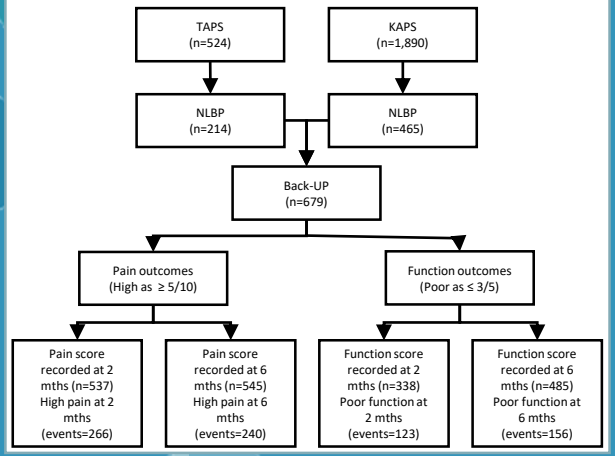
Visualisation of multivariable individualised prediction models for pain and function in patients with neck and/or low back pain

Lucinda Archer, Kym Snell, Siobhán Stynes, Kate Dunn, Nadine Foster, Gwenllian Wynne-Jones, Daniëlle van der Windt & Jonathan Hill

Objectives:
This presentation focusses on the development and internal validation of the Back-UP study's multivariable prediction models. These models aim to predict future pain and (separately) function in primary care patients presenting with neck and/or low back pain (NLBP). We also discuss the methods used to visualise these predictions.

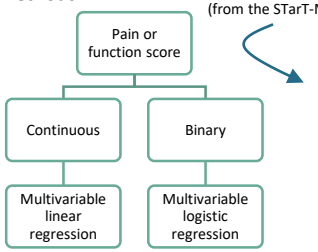
Datasets:

TAPS pilot study	Keele Aches and Pains Study
•pilot cluster RCT •2016-2017 •8 GP practices •6 month follow-up in >90%	•Prospective cohort •2014 - 2016 •14 GP practices •6 month follow-up in 79%



Methods:

All clinically-determined important predictors (from the STarT-MSK tool) forced into models



- Pain intensity
- Pain self-management
- Pain impact
- Walking short distances only
- Pain elsewhere
- Long-term expectations
- Other important health problems
- Emotional well-being
- Fear of harm
- Pain duration
- Pain site

Prediction models:

1. Patient's long-term expectations ("Do you think your condition will last a long time?") was the strongest predictor of pain at both time-points
2. Fear of harm from physical activity and having other important health conditions contributed most to predicting poor function
3. Emotional well-being ("Has pain made you feel down or depressed in the last two weeks?") had low predictive ability in any model

Prognostic performance was assessed using internal validation by bootstrapping with 1,000 samples:

Outcome	Model	Calibration slope	CITL	E/O	R^2	C-statistic
Pain score	Linear	0.98	0.55	0.87	0.37	-
Probability of high pain	Logistic	0.94	-0.82	0.97	0.33*	0.8

* Nagelkerke's R^2

Box 1: Demonstration of equations for predicting 6 month pain in NLBP patients (pre-shrinkage)

6-month pain score = – 0.51 + 0.247 x (Pain intensity) + 0.195 x (Pain self-management) + 0.581 x (Pain impact) + 0.858 x (Walking short distances only) + 0.256 x (Pain elsewhere) + 1.538 x (Long-term expectations) + 0.532 x (Other important health problems) – 0.002 x (Emotional well-being) – 0.399 x (Fear of harm) + 1.039 x (Pain duration) + 0.473 x (Pain site)

$$\text{Probability of high pain in 6 months} = \frac{\exp(LP)}{1+\exp(LP)}$$

LP = -1.239 + 0.218 x (Pain intensity) + 0.175 x (Pain self-management) + 0.318 x (Pain impact) + 0.809 x (Walking short distances only) + 0.269 x (Pain elsewhere) + 1.207 x (Long-term expectations) + 0.304 x (Other important health problems) + 0.233 x (Emotional well-being) – 0.442 x (Fear of harm) + 0.737 x (Pain duration) + 0.022 x (Pain site)

Where:

- exp is the exponential function
- Pain intensity is scored from 0 to 10, where 0 is "no pain" and 10 is "pain as bad as it could be"
- Pain site is scored as 1 for patients with their worst pain in their back, and 0 for neck
- All other variables are scored 1 if the patient answered "yes" to that question, and 0 otherwise

