

Research report

Happier workers Healthier patients

An analysis of healthcare worker
engagement and health service
outcomes in Victoria

Report prepared for Safer Care Victoria, in collaboration with Victorian Managed Insurance Authority and the Victorian Public Sector Commission by University of Melbourne

Authors:

Prof Simon Bell¹, Dr Niharika Garud¹, Dr Rakesh Pati²,
Dr Victor Sojo¹, Dr Josh Healy, Dr Mladen Adamovic

Research Assistants:

Fatemeh Saninejad, Gregory McCallum, Rebecca
Schachtman, Deborah J Towns

¹ University of Melbourne

² Deakin University

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Executive summary

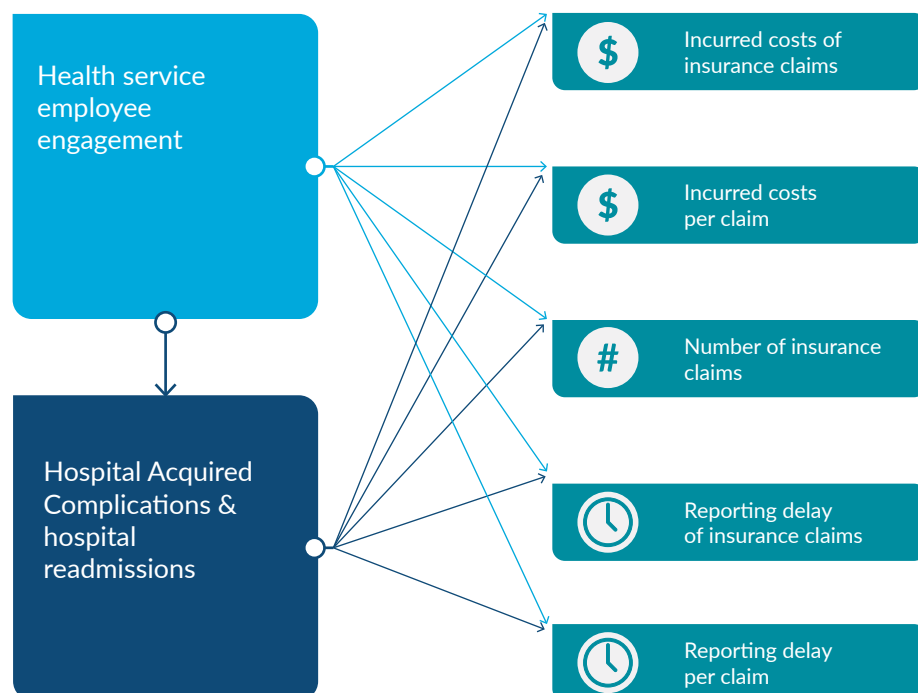
Objectives

Every day, millions of Australians rely on the public health system for the delivery of health and care. The link between employee engagement and outcomes is well documented across a range of sectors and settings. This report explores how engagement levels for Victorian public health service employees impact patient and financial outcomes for hospitals, medical indemnity insurers, and the broader community.

The research explores links between:

- 1** employee engagement, hospital acquired complications and readmission rates
- 2** employee engagement, hospital acquired complications, reporting delays for insurance claims, and the cost of insurance claims.

Figure 1 Hypothesised relationship between health service employee engagement, Hospital Acquired Complications and insurance outcomes



Contributions & implications

The findings have broad implications. Engagement and satisfaction among public health care workers impact the care patients receive in public healthcare settings. Higher engagement levels are linked to better outcomes for patients and benefits for communities through reduced insurance claims and hospital administration costs.

In the Australian context, public healthcare systems provide a wide range of services to a diverse community. Before the COVID-19 pandemic, the Commonwealth Government was spending around 10% of the gross domestic product on health (Australian Institute of Health and Welfare, 2020), so the findings of this research can inform policy and decision making on investments in the public health system and the wellbeing of its workers, as well as the culture of the organisations in the system. Furthermore, Hospital Acquired Complications are estimated to represent 8.9% of hospital budgets; approximately \$4.1 billion per year¹.

This research complements earlier research conducted by the State Services Authority (SSA) and Victorian Managed Insurance Authority (VMIA) on how employee behaviour determines health service outcomes (State Services Authority & Victorian Managed Insurance Authority, 2012).

Methods

This research links three datasets for the period 2013-2018:

- 1** **employee engagement data** from the People Matter Survey, provided by the Victorian Public Sector Commission
- 2** **insurance claims**, provided by Victorian Managed Insurance Authority
- 3** **Hospital Acquired Complication and readmission rates**, provided by Safer Care Victoria

The dataset was analysed using quantitative analysis techniques of correlations and panel data regressions for health service providers.

1 Source: <https://www.aihw.gov.au/reports/australias-health/health-expenditure>

Key findings

Exploring the impact of health service employee engagement on insurance claim outcomes, we found employee engagement to reduce incurred costs per claim, and reporting delays per claim. Our analyses found that health service employee engagement reduces average hospital acquired complications at health services. Employee engagement was also found to decrease most individual HAC categories, such as pressure injury, falls resulting in fracture or other intracranial injury, healthcare associated infection, surgical complications, gastrointestinal bleeding, medication complications, delirium, persistent incontinence, malnutrition, cardiac complications, and neonatal birth trauma. Employee engagement was also found to reduce hip replacement readmission rates in hospitals, while its impact on other readmission rates was not found to be significant. These relationships were examined through individual models studying relationships step by step between two key variables at a time.

