Prediction tool to determine return to work outcomes

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Who we are

The **Institute for Work & Health** is a not-for-profit research organization based in Toronto, Canada

We conduct and share research to protect and improve the health of working people. Our research is carried out in two broad domains:

(1) preventing work-related injury and illness through studies of workplace programs and practices, prevention policies and the health of workers at a population level, and

(2) improving the health and recovery of injured workers through research on treatment, return to work, disability prevention and management, and compensation policies

Our research is valued by policy-makers, workers and workplaces, clinicians, and occupational health, safety and disability management professionals

Introduction

- Prognosis is meant to predict the course or outcome of a disease process
- Predictive aim or explanatory aim
- Clinicians use prognostic information to: educate their patients, identify target groups for treatment, or to target specific factors to be modified through intervention
- Communication of prognosis can be used to reassure patients

What is a prediction rule?

- Developed in a study that tries to identify the best combination of medical signs, symptoms, and other findings in predicting the probability of a specific outcome
- Based on the most parsimonious model
- Clinicians have difficulty in estimated risks of diseases and outcomes (and it is unlikely that non-physicians do any better)
- Prediction models are key to individualizing diagnostic and treatment decision making

Steps in the development of a prediction rule

1. Derivation: the identification of factors with predictive power = based on systematic review

2. Validation: establishing the strength of the evidence and the reproducibility of the accuracy

3. Impact analysis: examines whether there is evidence that the rule changes the behavior of the user and improves outcomes and/or reduces costs

Objective

- We aim to assess prognosis and identify high risk patients who should be the focus of intervention

- By developing a tool to predict time until end of benefits and recurrences of benefits in workers with low back pain

- For whom:
  - Those active in work disability prevention

Methods

- Information available within the first 4 weeks of work disability
- 6,657 workers were selected
- Date of injury between January 1 and June 30, 2005
- Three sources of data:
  - Readily available data in insurers' databases
  - Data available in insurers' database that needs to be transformed or data entered to provide useful information
  - Readiness for RTW cohort data to explore promising prognostic factors
- Focus on 1,442 workers on full benefits at 4 weeks
- Predict outcomes at 6 months and over 2 years with the most parsimonious model
- Variables selected based on the literature (Manitoba systematic review)

Methods

- Cox regression for time on benefits in first episode for those still on full benefits at 4 weeks and time until recurrence for those that return to work after 4 weeks.
- Moving those factors forward that have a $p<0.20$ in univariate analysis
- Using a backward selection method to select factors
- Internal validation of model by means of bootstrapping (200 bootstrap samples) and retaining those factors that are in 50% of the final models

Methods: model fit: how well can we predict?

- Model fit using c-statistic, or the Area Under The Curve between risk score (xβ) and outcomes at 6 months (and 2 years)
- A guide for classifying the accuracy of the model:

  .90-1 = excellent

  .80-.90 = good

  .70-.80 = fair

  .60-.70 = poor

  .50-.60 = fail

Results: descriptives time on benefits

50% of our sample was on full benefits for 57 days (range=53.6, 60.4)

31.8 % at 3 months

15.2 % at six months

8.7 % at 12 months.

6.6 % at 24 months (95 workers)

Results: descriptives time until recurrence

1,347 at risk for a recurrence during follow-up

11.9 % had experienced a recurrence after 30 days

19.1 % after three months

21.7% after six months

23.7% after 12 months.

24.6% after two years

Variables considered

Strong evidence

Moderate evidence for NO effect

Moderate evidence for effect

Age
Gender
Job tenure
Previous lost time claim
Previous non lost time claim
Gross earnings mean (sd)
Language
Doubt work relatedness
Union member
Early RTW program
Recovery expected
Limitations for RTW from Form 8
Medication Prescribed
RTW discussed by health care provider
Advances paid by employer
Physical demands
Opioid prescription
Healthcare:
- *MD*
- *PT*
- *Chiro*
- *POC*

