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Balancing the NHS balanced scorecard!

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Abstract

In the UK, the split between opposition and supporters views of the National Health Service (NHS) performance ratings system is growing. Objective argument and consensus would be facilitated if a methodology was developed which showed the cause and effect relationships between the components of the performance rating system. The NHS hospital trust performance ratings data used in 2002 and 2003 were downloaded from the Department of Health performance rating website. Structural equation modelling was used to construct a causal-loop diagram showing the cause and effect relationships between the 16 common performance indicators in the two years. Scenario testing suggests that indicators of delayed transfer of care and of data quality are compromised if emergency readmissions performance is improved.

Keywords: Health services; Balanced scorecard; System thinking; Structural equation modelling; Performance management

1. Introduction

The ageing populations and increased cost of medical care in most developed countries have made healthcare a very demanding task for governments worldwide. Hospital staff and managers are under pressure and concerned for effective use of scarce resources and sustainable performance. To that effect, in the UK, the NHS has introduced a balanced scorecard [1] (BSC) as a part of the framework for hospital trusts' performance ratings. The purpose of the performance ratings framework is debatable but is assumed to contribute towards performance management in the NHS.

Many more organisations, both public and private, have been focusing on long-term performance and the use of BSC as part of a performance management framework [2–5]. The BSC is a balanced representation of performance of internal as well as external objectives. A typical BSC has financial, customer, internal processes, and learning and growth dimensions. These dimensions are interrelated with cause-and-effect relationships in a tree-like fashion [6]. Cause-and-effect relationships amongst these dimensions imply how fruits (financial measures) in the tree are related to leaves (customers), trunk (processes) and roots (learning and growth).

The NHS has been following a balanced scorecard approach since 2001. The framework is rapidly evolving [7–9]. Fig. 1 indicates that, prior to 2001, the performance ratings were based on a set of

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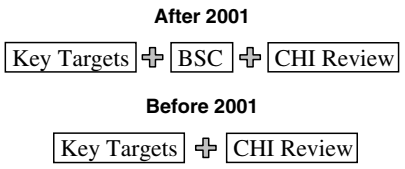


Fig. 1. Change in performance rating framework for NHS hospitals in UK.

key targets and reviews by the Commission for Health Improvement (CHI). Now, NHS hospital trusts are rated using BSC performance indicators in addition to the previous criteria.

The current NHS balanced scorecard is composed of three types of performance indicators: patient focus, clinical focus, and capability and capacity focus. More performance indicators (17) have been added to the BSC since the first year of publishing performance ratings. Table 1 shows the performance indicators included in the NHS BSC for the years 2001/2002 and 2002/2003.

Due to the complexity of the framework, hospital trusts find it difficult to interpret their performance ratings results to formulate an efficient strategy for performance improvement. The lack of literature (government or academic publications) on causal–

Table 1
Composition of the NHS balanced scorecard for year 2001/2002 and 2002/2003

	Indicators	2001/2002	2002/2003
Patient focus	A&E emergency admission waits (4 hours)		✓
	Better hospital food		✓
	Breast cancer treatment within a month	✓	✓
	Cancelled operations	✓	✓
	Day case booking		✓
	Delayed transfers of care	✓	✓
	Nine month heart operation waits		✓
	Outpatient A&E survey – access & waiting		✓
	Outpatient A&E survey – better information, more choice		✓
	Outpatient A&E survey – building relationships		✓
	Outpatient A&E survey – clean, comfortable, friendly place to be		✓
	Outpatient A&E survey – safe, high quality, co-ordinated care		✓
	Paediatric outpatient did not attend rates		✓
	Patient complaints procedure		✓
	Privacy & dignity[a]	✓	✓
	Six month inpatient waits	✓	✓
	Thirteen week outpatient waits	✓	✓
	Total inpatient waits - % of plan	✓	✓
	Waiting times for Rapid Access Chest Pain Clinic		✓
Clinical Focus	Clinical Negligence	✓	✓
	Deaths within 30 days of a heart bypass operation[a]	✓	✓
	Deaths within 30 days of selected surgical procedures[a]	✓	✓
	Emergency readmission to hospital following discharge	✓	✓
	Emergency readmission to hospital following discharge for children	✓	✓
	Emergency readmission to hospital following treatment for a fractured hip	✓	✓
	Emergency readmission to hospital following treatment for a stroke	✓	✓
	Returning home following hospital treatment for fractured hip	✓	
	Returning home following hospital treatment for stroke	✓	
	Infection control procedures		✓
	Methicillin Resistant Staphylococcus Aureus (MRSA) bacteraemia improvement score		✓
	Thrombolysis treatment time		✓
Capacity and Capability Focus	Consultant appraisal		✓
	Data quality	✓	✓
	Fire, Health & Safety		✓
	Information Governance	✓	✓
	Junior doctors' hours	✓	✓
	Sickness absence rate	✓	✓
	Staff opinion survey	✓	✓