Not surprisingly, we also found that an increase in average HACs significantly increases all insurance outcomes (incurred costs, reporting delay, number of claims, incurred costs per claim, and reporting delay per claim). In addition, most individual HAC categories (1 to 14), except HAC 15 (perineal laceration during delivery) and HAC 16 (neonatal birth trauma), were found to increase all insurance claims outcomes.

Our full statistical model analysing engagement, insurance and HAC outcomes together indicates that HACs mediate the relationship between employee engagement and insurance claim outcomes. Therefore, as health service employee engagement increases, the HACs decrease leading to a decrease in insurance outcomes (costs and delays).

Research limitations

Although we established the robustness of proposed relationships using multiple methods, care should be taken interpreting findings of this research. Firstly, due to limitations in data and data sources, the models do not control for all confounding variables that might impact health service outcomes, which might alter the significance and direct applicability of these results. Secondly, independent variables significantly explain only a small portion of the variance in dependent variables. Finally, the use of any statistical technique, including panel data regression analyses, is constrained by its underlying assumptions.

Future research

Findings from this research and future collaborative projects exploring relationships between employee behaviours, organisational factors and performance measures in health services will contribute to understanding why some health organisations produce better outcomes. These findings may inform intervention strategies that can be applied across a range of public and private healthcare settings, as well as in other sectors and geographies.

Funding declaration & information

This research initiative has been funded by Safer Care Victoria and Victorian Managed Insurance Authority.

Introduction

This report explores the relationship between **healthcare worker engagement** in Victorian public hospitals and two important health service outcomes:



complications that patients acquire in hospital

insurance claims parameters (such as the number and total cost of insurance claims, delays in reporting insurance claims, reporting delay per claim, and cost per claim).

Earlier research in Victorian hospitals has studied relationships between organisational culture measures and medical indemnity claims (State Services Authority & Victorian Managed Insurance Authority, 2012).

The Australian public health system receives significant government funding and generally enjoys positive public opinion (Australian Government Department of Health, 2019; Australian Institute of Health and Welfare, 2018; Hardie & Critchley, 2008). Health services vary across jurisdictions. Variations in Australia's healthcare system have been studied extensively, including in the Australian Atlas of Healthcare Variation Series (2015, 2017, and 2018). Understanding what drives disparities can inform population-level interventions for health services and the broader community to improve health outcomes.

Health service effectiveness depends on factors at the national, community, health service, care team, and patient levels (Stone, Harrison, Feldman, et al., 2005; Armstrong, 2011). Healthcare employees – doctors, nursing staff, technical staff and other employee groups – ultimately determine healthcare outcomes (Laugesen, 2015; Stone et al., 2005). In particular, employee engagement among healthcare workers is hypothesised to create better patient outcomes and more efficient service delivery (Baird, Tung, & Yu, 2019; Dobrzykowski & McFadden, 2019; Jorm, Hudson, & Wallace, 2019; Prottas, & Nummelin, 2018).

Existing knowledge on relationships between employees and outcomes in healthcare

Research studies in healthcare in Australia and other countries point to a wide range of factors that may influence the performance of healthcare practitioners, provider organisations and overall health outcomes for patients. One stream of research has shown the importance of hospital resources in driving healthcare outcomes and hospital performance. Another shows how employee behaviours and perceptions influence the quality of healthcare services in a variety of contexts (Jorm, Hudson & Wallace, 2019; Stone et al., 2005).

Through a comprehensive literature review, we shortlisted the key published evidence and prior research in two parts to provide an overview of the existing knowledge in this area:

1

key factors in the areas of hospital resources, including funding, costs, financial resources, human resources and managerial practices, that impact healthcare outcomes and hospital performance (see Appendix 1)

2

evidence on impact of engagement and other key behaviours of healthcare employees on a variety of health outcomes (see Appendix 2).

For the purposes of this study, we focused on understanding how healthcare employee engagement can shape healthcare outcomes in Victorian public hospitals.

Methods

Data sources

1. People Matter Survey

The Victorian Public Sector Commission (VPSC) assesses and provides advice on Victorian public sector workforce management and development. The VPSC's People and Analytics branch administers the People Matter Survey (PMS), a key data source for our report.

PMS is Victoria's main annual survey of public sector employees. It provides detailed, anonymised evidence about how Victorian public servants view their jobs and workplaces, whether these perceptions vary across different types of organisations and workers, and how these perceptions may be changing over time. The PMS provides a detailed view of employee engagement and job satisfaction, which underpins government strategies and initiatives to build positive and inclusive public sector workplaces that reflect the diversity of Victoria's broader population. In 2019, the PMS was voluntarily completed by more than 90,000 employees in nearly 200 eligible organisations.

For the purposes of this study, we analysed PMS data collected in Victorian public hospitals from 2013 to 2018 to assess consistency and selected key indicators for our analyses. Appendix 3 contains more information about the items used for our analyses.

The data was generously contributed by the health services listed in Appendix 4 for the purposes of conducting this research. After preliminary screening for validity, a longitudinal dataset was constructed for analysis by connecting the datasets from PMS responses of each year using the linking variable of health service. We used data on the dimension of health service over time, represented in the longitudinal dataset by "health service - year". Our analysis relies on observing changes over time in health service outcomes year-on-year for the period from 2013 to 2018.



Ethics approval

was received from the University of Melbourne before starting the data processing and analysis stages.

(ethics approval number: 1853295.1)

2. Insurance data - Victorian Managed Insurance Authority

Victorian Managed Insurance Authority (VMIA) is the Victorian Government's insurer and risk adviser. VMIA makes selected data available as part of its contribution to the Victorian Government's DataVic access policy. Our analyses use VMIA data on hospital insurance claims.

