Predictive risk stratification model: a randomised stepped-wedge trial in primary care (PRISMATIC)

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Scientific summary

PRISMATIC: randomised stepped-wedge trial in primary care

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Scientific summary

Background

With a higher proportion of older people in the UK population, demand on health and social care is increasing. New approaches are needed to shift care delivery out of hospital wherever possible, and to safely reduce emergency admissions to hospital. A predictive risk stratification tool (the Predictive RIsk Stratification Model; PRISM) has been developed for general practice to estimate risk of an emergency hospital admission in the following year for each registered patient. Practices can use the resulting risk scores to target primary- and community-based services at patients at the highest level of risk. The introduction of PRISM coincided with a new payment under the Quality and Outcomes Framework (QOF) in the contract for general practitioners (GPs) in Wales to identify and manage the care of people at high risk of emergency hospital admission.

Study aim

To evaluate the introduction of PRISM in primary care.

Objectives

To:

1. measure the effects on service usage, particularly emergency admissions to hospital
2. assess the effects of PRISM on quality of life and satisfaction
3. assess the technical performance of PRISM
4. estimate the costs of PRISM implementation and its effects
5. describe the processes of change associated with PRISM.

Setting

The trial site was in south Wales, and included all 32 general practices, grouped in 11 clusters, who agreed to take part within the Abertawe Bro Morgannwg University Health Board.

Methods

We undertook a systematic review; randomised stepped-wedge trial with control and intervention phases specific to each cluster, and participant-specific anonymised linked outcomes; and complementary investigation using qualitative methods evaluation. We implemented the intervention first in the practices of two GP champions and then at random in practice clusters over a 1-year period from March 2013.

We included routine linked data outcomes on all registered patients from 1 February 2013 to 30 September 2014, and assessed quality of life and satisfaction by self-completed postal questionnaire for a sample of patients at 6 and 18 months.

In our analyses we considered covariates and factors of gender, age, deprivation score, PRISM score, seasonality, trend and days at risk, with adjustment when appropriate.

Primary outcome

- Emergency hospital admissions.

Secondary outcomes

- Attendances at emergency departments (EDs).
- Primary care events.
- Outpatient attendances.
- Emergency admission bed-days.
- Health-related quality of life (Short Form questionnaire-12 items; SF-12).
- Patient satisfaction.
- NHS implementation costs.
- NHS recurrent costs.

We also compared deaths between control and intervention phases to monitor unexpected effects.

We worked closely with service users throughout the study.

Results

Systematic review

We included 13 papers from 11 studies, from 6632 papers initially identified. These studies were largely observational and heterogeneous in both intervention and population. Predictive risk stratification was generally used as a tool for identifying patients suitable for further intervention e.g. virtual ward, rather than as a formal part of that intervention. No studies reported comparative data about processes or outcomes related to predictive risk stratification. When predictive risk stratification was used as part of an RCT, risk tools were used to identify patients eligible for the trial – and were therefore used in the same way in both trial arms. Meta-analysis was not possible, as there were no comparative data available to examine the effects of predictive risk stratification on processes or ouctomes of care.

Randomised stepped-wedge trial

Numbers included

We included routine outcomes for 230,099 participants, with questionnaire responses from 1403 of these participants. Participants were assigned by initial predicted risk between four ranked risk groups, from 1 (lowest, constituting 80% of participants), through 2 and 3 (constituting, respectively, 15% and 4.5% of participants) to 4 (highest, constituting 0.5% of participants).

Clinical effectiveness: primary outcome

Across risk groups, people were admitted to hospital as emergencies, on average, 0.161 times per year in the control phase and 0.167 times per year in the intervention phase; these unadjusted rates varied between 0.063 in risk group 1 and 3.481 in risk group 4 in the control phase and between 0.066 in risk group 1 and 3.300 in risk group 4 in the intervention phase. Distribution of admissions was highly skewed, with most people not admitted to hospital at all and others admitted on multiple occasions.

The rate of emergency admissions was higher in the intervention phase than in the control phase [adjusted difference in number of emergency admissions per participant per year at risk $\Delta_L = 0.011$, 95% confidence interval (CI) 0.010 to 0.013]. This increase was found at all levels of risk.