[a] Variables related to special practices or high proportion of missing information.

effect relationships between different types of indicators poses difficulty in conceptualising dynamics and operations. Disagreements and doubts raised about the utility of NHS performance ratings [10–12] are the manifestation of this difficulty. These disagreements and doubts are similar to the fundamental questions highlighted by Akkermans and van Oorschot while introducing BSC in their recent case study of the use of system dynamics in BSC development [13]. They emphasised that the relevance of the balanced scorecard developed, and the processes used in developing it, should be tested rather than assumed. They also expressed concern whether all indicators should work in the same direction or counteract. These same issues might be behind the disagreements and doubts about the utility of the NHS balanced scorecard.

This paper proposes that a causal-loop diagram (CLD) can provide a holistic view of the system and help reduce the split between different views about the NHS performance ratings framework. Providing information about the connections and interactions between different performance indicators would increase awareness of performance ratings and the formulation of performance improvement strategies. A CLD is a way of presenting models of system thinking based on cause-and-effect relationships between different system components or aspects. System thinking explains the dynamics of a system under study and overcomes limitations of linear modelling by also accounting for feedback effects.

In order to identify cause-and-effect relationships amongst performance indicators in the NHS BSC, we apply structural equation modelling [14,15] (SEM) to NHS Hospital Trusts performance ratings data for 2001/2002 and 2002/2003. SEM has been used successfully for validating causal effect assumptions in social sciences, and encompasses and extends regression, econometric, and factor analysis methods. Bollen's [15] milestone work in SEM literature has built parallels and clarified differences between SEM and other traditional and established methods.

A resulting significant SEM model is used to construct a CLD, on the basis of which we investigate possible trade-offs (compromises) within the NHS BSC.

2. Methodology

Investigating cause-and-effect relationships between indicators requires a structured and logical approach: data selection and pre-processing, model investigation, and model representation. Fig. 2 outlines the framework addressing the objective of the paper with these methodological processes and outputs.

2.1. Data selection and pre-processing

We used 'NHS Performance Ratings' data for the years 2001/2002 and 2002/2003, published by the Department of Health in Microsoft® Excel® datasheets (http://www.performance.doh.gov.uk/performanceratings, last accessed February 8, 2005). For each year worksheets describe the indicators and list the names of the trusts by bands according to their performance. Despite the limitations of the data, two years of performance ratings data are sufficient to satisfy the time-lag assumption [16] related to causality and justify the use of the modification index (MI) for model investigation in SEM. The MI provides possible model parameters that would improve model fit and significance [17].

Table 1 shows that the two years have different sets of performance indicators. Nineteen indicators are common to both years (seven patient focus, seven clinical focus, and five capability and capacity focus indicators). Three indicators – Deaths within 30 Days of a Heart Bypass Operation, Deaths within 30 days of Selected Surgical Procedures, and Privacy and Dignity – have a high proportion

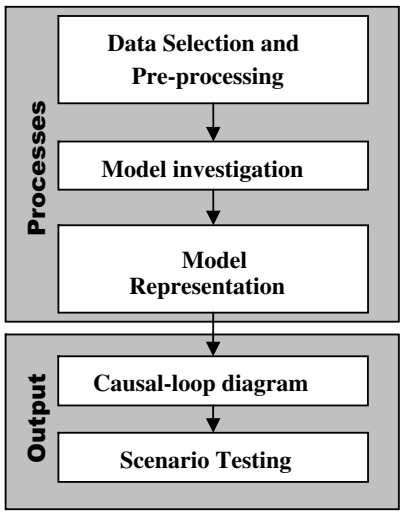


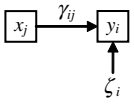
Fig. 2. Illustrated methodology.

of missing information or relate to special practice, hence, are not applicable to all hospital trusts. Thus this study is based on the 16 common performance indicators for which data is available.