For this study, we derived five dependent variables commonly identified as indicators of performance by VMIA from the data it provided:



Victorian Managed Insurance Authority is the Victorian Government's insurer and risk adviser.

1

One of the most important variables is the ***incurred costs of insurance claims made by health service providers*** each year. This indicates the dollar value of claims and potential claims in a given health service, and includes both amounts paid and amounts in reserve on a claim.

2

Reporting delay in days per year of each health service provider. Delays represent the difference between loss date and report date, as calculated by VMIA.

3

Number of claims and incidents notified to VMIA from a particular health care provider per year.

4

Reporting delay per claim, calculated by dividing the total delay by the number of claims made per health service provider per year.

5

Incurred costs per claim, calculated by dividing the total incurred costs by the number of claims made per health service provider per year.

3. Safer Care Victoria

i. Hospital Acquired Complications

Safer Care Victoria (SCV) is Victoria's agency for quality and safety improvement and is an administrative office of The Department of Health. The Department of Health (formerly the Department of Health and Human Services) is responsible for Victoria's public healthcare system and related social policies and hosts Victoria's Agency for Healthcare Information (VAHI).

Hospital Acquired Complication (HAC) refers to a "complication for which clinical risk mitigation strategies may reduce (but not necessarily eliminate) the risk of that complication occurring" (Australian Commission on Safety and Quality in Health Care - ACSQHC, 2019). ACSQHC defines a list of 16 HAC categories and further subcategories (Appendix 5).

The data provided include the count of 'in scope' episodes with a HAC for each of the HAC categories and subcategories. The counts at the subcategory levels do not add up to the count at category levels since the counts relate to the presence or absence of a HAC at that level. For example, if an episode had both a cardiac arrest and an arrhythmia complication (two different subcategories of cardiac complications), it will contribute a count of one for each of these subcategories and will also contribute only one to the count of cardiac complications.

The identification of 'in scope' episodes uses a method adopted by VAHI, updated for the most recent version of specifications from the Commission (v1.1, which includes mental health episodes previously excluded). Counts of 'in scope' episodes enable conversion to a rate/proportion. The criteria used for determining an 'in scope' episode are the same for all HACs, but HAC 15 and HAC 16 were converted to rates using a denominator provided by SCV. Data on some HACs were not available (see Appendix 5), and therefore excluded from our study.

For this study, we used HACs at each category level per health service provider. We also created an average HAC variable by averaging the HACs per health service provider per year per category, which was achieved by dividing the total counts of HACs per health service provider per year by the number of HAC categories for which data was provided. We included the variable of average HAC instead of total HAC, as it reduces the bias due to missing HAC data. For example, if the data for any HAC is missing, the total HAC would include it as zero or "0" value whereas an average HAC does not include the missing data in the analysis. Our study also included HACs at the individual category level (Appendix 5 contains the detailed list of HAC categories and subcategories).



Safer Care Victoria is Victoria's agency for quality and safety improvement, and is an administrative office of The Department of Health.

ii Readmission rate data

VAHI produces readmission rates for five types of readmissions:

- 1 Acute Myocardial Infarction (MI)
- 2 Heart failure
- 3 Hip replacements
- 4 Knee replacements
- 5 Tonsillectomy and Adenoidectomy.

Data were provided for the first four types of readmission rates which were used in this study. We also calculated the average readmission rate per health service provider for inclusion. This data is gathered at selected hospitals specialising in the medical procedures with varying levels of activity for these services and their share in the total activity in hospitals that provide them.

Linking the datasets

For our research, we analysed data on health service levels (health service providers), not for individual hospital campuses. Data from each source was cleaned and outliers removed. Diagnostics on the data revealed common linking variables that created linkages between the three datasets. Since all datasets had multiple variables gathered at different levels of analyses (individual, team/functional group, hospital, campus, health service provider), we linked the three datasets at the level of health service providers. The datasets for each health service provider were coded with unique health service provider IDs to create a panel dataset for processing and analyses.

The People Matter Survey data were aggregated and developed into two measures: percentage of employees agreeing and the weighted average of the responses.

We calculated two variables using the following formulae:

Equation 1

Agree percentage (PMS)

$$\textit{Agree percentage} = \frac{\{(\text{Number of employees responding "strongly agree"} + \text{Number of employees responding "agree"}) / \text{Total number of employees responding to the question}\} * 100$$

To calculate the weighted average, we coded the levels of scale into different points with most unfavourable as lowest (1) and most favourable as highest (5). For example, an item with a 5 point disagree-agree scale was coded as follows:

1	strongly disagree
2	disagree
3	neither agree nor disagree
4	agree
5	strongly agree

Then we calculated a weighted average using the following formula.

Equation 2

Weighted average (PMS)

$$\textit{Weighted average} = \frac{\{(1 * \text{number of employees responding "strongly disagree"} + 2 * \text{number of employees responding "disagree"} + 3 * \text{number of employees responding "neither agree nor disagree"} + 4 * \text{number of employees responding "agree"} + 5 * \text{number of employees responding "strongly agree"}\} / \text{Total number of employees responded to the question\}}$$

Quantitative analyses

We performed **correlation** and **panel** data analysis for this study.

Correlation analysis

<i>Correlation analysis</i>	<i>a statistical technique that evaluates a relationship between two variables, and is used to test possible connections between variables</i>
-----------------------------	--

A significant correlation indicates that a systematic change in one variable is associated with a systematic change in the other, either positive or negative.

<i>Positive correlation</i>	<i>two variables increase or decrease together</i>
<i>Negative correlation</i>	<i>one variable decreases when the other increases</i>

We use Pearson's two tailed correlation in this study. Pearson's coefficient is the measurement of correlation and ranges between +1 and -1, with -1 the strongest negative correlation possible and +1 the strongest positive correlation possible. Values closer to zero highlights weaker correlation, and values closer to -1/+1 indicate high correlation.