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Clinical effectiveness: secondary outcomes

Emergency department attendances

People attended ED, on average, 0.359 times per year in the control phase and 0.361 times per year in the intervention phase, rising with risk group from 0.266 in the control phase and 0.271 times per year in the intervention phase in risk group 1 to 3.235 times per year in the control phase and 3.037 times per year in the intervention phase in risk group 4 (all unadjusted rates). Again, the distribution of attendances was highly skewed.

The average rate of ED attendances was higher in the intervention phase than in the control phase (adjusted difference in emergency attendances per participant per year at risk $\Delta_L = 0.030$, 95% CI 0.028 to 0.032).

General practitioner activity

General practitioner events were much more common, an average of 14.10 per patient per year in the control phase and 14.08 per patient per year in the intervention phase, rising from 9.32 per patient per year in the control phase and 9.42 per patient per year in the intervention phase at the lowest level of risk to 78.72 per patient per year and 67.3 per patient per year at the highest level of risk (all unadjusted rates), respectively.

There was an increase in the average number of days with recorded events per participant per year at risk (adjusted $\Delta_L = 0.011$,95% CI 0.007 to 0.014). This effect was reversed in the two groups at highest risk.

Outpatient visits

Across all risk revels, patients made, on average, 1.704 outpatient attendances per year in the control phase and 1.717 in the intervention phase, rising from 1.022 outpatient attendances per year in the control phase and 1.086 outpatient attendances per year in the intervention phase in risk group 1 to 13.833 outpatient attendances per year in the control phase and 13.503 outpatient attendances per year in the intervention phase in risk group 4 (unadjusted), respectively.

Outpatient attendances per patient per year were slightly higher in the intervention phase ($\Delta_L = 0.055$, 95% CI 0.051 to 0.058); this was consistent across risk groups, except at the highest level, at which no significant difference was seen between phases.

Time spent in hospital

People spent an average of 0.792 days per year in hospital in the control phase, compared with 0.728 days in the intervention phase, rising from 0.276 days per year in the control phase and 0.263 days per year in the intervention phase in risk group 1 to 15.15 days per year in the control phase and 13.38 days per year in the intervention phase in risk group 4. The distribution of data was highly skewed, with most people spending no time in hospital and a small number spending long periods of time in hospital.

Once figures were adjusted, on average, participants spent more days in hospital per year during the intervention phase than during the control phase ($\Delta_L = 0.029$, 95% CI 0.026 to 0.031), an effect that was consistent across risk groups, rising from 0.015 in risk group 1 to 0.197 in risk group 4.

Mortality

There was no evidence of any difference in death rates between phases: 9.58 per 1000 patients per year in the control phase and 9.25 per 1000 patients per year in the intervention phase.

Self-reported outcomes

There was no significant effect on SF-12 Mental Health Component scores between phases (adjusted $\Delta = -0.720$, 95% CI –1.469 to 0.030). SF-12 Physical Health Component scores were significantly higher in the intervention phase (adjusted $\Delta = 1.465$, 95% CI 0.774 to 2.157), with a trend towards greater improvements at the higher levels of risk (adjusted $\Delta = -4.385$ in risk group 1, but 4.103 in risk group 4). These differences were not reflected in adjusted Short Form questionnaire-6 Dimensions scores.

Satisfaction scores were slightly, but significantly, lower in the intervention phase (adjusted $\Delta = -0.074$, 95% CI –0.133 to –0.015), but not consistently across risk levels.

Economic evaluation

Intervention costs

We estimated that use of PRISM software cost £822 per general practice in year 1 (including activation and training), and projected that it would cost £474 per practice in every subsequent year. With 32 practices with 230,000 registered patients included in the analysis, we estimated that PRISM implementation cost is £0.12 per patient per year.

Resource costs

Total costs of admissions to hospital, ED attendances, GP activity and outpatient visits per patient per year were higher in the intervention phase than in the control phase (adjusted $\Delta = £76$, 95% CI £46 to £106), an effect that generally increased with risk level.

Processes of change: qualitative findings

At baseline, GPs and practice staff expressed a willingness to adopt PRISM, but raised concerns about whether or not it would identify patients not yet known, and about whether or not there were sufficient community-based services to deliver care to patients identified as at high risk, in order to prevent hospital admission.