Data pre-processing involved definition of missing values for selected performance indicators and conversion of all percentage variables into fractions of one to minimise scale difference.

2.2. Model investigation

The following general path diagram provides a conceptual structure for the model of causal relationships investigated. The model tests the causal effect of 2001/2002 indicators (x_j) on 2002/2003 indicators (y_i).



The above model can be specified in terms of equations as

$$y_i = \gamma_{ij} x_j + \zeta_i, \quad \text{for } i = 1, \ldots, m \text{ and } j = 1, \ldots, n.$$

Here γ_{ij} is the coefficient suggesting the presence and measuring the weight of the causal relationship between the variables x_j and y_i. The variable ζ_i represents the exogenous unobserved influence on the variable y_i. For $i = j$, x_j and y_i are observations of the same indicator for 2001/2002 and 2002/2003 respectively.

We used AMOS (Analysis of Moment Structures), a software add-in package for SPSS, to examine the above structural equation model. The final significant model was the result of forward–backward iterations; at each iteration we included parameters suggested by the MI and unselected non-significant parameters that improved model fit. We stopped this process when no more parameters suggested by the MI found significant and improved model fit. Details of the procedure can be found in technical report [18]. The MI produced by AMOS is as described by Jöreskog and Sörbom [19] and explained by Sörbom [17].

2.3. Model representation

The significant structural equation model provided information about causal relationships amongst the selected performance indicators used in the NHS BSC. Each significant causal relationship identified by this model was translated into either a positive or a negative causal effect in a CLD.

3. Results

3.1. The Causal-loops

The Causal-loop diagram in Fig. 3 is the common minimum significant structure derived from the 16 common performance indicators of the NHS BSC. As more information can be made available, other performance indicators can prove to be linked with this structure using the same methodology. Clinical Negligence, a performance indicator of Clinical Focus in the NHS BSC, was not found significantly related with other indicators included in the study (see Fig. 3) and therefore is shown in Fig. 3 but omitted in later figures.

There are 12 reinforcing loops (R) and five balancing loops (B). Reinforcing loops indicate a structure with exponential growth or decay, also known as "snowball effect". Balancing loops, also known as swinging-weights, indicate that the structure has an in-built counter effect, which controls growth or decay. In a CLD, reinforcing loops have no or an even number of negative effect links. For any cause and effect variables linked with negative link, the effect will have opposite results than the cause variable. In reinforcing loops though, the effect variables linked with only every odd numbered negative link are in contradictory position to that of the other variables in the loop. This feature is pivotal to scenario testing. On the other hand, negative effect links in the balancing loops stabilise such contradictory positions with counter effects at the next iteration in the loop.

In Fig. 3, Emergency Readmissions, defined as emergency readmission to hospital within 28 days, is a critical indicator since it is part of all reinforcing loops and all balancing loops except one. Emergency Readmissions has the largest number of links (outward and inward together) to other indicators. Its position in this derived network of causal relationships means that improving emergency readmission induces further improvement at the next iteration (year) and degradation in emergency readmission induces further degradation. The percentage of planned target achieved for the total number of patients waiting for an inpatient appointment (Total