Panel data

<i>Panel data analyses</i>	<i>the statistical analysis of data sets consisting of multiple observations on each sampling unit</i>
----------------------------	--

Panel data often contains a large number of observations of multiple factors at the same level over multiple time periods, allowing the study of differences between multiple subjects/entities along with differences observed for each subject/entity over time.

Panel data regression models were used to analyse the final dataset. Regression models using panel data are better able to show cause and effect relationships. When a predictor or independent variable changes, regression models show the impact on the outcome or dependent variable, either positive or negative.

Findings & results

i. Results from correlation analyses

Table 6 provides the mean and standard deviation (SD) of variables, and Table 7 presents the correlation between all variables. All five dependent variables from the insurance data are correlated. All HAC variables are highly correlated (above 0.7), except HAC 15 and HAC 16 (which are ratios). As all HACs are also highly correlated with each other, the final regression analyses would face multicollinearity issues if all HACs were included in the model simultaneously.

Therefore, in our main analyses, we take the average HACs for the model and then test the relationships between each HAC and insurance outcomes individually. A health service provider with a high prevalence of one HAC is very likely to have a high prevalence in other HACs. It's therefore desirable for health service providers to have low HACs for all conditions. All HACs (except HAC 15 and HAC 16) were also found to positively relate to insurance outcomes. This indicates that as the number of HACs for a health service provider increases, the incurred costs, reporting delay, number of claims, reporting delay per claim, and incurred costs per claim also increase.

For readmission rates, hip replacements and heart failure were found to significantly correlate with the number of claims and reporting delay per claim, respectively. Other than the above, our findings indicated no correlation between readmission rates data and insurance data. The average readmission rate was also not found to be correlated to any of the insurance variables, and therefore removed from the analysis.

Our correlation analysis indicated that 2 of the engagement items from engagement scale negatively correlated to the insurance outcomes of incurred costs, reporting delay, number of claims, reporting delay per claim, and incurred costs per claim:

- an employee's strong personal attachment to their organisation
- an organisation's motivation to employees to achieve its objectives

Initial scatter plot analysis highlighted a clear negative correlation between employee engagement and:

- reporting delay per claim (Figure 2), as well as
- incurred costs per claim (Figure 3)

The correlation table also highlights that engagement variable was found to have a significant negative correlation with reporting delay, reporting delay per claim, incurred costs per claim. That is, hospitals with employees showing higher engagement had lower reporting delays, reporting delay per claim, and incurred costs per claim.

Figure 2 Employee engagement and reporting delay per claim

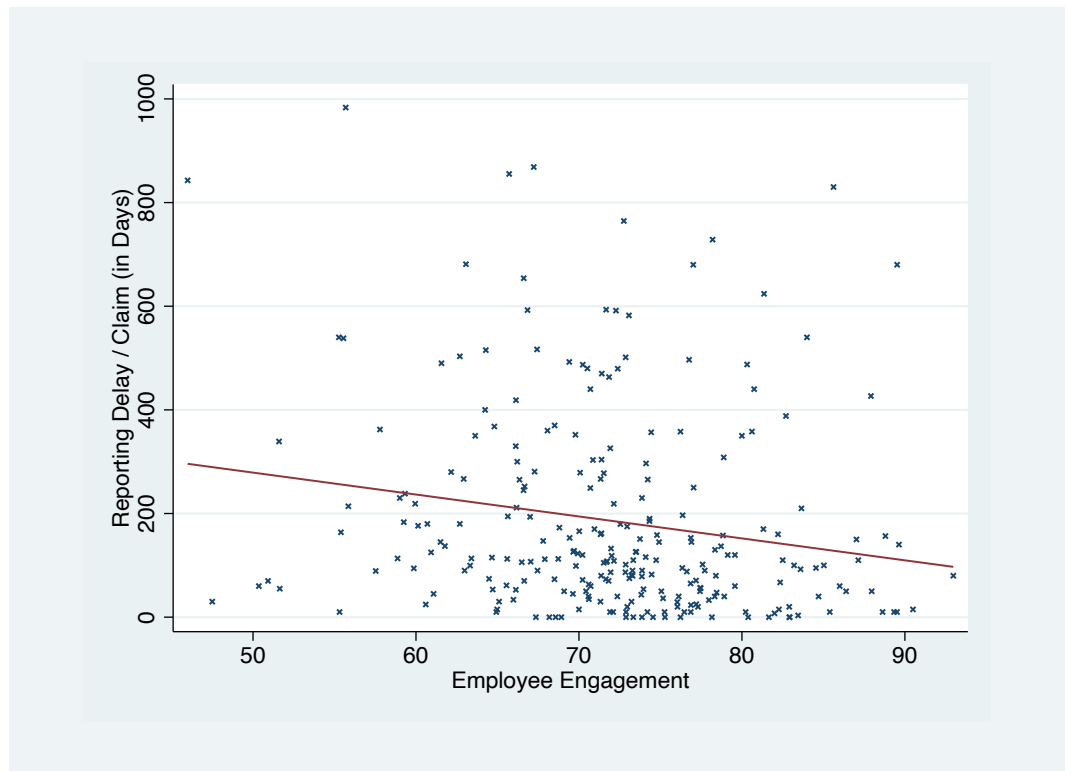
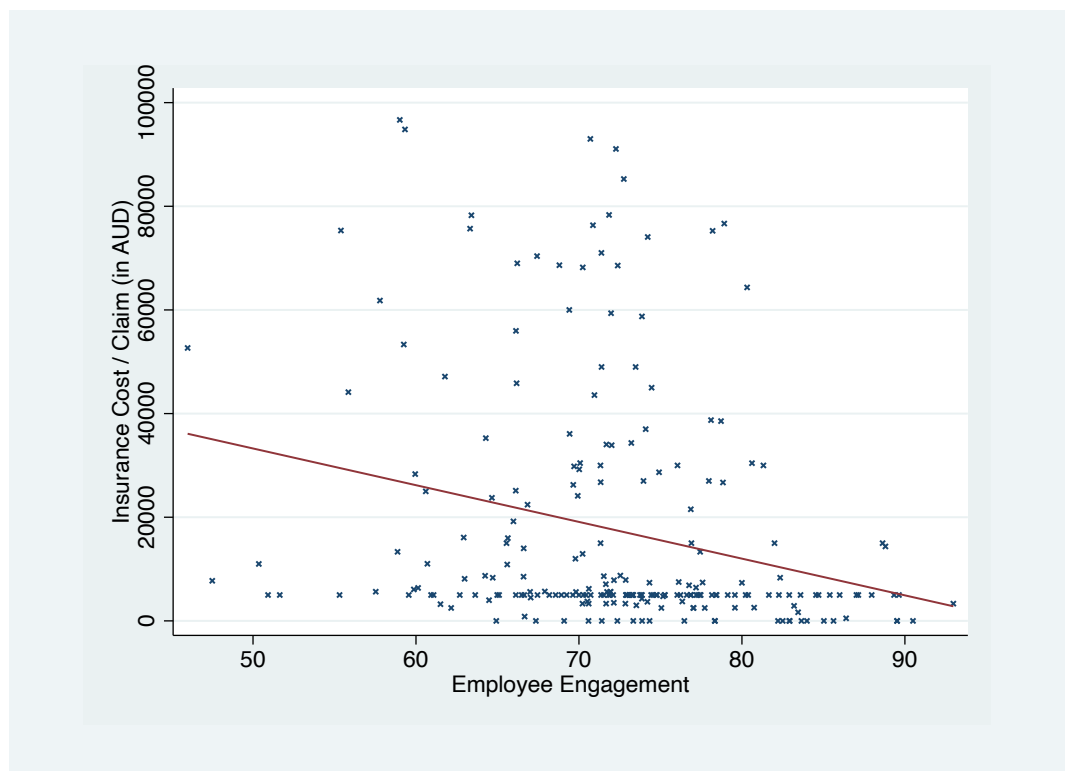