Functional Abilities Forms

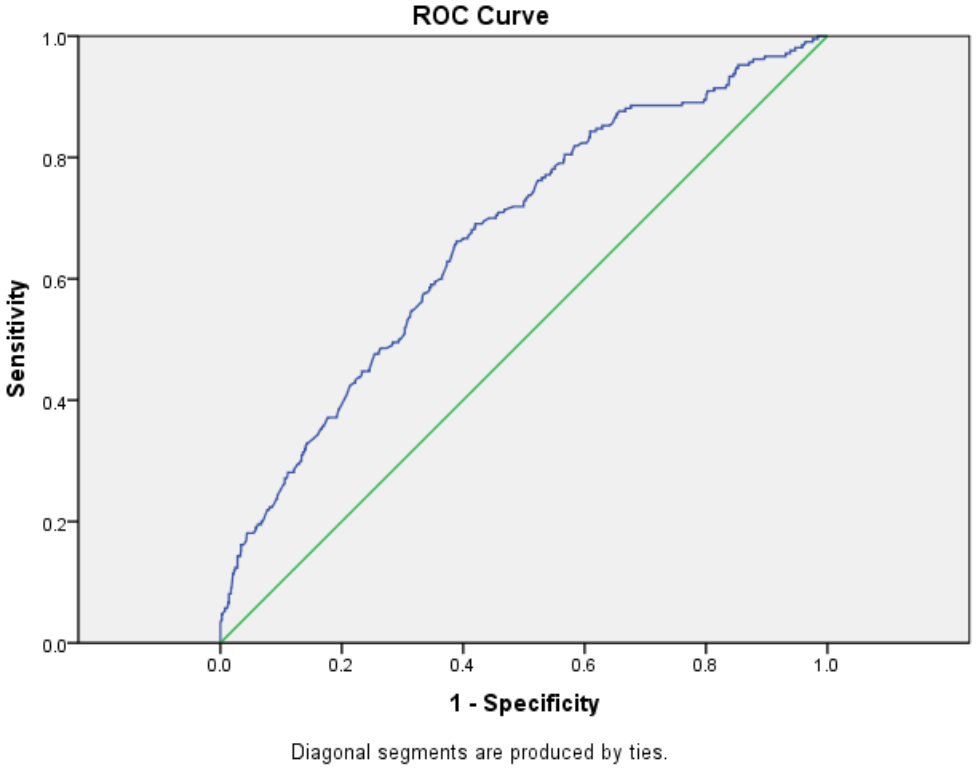
Strong evidence

Moderate evidence for NO effect

Moderate evidence for effect

Variables considered:	Variables in final model (n=1442)	>1 = faster end of benefits
Age	Age in categories	
Gender	15-<25 (n=96)	1.265 [1.000, 1.602]
~~Job tenure~~	25-<35 (n=291)	1
~~Previous lost time claim~~	35-<45 (n=486)	.904 [.777, 1.051]
~~Previous non-lost time claim~~	45-<55 (n=411)	.843 [.721, .985]
~~Gross earnings- mean (sd)~~	55-65 (n=152)	.645 [.523, .795]
~~Language~~	Men (n=877) vs Women (n=538)	1 vs .969 [.865, 1.086]
Doubt work relatedness	Union member, no (n=651)	1
Union member	yes (n=599)	1.139 [1.006, 1.290]
Early RTW program	Missing (n=165)	1.339 [1.122, 1.598]
~~*Recovery expected*~~	Doubt work relatedness, No (n=1041) ref	1
~~*Limitations for RTW from Form 8*~~	Yes (n=194)	.919 [.782, 1.081]
	Missing value (n=180)	1.177 [.996, 1.390]
~~*Medication Prescribed*~~	Early RTW program, Yes (n=1074)	1
~~*RTW discussed by health care provider*~~	No (n=275)	.589 [.506, .687]
	Missing (n=106)	.699 [.560, .871]
~~*Advances paid by employer*~~	*Physical demands: Non-manual (n=139)*	1
Physical demands	*Mixed manual (n=465)*	1.050 [.862, 1.279]
Opioid prescription	*Manual (n=798)*	.835 [.690, .1.012]
~~*Healthcare*~~	*Missing (n=40)*	.946 [.650, 1.021]
~~*MD*~~	*No opioid prescription vs Any opioid prescription (n=136)*	1
~~*PT*~~		.705 [.580, .856]
~~*Chiro*~~	*0 FAF forms (ref)(n=736)*	1
~~*POC*~~	*1 FAF (n=421)*	1.119 [.986, 1.270]
Functional Abilities Forms	*2 FAF (n=178)*	1.211 [1.021, 1.436]
	3 FAF (n=56)	1.425 [1.074, 1.889]
	4 or more FAF (n=24)	2.320 [1.530, 3.519]
	Program of care, no (n=1145)	1
	Yes (n=270)	1.152 [1.001, 1.326]