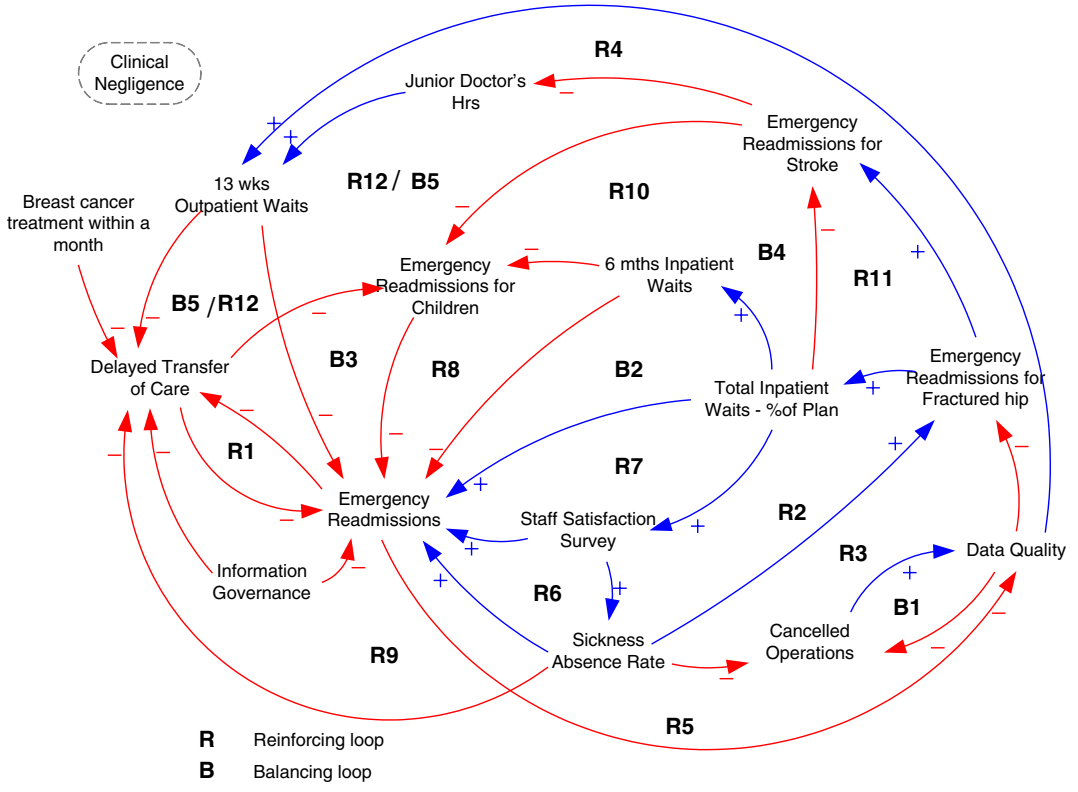


Fig. 3. Causal-loop diagram for the NHS balanced scorecard.

Inpatient Waits – % of Plan) and the amount of time wasted through absences as a percentage of staff time available for the directly employed NHS staff (Sickness Absence Rate) are the second most connected indicators. These three performance indicators, one of clinical focus (Emergency Readmissions), one of patient focus (Total Inpatient Waits – % of Plan) and one of capability & capacity focus (Sickness Absence Rate) have links to and from all three types of indicators. The definitions of Emergency Readmissions and Sickness Absence Rate are intuitive. The third indicator, Total Inpatient Waits – % of Plan, is defined as a measure of deviation from the planned targets. On a given year, a trust may serve more or less than its planned patient intake, from the total number of patients who are waiting for an appointment. The purpose of this performance indicator is to reduce waiting times for patients. There are two loops in Fig. 3, labelled as R12/B5 and B5/R12, which are balancing or reinforcing depending on the dominance of the causal link/effect from the Total Inpatient Waits – % of Plan to the Emergency Readmissions for Stroke.

3.2. Scenario testing

We investigate the effects of intervention on Emergency Readmissions, the most linked indicator. For the purpose of analysis, the six possible scenarios can be grouped in two sets of three scenarios, depending on whether the balancing loop B3 in Fig. 3 is assumed or not to be dormant. In either case similar results are obtained, therefore only the three scenarios where B3 is dormant are considered.

The links to Emergency Readmissions for Stroke have different polarity (see Fig. 3), therefore their combined effect on this indicator cannot be ascertained without further assumptions regarding their dominance. In Scenario A (Fig. 4), we assume that the negative link from Total Inpatient Waits – % of Plan is non-dominant, i.e. the links which it affects are dominated by other competing effects, and are able to ascertain all effects in the CLD. However, when we assume this link is dominant, more assumptions are required to ascertain the combined effect of the links to Emergency Readmissions for Children. Thus, in Scenario B (Fig. 5) and Scenario C (Fig. 6), the link from Total Inpatient