Figure 3 Employee engagement and incurred costs per claim



Our findings also indicated that experiencing bullying was positively correlated to cost and delay of insurance outcomes. So, health service providers should implement strategies to address and reduce bullying behaviours in their organisations. Our study also indicated that learning culture (*“The culture in my work area makes it easy to learn from the errors of others”*) increases the costs and delays in the short-term. This effect may be due to the additional costs and time required for learning processes. However, we expect learning culture to have an overall positive long-term effect on reducing delays in reporting and insured costs.

In our initial scatter plot analysis exploring the impact of employee engagement on HACs and re-admissions, we found employee engagement to have a negative impact on both total HACs (see Figure 4) and total re-admissions of the hospital (see Figure 5).

Figure 4 Employee engagement and total HACs

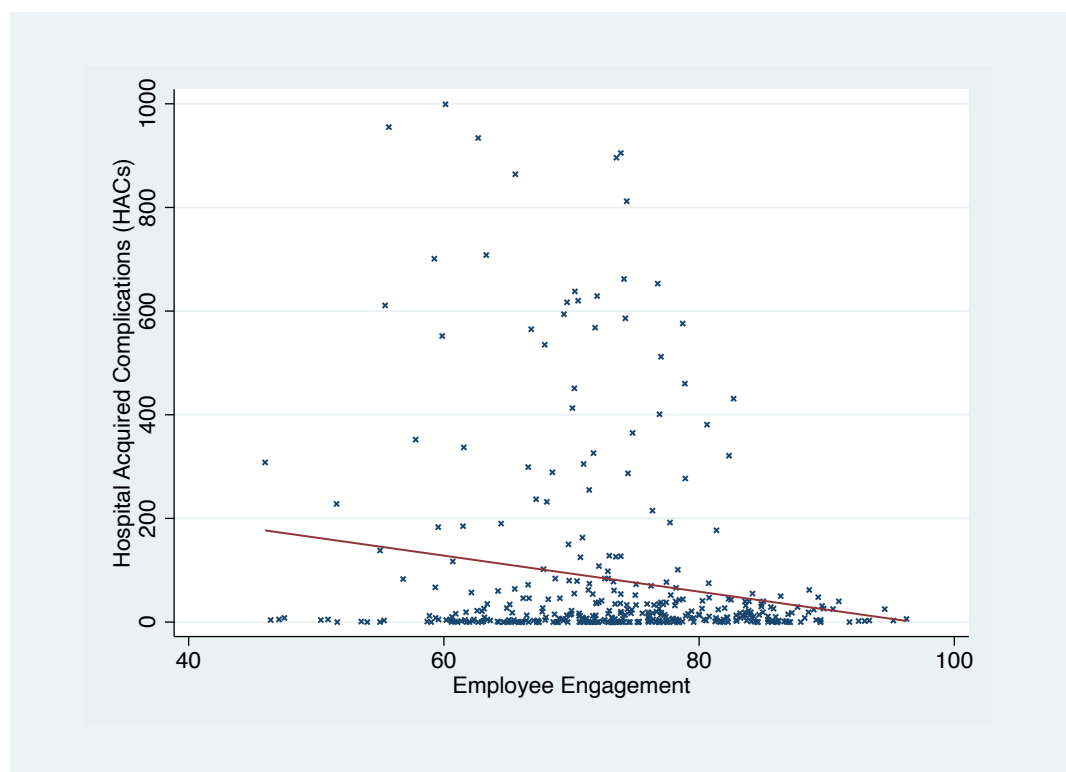
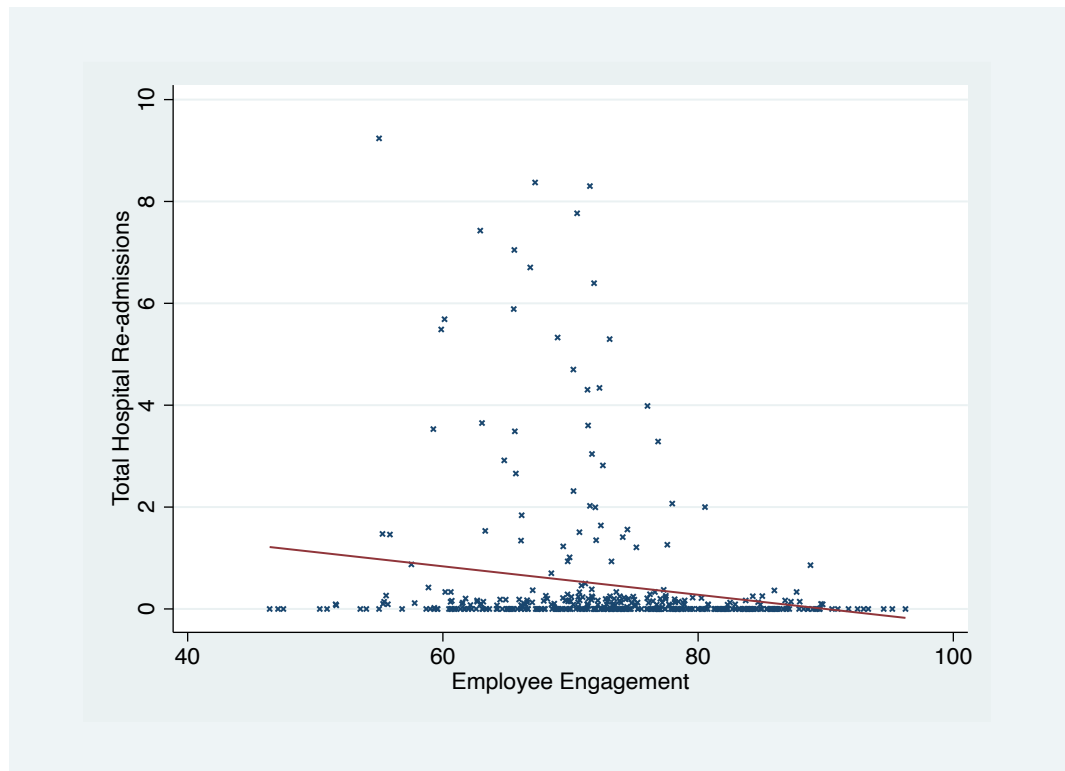


Figure 5 Employee engagement and total re-admissions



Overall engagement was found to have a negative correlation with most individual categories of HACs and average HACs. Apart from the overall engagement variable, we further analysed the five individual engagement items that create the overall engagement variable to test their individual effects on individual HACs, average HACs and readmission rates variables (see Table 6).

5 most important individual engagement items and employee recommendation variables for their individual effects on HACs (individual HACs and average HAC)	
Strongest effect	I feel strong personal attachment for my organisation
Moderately strong effect	My organisation motivated me to help achieve its objectives
Moderately strong effect	My organisation inspires me to do the best in my job
No effect	I would recommend my organisation as a good place to work
No effect	I am proud to tell others I work for my organisation

None of the five engagement items influence any of the four readmission rates variables.