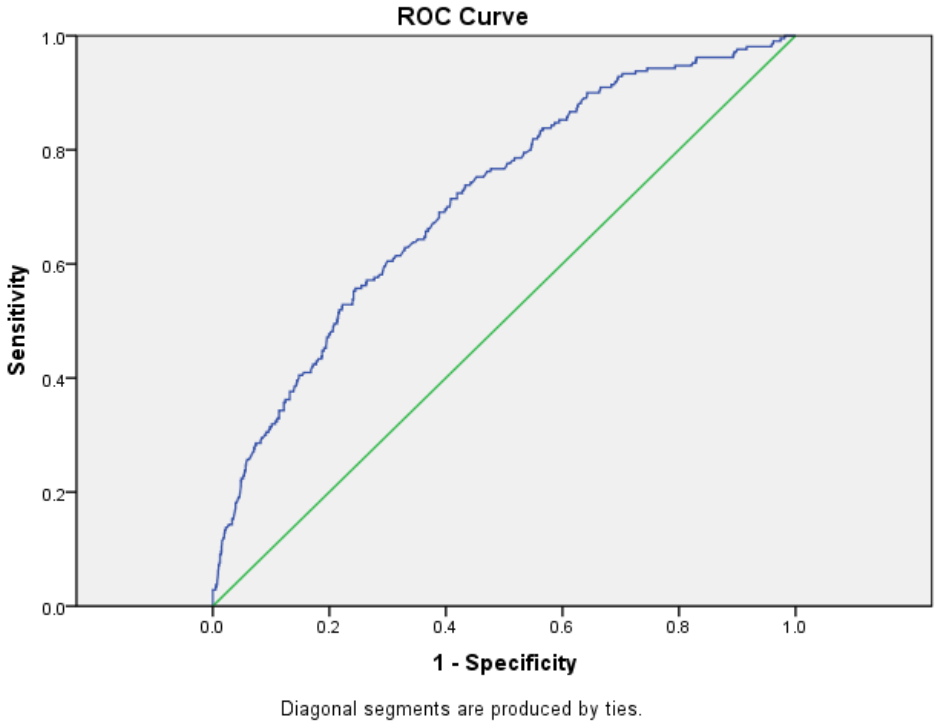
First step: predictive validity of the model based on info available in the claim file (with a little work)



- Score on rule (xβ) vs benefits status @ 6 months

- Area Under the Curve = .670, 95% CI =[.630, .709] (“poor”)