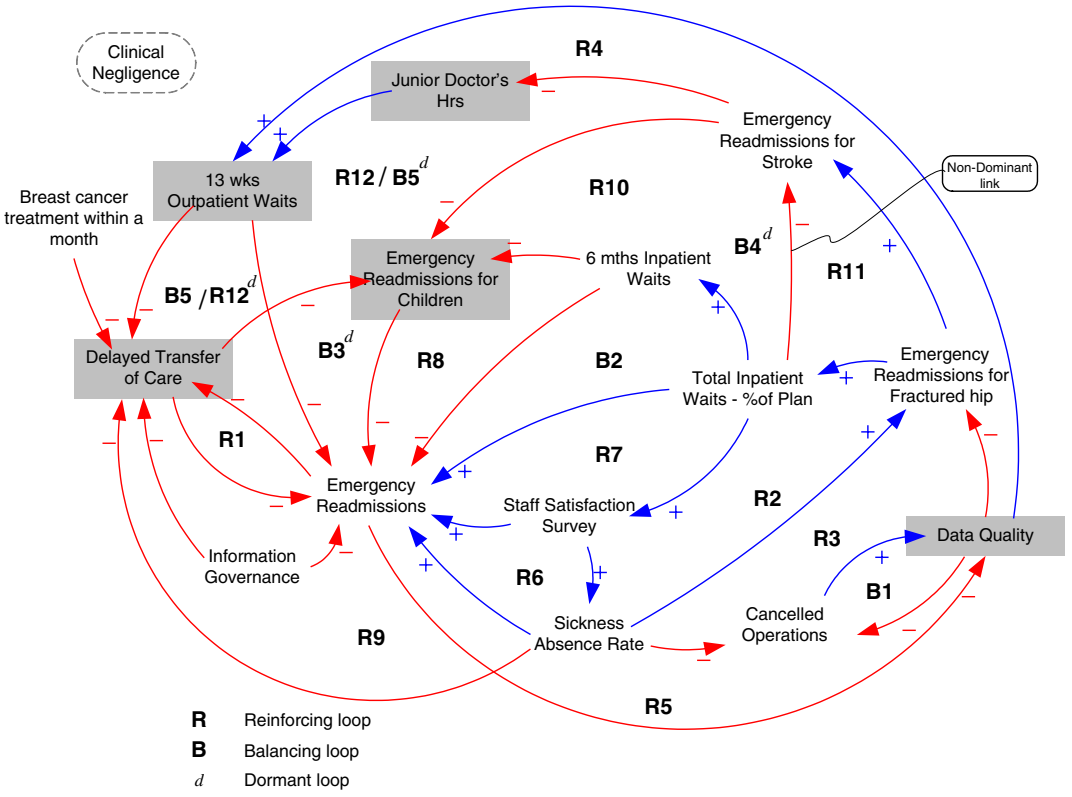


Fig. 4. Scenario A. The negative link from the Total Inpatient Waits – % of Plan to the Emergency Readmissions for Stroke is assumed non-dominant.

Waits – % of Plan and from Emergency Readmissions for Stroke is assumed non-dominant respectively.

The states of indicators resulting from these three scenarios are listed in Table 2. In all three scenarios, the percentage of patients whose transfer from hospital was delayed (Delayed Transfer of Care) will be compromised due to the direct negative link bringing the effect of improvement in Emergency Readmissions to Delayed Transfer of Care. On the other side, the negative link from Emergency Readmissions will compromise the Data Quality indicator due to the effect of the negative link in the reinforcing loop. N.B. In the long term, this effect will be diluted because of its relationship with Cancelled Operations in loop B1. The resulting negative effect from Data Quality improves Emergency Readmissions for Fractured Hip.

Specific to each scenario, whether Emergency Readmissions for Stroke will be compromised or not depends on the end result of the negative effect from Total Inpatient Waits – % of Plan, the positive effect from Emergency Readmissions for Fractured Hip, and the direct positive effect from Emergency Readmissions. Emergency Readmissions for Stroke is compromised in Scenario B (Fig. 5) and Scenario C (Fig. 6), but not in Scenario A (Fig. 4). Consequently, based on the position of Emergency Readmissions for Stroke, the indicator of the percentage of junior doctors complying in full with the New Deal on junior doctors' hours (Junior Doctors' Hours) and that of the percentage of patients seen within 13 weeks of GP written referral (13 weeks Outpatient Waits) will be compromised if Emergency Readmissions for Stroke is not compromised, which is the case in Scenario A. Emergency Readmissions for Children is compromised in Scenario A and C but not in Scenario B. The presence of different non-dominant links differentiates each scenario and the state of the concerned performance indicators. Compromised indicators are highlighted with grey-shaded rectangles in Figs. 4–6.