We also compared the individual effect of the employee recommendation variable calculated using a single item PMS_Part2_6h – “I would recommend a friend or relative to be treated as a patient here” gathered under the category of patient safety in annual PMS surveys was found to negatively correlate with some HACs and also with average HACs. Similarly, PMS_Part1_6g – “Management is driving us to be a safety-centred organisation” and PMS_Part2_2a – “Considering everything, how satisfied are you with your current job?” were found to negatively correlate with most HACs and average HAC.

ii Results from panel data regression models average HAC results

For the main model in Table 1, we used a fixed effect panel model. Model 1 uses average HAC as a dependent variable and explores the impact of engagement. For models 2 to 6, we included incurred costs, reporting delay, number of claims, reporting delay per claim, and incurred costs per claim as dependent variables respectively. For all the above models, we included the lag variable of engagement as independent variables and included all other PMS questions (employee recommendation, client satisfaction, senior manager values, learning culture, patient safety focus, employee satisfaction, and bullying) as control variables. We also included the lag of average HACs as an independent variable for models 2 to 6.

The results of model 1 highlight that engagement negatively influences HACs. Therefore, higher employee engagement within a health service provider helps reduce HACs. The findings from models 2 to 6 clearly indicate that average HACs of the health service providers positively drive total incurred insurance costs, incurred costs per claim, number of claims, overall reporting delays and reporting delay per claim. The result also indicated that employee engagement at the health service does not influence the insurance claim costs directly when HACs is included. Therefore, employee engagement impacts insurance outcomes via HACs.

The models testing the impact of average readmission rate (average of the four readmission rates) on insurance outcome highlighted no significant results. They’re not included in the main result tables but their individual impact is discussed later. For robustness, we also tested all relationships using random effect models and found that the results were consistent with our main findings.

