken/planned
When is the score inaccurate?	We have extracted data to compare NEWS, CARS and blood tests only for a range of (over 40) common conditions (e.g. renal failure, liver disease, COPD, heart disease; see appendix 2). This work demonstrates CARS to be as accurate as or more accurate than NEWS on almost all occasions.
CARS v Clinical Judgement; do we need a protocol or list of actions?	We focused on this remaining question in our second round of focus groups.
Practitioner Overload and resource implications	We will present the score in a readily accessible manner, we will implement small scale and measure any potential impact on practitioner workload and address where possible as part of the implementation process.
We want to understand what does it consist of and why other things are not included.	We have compiled PPT presentations that include this information (appendix 3). We ensure this information is visually linked and accessible with the CARS when it is "live" in practice
CARS compared with NEWS	As point 1.
We want to see the algorithm	We have made this available for all presentations
How often will it update? How will I know how old it is? What will it look like? Can we see a trend? Can we see all of the component variables?	We have added all preferences stated from the FGs to our implementation plan
What about those patients without a score – if it works – shouldn't all have it?	We intend to conduct a sub study to investigate which patients do not have the NEWS score and why.
What's the impact on admission to HDU? Cost/number of beds?	We will implement the CARS small scale on only local AMUs to minimise and allow the assessment of cost impact
Let me see examples with real people?	We have conducted notes audits as part of the development of CARS and from this produced anonymised vignettes that we are able to use as training resources
Presentation of the score	All preferences and ideas from FGs have been fed into the IT teams.

CARS vs NEWS vs Bloods





Conclusions

- Co-design for development and implementation of risk scores is rare
- Staff and SU/C input was integral to the development of CARS
- Next steps – staged approach to implementing CARS – with continual feedback from staff and SU/Cs

Contact Details

@Improve_Academy

@AHSN_YandH

@ImprovementAcademy

www.improvementacademy.org

www.yhahsn.org.uk

t: 01274 383966

e: academy@yhahsn.nhs.uk