The scenario comparison in Table 2 provides a clearer picture regarding possible compromises. Table 2 lists the performance indicators that have been participating in the various loops and their

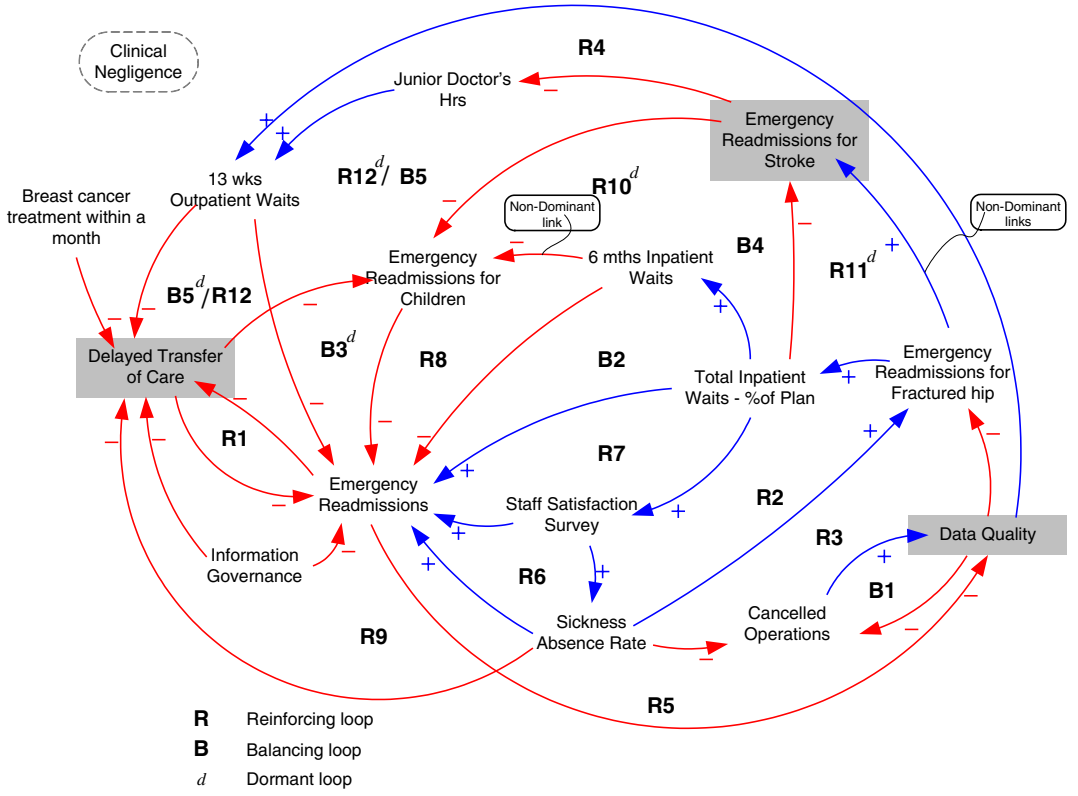


Fig. 5. Scenario B. The positive link from Emergency Readmissions for Fractured Hip to Emergency Readmissions for Stroke, the positive link from emergency readmission to Emergency Readmissions for Stroke and the negative link from 6 months Inpatient Waits to Emergency Readmissions for Children are assumed non-dominant.

proposed status under different scenarios. It suggests that compared to overall emergency readmission, Data Quality and Delayed Transfer of Care indicators are compromised in all scenarios. Junior Doctors' Hours and 13 weeks Outpatient Waits indicators are compromised in Scenario A. Emergency Readmissions for Stroke is compromised in Scenario B and C; and Emergency Readmissions for Children is compromised in Scenario A and C. In all scenarios, the loop B3 is assumed dormant, i.e. its effect is ignored. If the loop B3 is not dormant then each scenario could be extended to have sub-scenarios. It will also reduce the effectiveness of the intervention brought for emergency readmission conditions, and the contrast between com- promised and non-compromised performance indicators.

4. Discussion

We applied structural equation modelling to identify the relationships between 16 common performance indicators in the NHS Balanced Scorecards (BSC) for 2001/2002 and 2002/2003 and derived a causal-loop diagram (CLD) to show how the indicators interact. Scenario testing indicates that the NHS BSC has conflicting subsets of indicators. As far as the Emergency Readmissions indicator is concerned, reducing Emergency Readmissions in NHS hospitals impacts negatively on Delayed Transfer of Care and Data Quality. These adverse effects would have to be compensated by other intervention(s), which in turn could increase Emergency Readmissions.