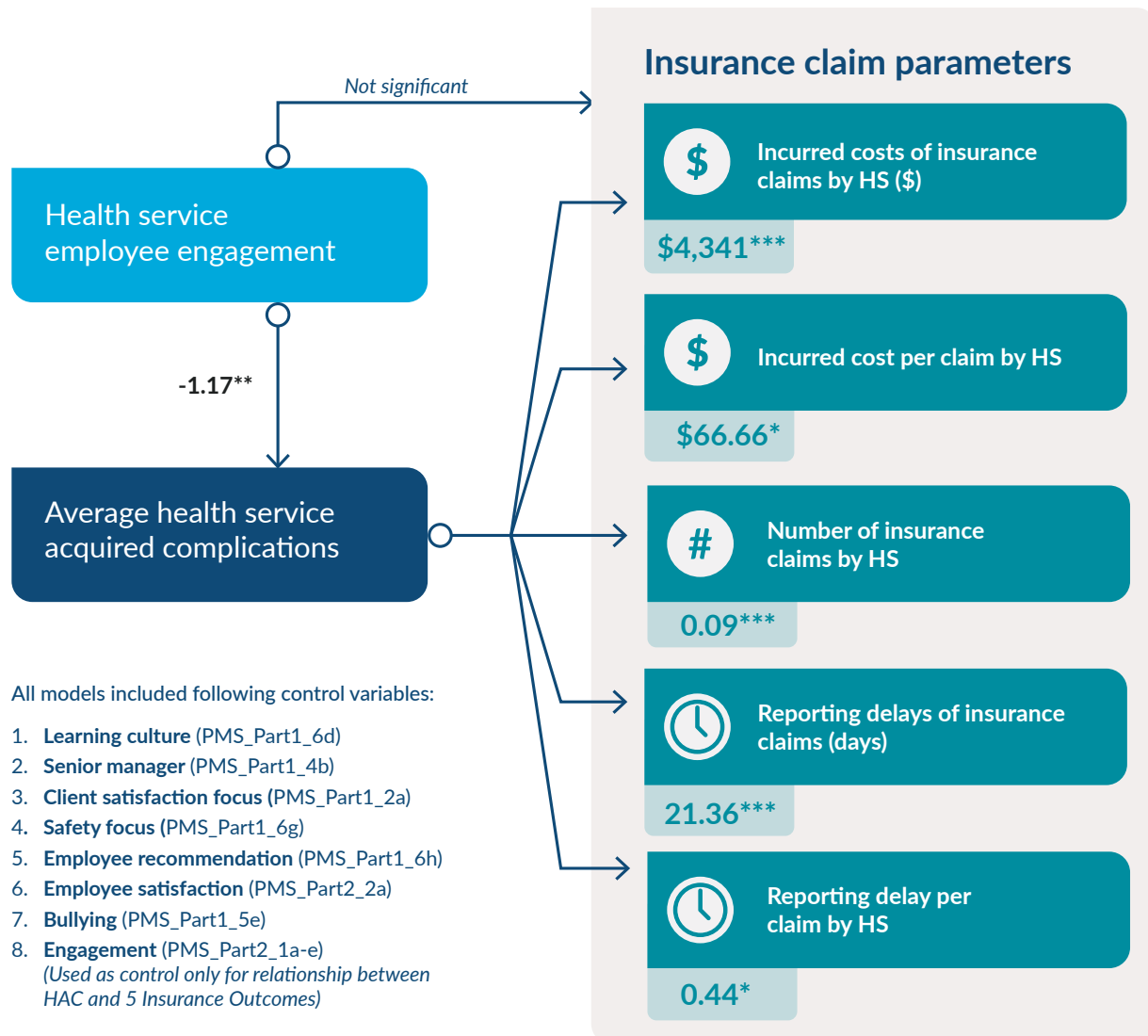
Figure 6 graphically presents the final results, provided in detail in Table 1.

The findings clearly highlight that a 1% increase in health service employee engagement (HS engagement) reduces the average HAC by 1.17 (a decrease of about 3%).

The findings also highlight that a 1-unit decrease in HACs on average lead to:

- total cost savings of \$4,341
- decrease in insured costs per claim of \$66.67
- reduction in reporting delays of 21.36 days
- reduction in number of claims of 0.09
- reduction in reporting delay per claim of 0.44 days per claim

Figure 6 Final model results: Health service employee engagement impact on HAC and insurance outcomes



Note	
	<ul style="list-style-type: none"> • HS = Health Service • NS = Not significant • All analyses presented here are prepared using the fixed effects panel model • Engagement does not have any significant impact on insurance claim parameters • *** denotes p<0.001; ** denotes p<0.01; * denotes p<0.05; † denotes p<0.01

Table 1 Final model results

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Average HAC	Incurred costs	Reporting delay	Reporting delay per claim	Number of claims	Incurred costs per claim
Average HAC		4341.00***	21.36***	0.44*	0.09***	66.66*
Engagement (PMS_Part2_1a-e)	-1.17**	-9256.88	-62.71	-0.05	0.15	-824.97
Employee recommendation (PMS_Part1_6h)	0.57	7311.41	81.78	9.27**	0.50	-187.38
Client satisfaction focus (PMS_Part1_2a)	-0.43	22139.95	9.27	1.15	-0.26	-185.44
Senior manager values (PMS_Part1_4b)	0.13	-3795.63	-20.10	-4.17	-0.04	-734.07
Learning culture (PMS_Part1_6d)	0.01	6629.00	54.86	-3.20	0.00	681.34
Patient safety focus (PMS_Part1_6g)	0.08	3383.99	-6.10	-6.26	-0.11	-396.7
Employee satisfaction (PMS_Part2_2a)	0.10	-20765.42	-104.15*	-5.47†	-0.34	150.71
Bullying (PMS_Part1_5e)	0.45	-3553.85	28.95	3.88	-0.07	682.1
Number of HS	86	64	64	64	64	64
N	334	149	149	149	149	149
R2 Within	0.075	0.261	0.468	0.266	0.304	0.0176
R2 Between	0.001	0.404	0.412	0.050	0.321	0.1356
R2 Overall	0.005	0.326	0.379	0.053	0.284	0.0659
F	19.27**	2.97**	7.42***	3.06**	3.7***	11.14***