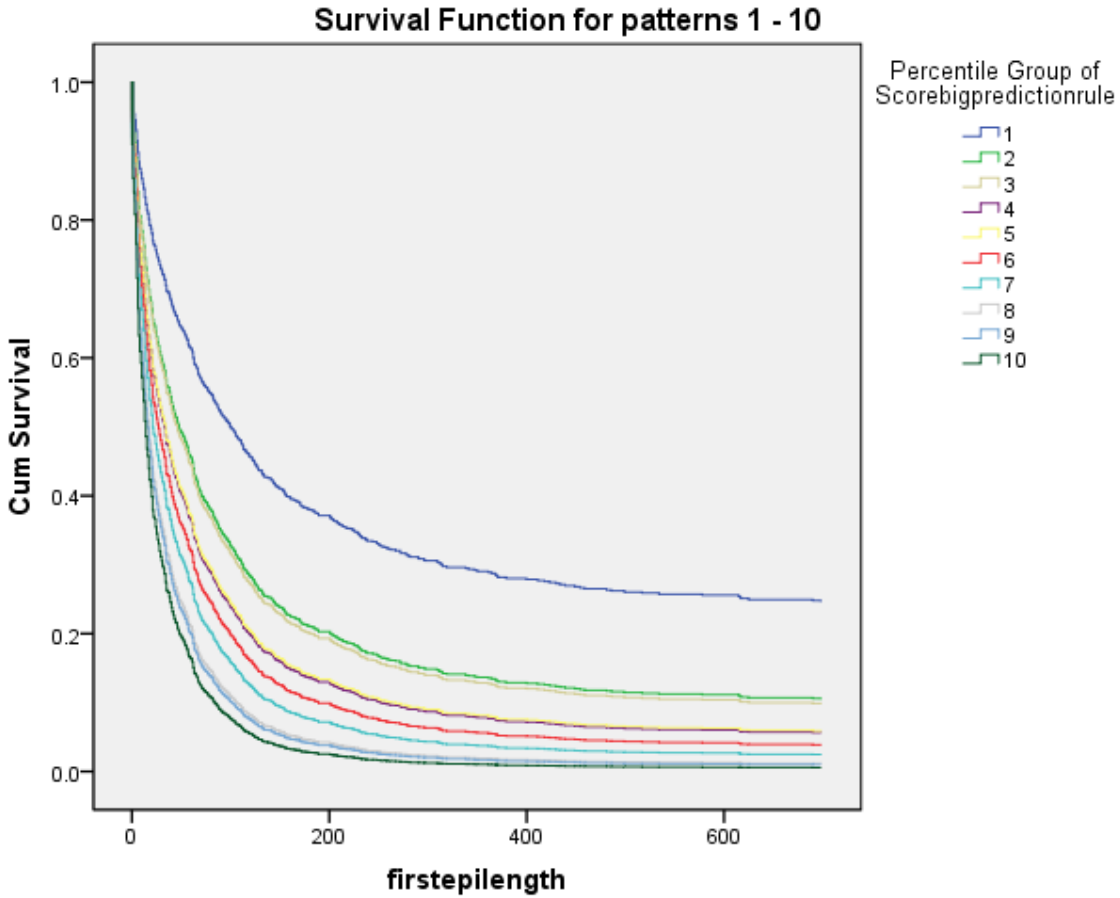
Second step: predictive validity of the model with data entered from Forms



- Score on rule (xβ) vs benefits status @ 6 months

- An Area Under the Curve= .712 [.674, .749] (“fair”)

Intermezzo: Communicating risk?



- Splitting into 10 groups based on score on prediction rule

What does that mean? I

From bad to good	HRR>1= faster end of benefits	95% CI for HRR	
0-10%	1.00		
10-20%	1.61	1.24	2.08
20-30%	1.66	1.29	2.14
30-40%	2.06	1.60	2.66
40-50%	2.03	1.57	2.62
50-60%	2.33	1.81	3.00
60-70%	2.66	2.06	3.42
70-80%	3.19	2.48	4.12
80-90%	3.30	2.56	4.25
90-100%	3.71	2.87	4.78

What does that mean? II

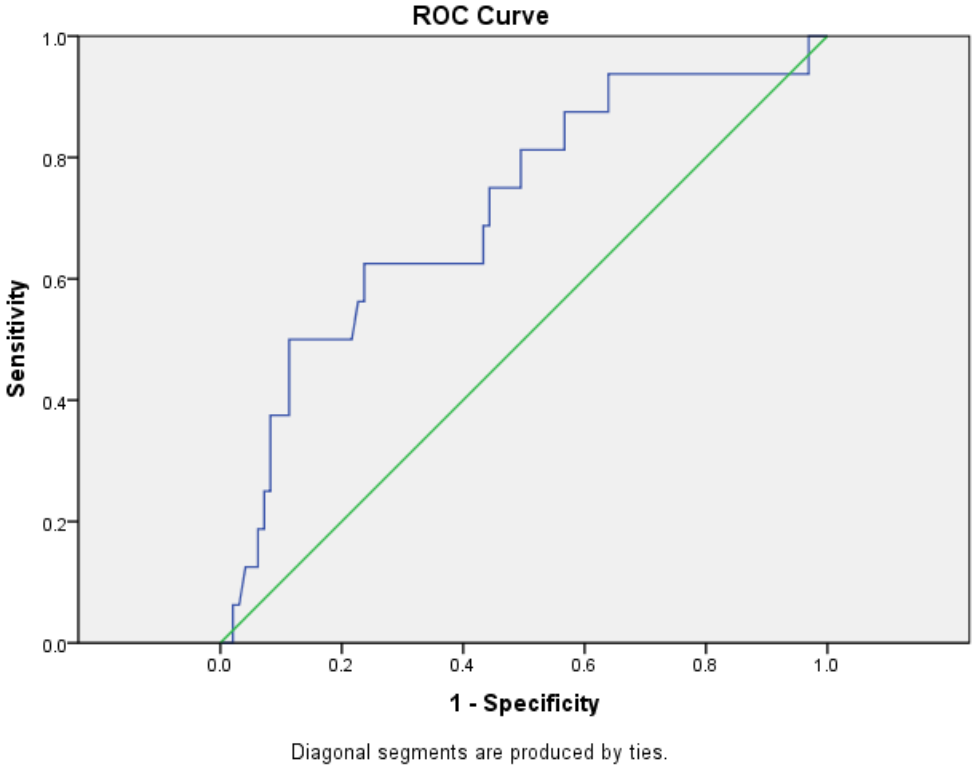
From risk score to RTW status at 6 months and 2 years