All practices reported that they used PRISM to fulfil their QOF targets, and generally limited their use of PRISM to the small number at highest risk. After the QOF reporting period ended, only two practices reported continuing to regularly use PRISM. Reasons given for not using it included lack of time to work prospectively, inadequate support, limited internet access, and data being out of date and not well integrated with practice records.

General practitioners were unsure if using PRISM had any effect on emergency admissions and ED attendances. They felt that PRISM had changed their awareness of patients and focused them on targeting the patients at highest risk, although they were not sure that proactive management could make any difference to emergency admissions in this group. Among health service managers and community health staff, awareness and understanding of PRISM was high, though they expressed similar concerns as practice staff about the availability of services to which practices could refer.

Technical performance

Using data from 51,600 patients with both an early PRISM score and a sufficient control phase, PRISM showed good technical performance, comparable to existing risk prediction tools (*c*-statistic of 0.749). However, it generally underpredicted risk at higher risk levels and overpredicted risk at the lowest risk level.

Conclusions: implications for health care – research recommendations

Summary of key findings

- Our systematic review found that previous research evidence, limited in scope and quality, showed minimal effects of predictive risk stratification tools on emergency admissions.
- Primary outcome: emergency admissions increased slightly in the intervention phase of the trial. Secondary outcomes: attendances at EDs, GP events and outpatient visits were also slightly higher in the intervention phase; and patients spent more time in hospital in the intervention phase. Mental health quality-of-life scores were not dissimilar between phases. Physical health scores were higher in the intervention phase. Satisfaction scores were lower in the intervention phase.

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- Costs: set-up and running costs of PRISM were low, at £0.12 per patient per year; resource costs were £76 per patient per year higher in the intervention phase than in the control phase.
- Processes of change associated with PRISM: a change to the GP contract for 12 months encouraged use of PRISM, but, after this period ended, use was reported as minimal. All users reported some change in practice resulting from PRISM.
- Technical performance of PRISM: the extent to which PRISM accurately predicted risk of emergency admission to hospital was consistent with similar models.

Strengths and weaknesses of the research

Our stepped-wedge study design randomised clusters of general practices to receive PRISM tool at intervals over 1 year. Together with linked routine outcome data, this enabled us to conduct a rigorous evaluation of this population-level intervention by monitoring outcomes for nearly 250,000 people. We anonymously linked self-completed questionnaires from a sample stratified to favour higher levels of risk to our routine data outcomes, thus describing effects on quality of life and satisfaction as well as on health service use. Response rates were no higher than expected in this general population and need non-response analysis.

This was the first evaluation of the effects of the introduction of a PRISM in normal practice, even though the tools have since been widely introduced across the UK as part of a comprehensive policy for the care of people with chronic conditions.

Conclusions

Use of anonymised data linkage has enabled us to conduct an experimental study with a randomised design at the population level, and include almost all primary and secondary routine outcomes, as well as self-reported outcomes from a sample of patients.

Introduction of PRISM in primary care in a large urban area in Wales was followed by increased emergency admissions, both overall and at each level of risk. We also found increases in each secondary measure of resource use following PRISM implementation. There was evidence of improved quality of life, but satisfaction scores were slightly lower.

Despite low reported use of PRISM, we found clinically and operationally important effects of the introduction of the new risk stratification tool alongside contractual incentives (QOF) to target those at the highest risk of emergency admission to hospital. Unexpectedly, most effects were in the opposite direction to those intended. Although we cannot disentangle the effects of introducing PRISM from those of introducing the QOF targets, this has the merit of reflecting practice across the UK, where predictive risk stratification tools for emergency admissions operate alongside incentives to focus on patients at risk. Hence, we believe that our findings from a large population in south-west Wales, mixing urban and semi-urban, are generalisable.

In brief, the introduction of PRISM increased emergency episodes, hospital admissions and costs across the population and at each risk level without clear evidence of benefits to patients.

Recommendations for research

1. Evaluate the alternative approach of delivering different services to different levels of risk, rather than the current focus on the very highest level of risk.
2. Investigate the effects of emergency admission risk stratification tools on vulnerable populations and health inequalities.
3. Conduct a secondary analysis of the Predictive Risk Stratification: A Trial in Chronic Conditions Management data set by condition type.
4. Explore the acceptability of predictive risk stratification and communication of risk scores to patients and practitioners.

Trial and study registration

The trial is registered as ISRCTN55538212 and the study is registered as PROSPERO CRD42015016874.

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