Example 1

For a back pain patient with a Pain intensity of 7, pain elsewhere, low long-term expectations and pain that has lasted for more than 6 months, pain in 6 months' time would be estimated as:

6-month pain score = – 0.51 + 0.247 x (7) + 0.195 x (0) + 0.581 x (0) + 0.858 x (0) + 0.256 x (1) + 1.538 x (1) + 0.532 x (0) – 0.002 x (0) – 0.399 x (0) + 1.039 x (1) + 0.473 x (1)
= – 0.51 + (0.247 x 7) + 0.256 + 1.538 + 1.039 + 0.473
= 4.5 out of 10

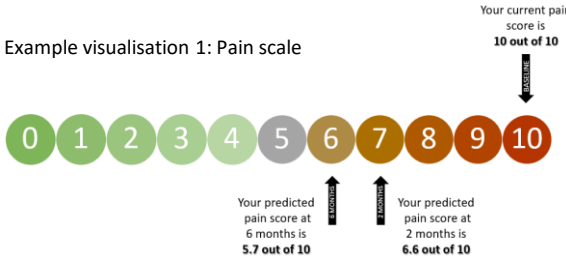
LP = -1.239 + 0.218 x (7) + 0.175 x (0) + 0.318 x (0) + 0.809 x (0) + 0.269 x (1) + 1.207 x (1) + 0.304 x (0) + 0.233 x (0) – 0.442 x (0) + 0.737 x (1) + 0.022 x (1)
= -1.239 + (0.218 x 7) + 0.269 + 1.207 + 0.737 + 0.022
= 2.5

So

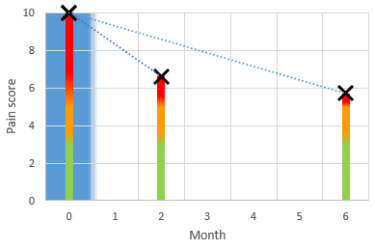
Probability of high pain in 6 months = $\frac{\exp(2.5)}{1+\exp(2.5)}$ = 92%

Visualisations:
Examples of how to visually present the predictions using plots and graphs were created. They were presented to a clinical expert group of General Practitioners (GPs) and Physiotherapists for feedback on their preferences regarding ease of comprehension and appropriateness for communicating predictions to patients.

Example visualisation 1: Pain scale

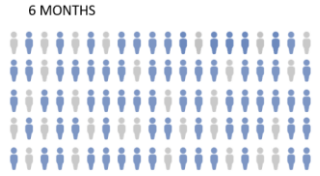


Example visualisation 2: Unlabelled bar chart, linked to baseline



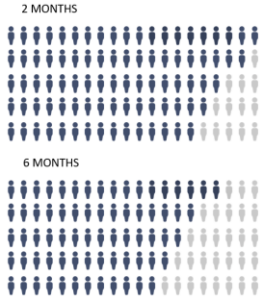
Example visualisation 3: Probability scale

Example visualisation 4: Unordered personograph



In 6 months time, 71 out of 100 people who answered the same way on the questionnaire will still be in a lot of pain.

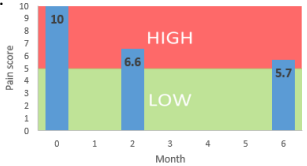
Clinical expert group:
The clinical expert group expressed a clear preference for ordered personographs when communicating probabilities of high pain or poor function.



In 2 months time, 87 out of 100 people who answered the same way on the questionnaire will still be in a lot of pain.

In 6 months time, 71 out of 100 people who answered the same way on the questionnaire will still be in a lot of pain.

It was harder to get agreement on the best way to present continuous scores at different time points. After further discussion, traditional labelled bar charts were selected to communicate predicted pain score and predicted physical function score.



Conclusion:
We built on existing subgrouping approaches using the Keele STarT MSK Tool to develop and validate multivariable prediction models that predict future pain and function scores at 2 and 6 months for NLBP patients.
We subsequently explored clinical experts' views about their preferred mode of visual presentation of these predictions for use in routine clinical practice. Further input from patients is planned. The tool and visualisation will be housed within the Back-UP digital platform.

This poster presents work conducted as part of a project funded by the European Horizon 2020 research and innovation programme under grant agreement No 777090.
Contact: l.archer@keele.ac.uk