From bad to good	Benefits @ 6 months		Benefits @ 2 years	
	ON	OFF	ON	OFF
0-10%	41%	59%	25%	75%
10-20%	22%	78%	13%	87%
20-30%	21%	79%	9%	91%
30-40%	12%	88%	5%	95%
40-50%	18%	82%	6%	94%
50-60%	13%	87%	3%	97%
60-70%	10%	90%	3%	97%
70-80%	6%	94%	1%	99%
80-90%	4%	96%	1%	99%
90-100%	4%	96%	1%	99%
Total	15%	85%	7%	93%

Early intervention?

From bad to good	POC 1st 4 weeks?		FAF 1st 4 weeks?		RTW program in workplace		
	no	yes	no	yes	No	Yes	Missing
0-10%	89%	11%	87%	13%	76%	9%	15%
10-20%	82%	18%	70%	30%	48%	33%	19%
20-30%	88%	12%	61%	39%	36%	46%	18%
30-40%	90%	10%	68%	32%	13%	81%	6%
40-50%	79%	21%	59%	41%	11%	76%	12%
50-60%	88%	12%	53%	47%	4%	93%	3%
60-70%	83%	17%	45%	55%	2%	95%	3%
70-80%	76%	24%	43%	57%	2%	91%	7%
80-90%	72%	28%	23%	77%	1%	99%	1%
90-100%	65%	35%	14%	86%	0%	99%	1%
Total	81%	19%	52%	48%	19%	72%	8%

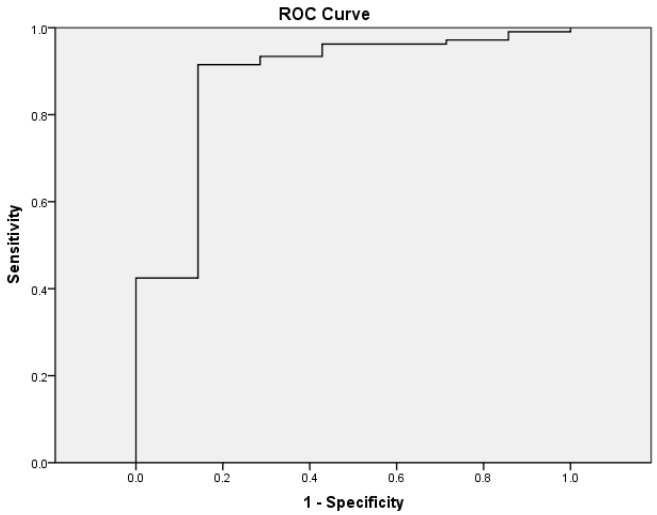
Third step: Predictive validity of the prediction rule adding information from the R-RTW study (n=113)



- We first determined the Area Under The Curve using the scores on the prediction rule as derived in the bigger sample to prevent over fitting of the model.
- AUC= .713 (.712 in full sample)

Predictive validity: adding functional disability, pain and depression

Variable	Hazard Rate ratio [95% CI]
Prediction rule score/decile	1.118 [1.045, 1.196]
Pain score (10 point VAS scale)	0.846 [0.785, 0.912]