Usually CLDs are created following qualitative and formative studies involving stakeholders and expert opinion. Data is collected to validate the model. Commercially, BSCs are used to foster sustainable growth and development. In these models the four dimensions used – learning and growth, internal processes, customers and financial – have established cause-and-effect relationships. However, although the dimensions in the NHS BSC are meaningful, their inter-relationships are unclear.

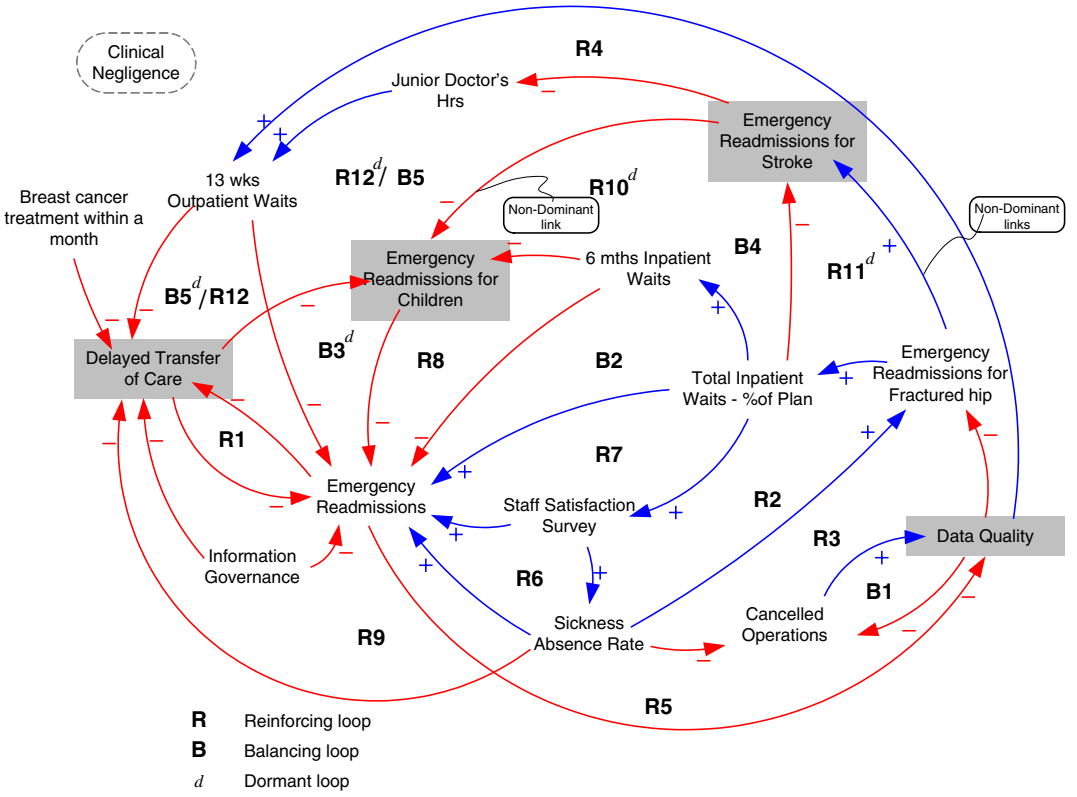


Fig. 6. Scenario C. The positive link from Emergency Readmissions for Fractured Hip to Emergency Readmissions for Stroke, the positive link from Emergency Readmissions to Emergency Readmissions for Stroke and the negative link from Emergency Readmissions for Stroke to Emergency Readmissions for Children are assumed non-dominant.