Factors were added to the Cox regression model containing the risk score. Pain score and risk score remained in the final model AUC @ 6 months= .880, 95% CI= [.737, 1.000]

.90-1 = excellent
.80-.90 = good

Results: Recurrences I

25 factors considered, 17 had an association of p<0.20 and were entered in a bootstrapping analysis, first three 'forced into the model

First block risk factors	Bootstrap prop	mHRR > 1= faster recurrence
First episode length beyond 4 weeks	1.000	1.001 [1.000, 1.002]
Age in categories	1.000	
15-<25 (n=96)		0.697 [0.408, 1.189]
25-<35 (n=275)		1
35-<45 (n=461)		0.972 [0.719, 1.314]
45-<55 (n=382)		0.982 [0.718, 1.342]
55-<65 (n=133)		0.864 [0.565, 1.322]
Men (n=821)	**1.000**	**1**
Women (n=526)		**1.360 [1.089, 1.700]**
Physical demands	**0.725**	
Non-manual (n=132)		**1**
Mixed (n=448)		**1.118 [0.727, 1.720]**
Manual (n=730)		**1.547 [1.023, 2.340]**
Missing (n=37)		**1.430 [0.664, 3.076]**
Opioid prescription	**0.675**	
No (1231)		**1**
Yes (116)		**1.520 [1.086, 2.126]**
Functional ability forms	**0.630**	
0 (n=687)		**1**
1 (n=404)		**1.312 [1.024, 1.682]**
2 (n=176)		**1.575 [1.152, 2.152]**
3 (n=56)		**1.260 [0.738, 2.151]**
4+ (n=24)		**1.454 [0.709, 2.985]**

Results: Recurrences II

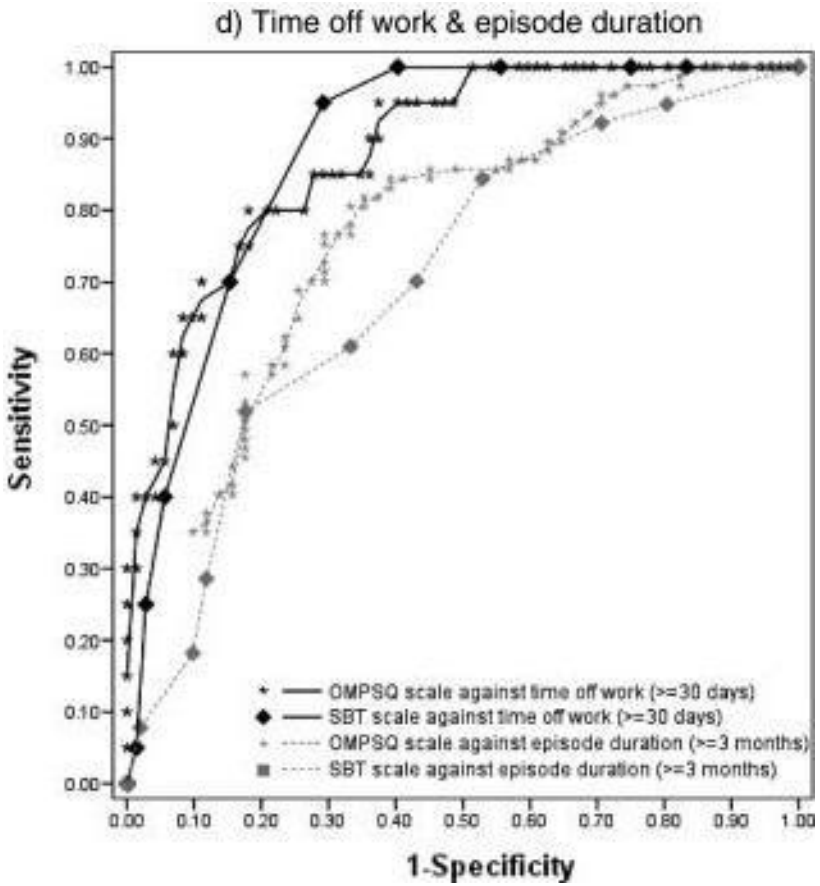
Area under the curve of the prediction rule for time until recurrences

= 0.595 (95% CI=0.545, 0.642) at 1 month

= 0.613 (95% CI= 0.573, 0.652) at three months

= 0.607 (95 % CI= 0.570, 0.645) at six months after end of first episode

How do we compare?



- Orebro scale
- AUC= 0.81
- AUC= 0.69 (in New Brunswick)
- The Orebro and STaRt Back tool seem to perform similar in the UK
- Heymans et al, 2009: AUC= 0.63

Next steps

1. Derivation: the identification of factors with predictive power

2. Validation: establishing the strength of the evidence and the reproducibility of the accuracy

3. Impact analysis: examines whether there is evidence that the rule changes the behavior of the user and improves outcomes and/or reduces costs

Hill et al The Lancet 2011

Comparison of stratified primary care management for low back pain with current best practice (STarT Back): a randomised controlled trial

Jonathan C Hill, David G T Whitehurst, Martyn Lewis, Stirling Bryan, Kate M Dunn, Nadine E Foster, Kika Konstantinou, Chris J Main, Elizabeth Mason, Simon Somerville, Gail Sowden, Kanchan Vohora, Elaine M Hay

Summary

Background Back pain remains a challenge for primary care internationally. One model that has not been tested is stratification of the management according to the patient's prognosis (low, medium, or high risk). We compared the clinical effectiveness and cost-effectiveness of stratified primary care (intervention) with non-stratified current best practice (control).

Methods 1573 adults (aged ≥18 years) with back pain (with or without radiculopathy) consultations at ten general practices in England responded to invitations to attend an assessment clinic. Eligible participants were randomly assigned by use of computer-generated stratified blocks with a 2:1 ratio to intervention or control group. Primary outcome was the effect of treatment on the Roland Morris Disability Questionnaire (RMDQ) score at 12 months. In the economic evaluation, we focused on estimating incremental quality-adjusted life years (QALYs) and health-care costs related to back pain. Analysis was by intention to treat. This study is registered, number ISRCTN37113406.

Findings 851 patients were assigned to the intervention (n=568) and control groups (n=283). Overall, adjusted mean changes in RMDQ scores were significantly higher in the intervention group than in the control group at 4 months (4·7 [SD 5·9] *vs* 3·0 [5·9], between-group difference 1·81 [95% CI 1·06–2·57]) and at 12 months (4·3 [6·4] *vs* 3·3 [6·2], 1·06 [0·25–1·86]), equating to effect sizes of 0·32 (0·19–0·45) and 0·19 (0·04–0·33), respectively. At 12 months, stratified care was associated with a mean increase in generic health benefit (0·039 additional QALYs) and cost savings (£240·01 *vs* £274·40) compared with the control group.

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Arthritis Research UK Primary Care Centre, Primary Care Sciences, Keele University, Stoke-on-Trent, UK (J C Hill PhD, D G T Whitehurst PhD, M Lewis PhD, K M Dunn PhD, Prof N E Foster DPhil, K Konstantinou PhD, Prof C J Main PhD, E Mason MSc, S Somerville MSc, G Sowden MSc, K Vohora BSc, Prof E M Hay MD); **School of Population and Public Health, University of British Columbia, Vancouver, BC, Canada** (Prof S Bryan PhD,

Discussion

- Do we know enough?
- When do you develop tools/ implement knowledge?
- Are these tools better compared to “the clinicians’ /experts’ gut feeling”?
- Is there an expert to make the same judgement?
- What interventions should follow after being classified as ‘high risk’?

There's an App for that…..

Population

Variable	Claim database (after 4 weeks) (n=1,442) N (per cent)
Age at accident (/yr) mean (sd)	41.3 (10.5)
Men Women	890 (61.7) 552 (38.3)
Previous claim yes no	 1091 (75.7) 351 (24.3)
Physical demands of the workplace Non-manual Mixed manual Manual Missing	 139 (9.6) 465 (32.2) 798 (55.3) 40 (2.8)
Gross earnings, mean (sd); median; (min, max)	731.43 (332.52); 694.00; (78.00, 2387.00)
Language French/English Other	 1396 (96.8) 46 (3.2)
Union member Yes No Missing	 610 (48.2) 656 (51.8) 176
Early RTW program, Yes No Missing	1042 (78.9) 278 (21.1) 122

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