Table 2
Tabulated patterns based on Scenarios A, B, and C

	Performance Variables (affected by the feedback loops)	Improvement in Emergency Readmission		
		Scenario A	Scenario B	Scenario C
Patient Focus	6mths Inpatient waits	0	0	0
	Total Inpatient waits-%of Plan	0	0	0
	13wks Outpatient waits	1	0	0
	Cancelled Operations	0	0	0
	Delayed Transfer of Care	1	1	1
Clinical Focus	Emergency Readmission	0	0	0
	Emergency Readmission for Children	1	0	1
	Emergency Readmission for Fractured hip	0	0	0
	Emergency Readmission for Stroke	0	1	1
Capcity & Capability Focus	Data Quality	1	1	1
	Staff Satisfaction Survey	0	0	0
	Junior Doctors' Hrs	1	0	0
	Sickness absence rate	0	0	0

not compromised
compromised

Identifying the statistically significant relationships between the indicators in the NHS BSC would provide the basis for understanding the dynamics of a basket of performance indicators. This objective forms the basis of this novel approach to reconstruct the relationships between indicators of the NHS BSC. Using structured equation modelling we determined the statistical relationships (p-value < 0.05) between 16 of the common indicators in the scorecard. Using casual-loop diagrams we found that the key indicator was emergency readmission.

The central role of emergency readmission within the current set of indicators suggests that the starting point to address the recurring problems in NHS hospitals is to focus on the clinical and social causes of emergency readmissions. A word of caution should be expressed, however, because our CLD was based only on two years Performance Data for all Acute NHS Trusts in England. Three performance indicators were excluded as they had insufficient data. If the data had been available, including these indicators might have added more links and loops. However, the structure presented here would remain valid as the existing relationships would not have changed. Thus causal-loop diagrams could be used as a reference framework, to build a consensus for policy actions that would lead to a solution for current problems.

In this study, the purpose of the reconstructed CLD is to understand the impact of the basket of BSC indicators, rather than to validate each relationship separately. However in some cases, practical explanations can be provided. For instance the relationship between Emergency Readmissions and Delayed Transfer of Care could be explained by introducing an intermediate indicator measuring length of stay (Fig. 7). The relationships between length of stay and emergency readmission have been investigated by Leyland [20] and Kossovsky et al. [21]. Their findings imply that delayed transfers of care results in increased length of stay, so there is a positive correlation between the corresponding indicators.

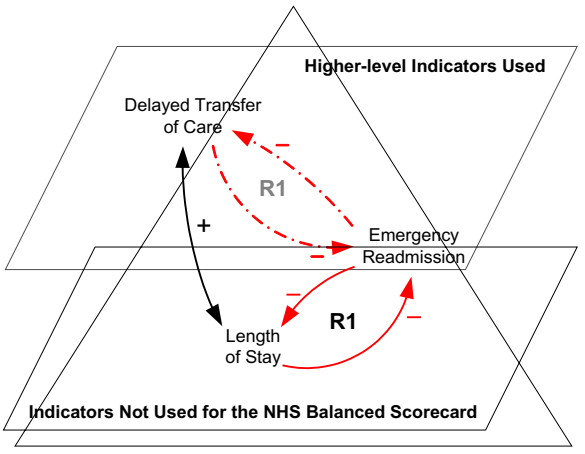


Fig. 7. Connections to lower-level indicator(s).

The NHS star rating system has received numerous criticisms [22–26] aimed at both individual components and at the overall scheme. The approach developed here provides a basis for answering questions about 'how and what works' in the existing healthcare system.

5. Conclusion

Managing performance in large organisations such as the NHS consists in orchestrating continuously a vast number of indicators. Frameworks such as BSC are useful strategic tools that link various performance indicators to performance management activities/processes of the organisation. However, their success is determined by the knowledge of relationships between indicators and how these relationships address long-term performance goals. Using historic NHS performance indicators we have identified a list of relationships that can be further investigated for in-depth knowledge. This knowledge can be acquired from the detailed interrelationships between different aspect of the present healthcare units and the whole system. Scenario analysis results suggest that current performance improvement may not be sustainable due to a conflict of indicators in the NHS BSC. This raises questions about the long-term effect of current policies in the UK, which aim at giving increasing autonomy to top performing hospitals.

The findings in this research are inferences about an average acute NHS hospital trust. The study is using the maximum possible number of indicators that could have been used. The use of subset of indicators is a limitation of data availability. The Department of Health can easily incorporate all possible indicators by recalculating indicator values with calibrated and consistent criteria from their existing data silos. The network of causal relationships in this study is based on identified linear relationships between performance indicators using structural equation modelling. Non-linear relationships could provide more detailed characteristics

of the relationships between indicators and could be investigated in further research. Further research will look for approaches to incorporate the changing composition of the BSC and observe characteristics over a longer period.

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