Note

- HS = Health Service
- All analyses use fixed effect panel models
- All predictor (independent) variables have a 1 year lag
- *** denotes p<0.001; ** denotes p<0.01; * denotes p<0.05; † denotes p<0.01

Figure 7 Graphical representation of individual HAC impact on insurance outcomes

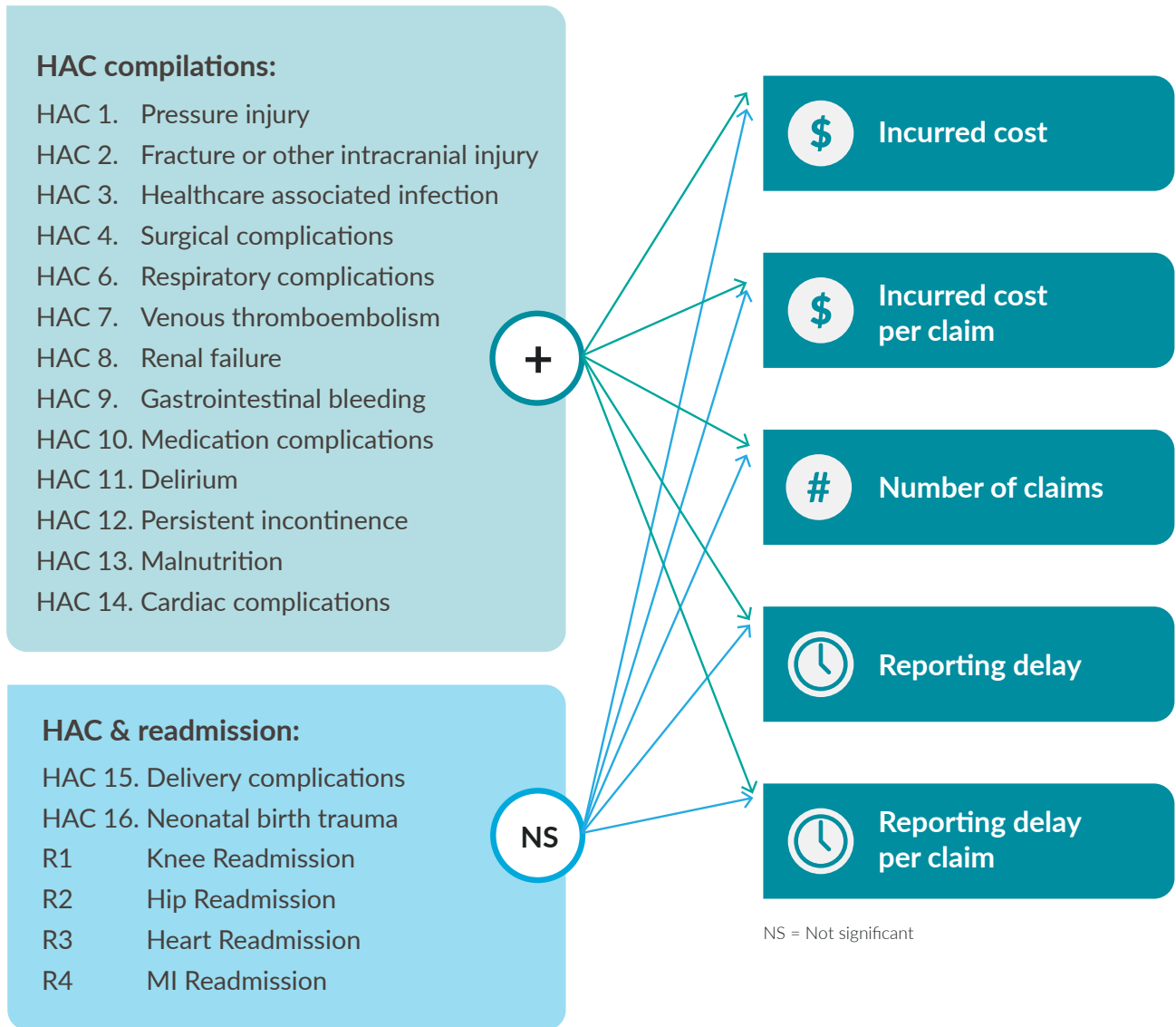


Figure 7 and Table 2 present results from multiple models where the impact of HACs and readmission rates are highlighted on all insurance outcomes – incurred costs, reporting delay, number of claims, reporting delay per claim, and incurred costs per claim. Each data point in Table 2 is calculated using a random effects model, where each HAC and readmission rate data are individually taken as independent variables.

Similar to findings from the correlations table, results from Table 2 clearly highlight that HACs 1 to 14 positively drive each of the four insurance parameters. However, we did not find any significant impact of HACs 15 and 16 on incurred costs, reporting delay, reporting delay per claim, number of claims and incurred costs per claim. Furthermore, none of the readmission rate indicators had any significant effects on insurance outcomes.

Table 2 HAC lag model and insurance claim parameters

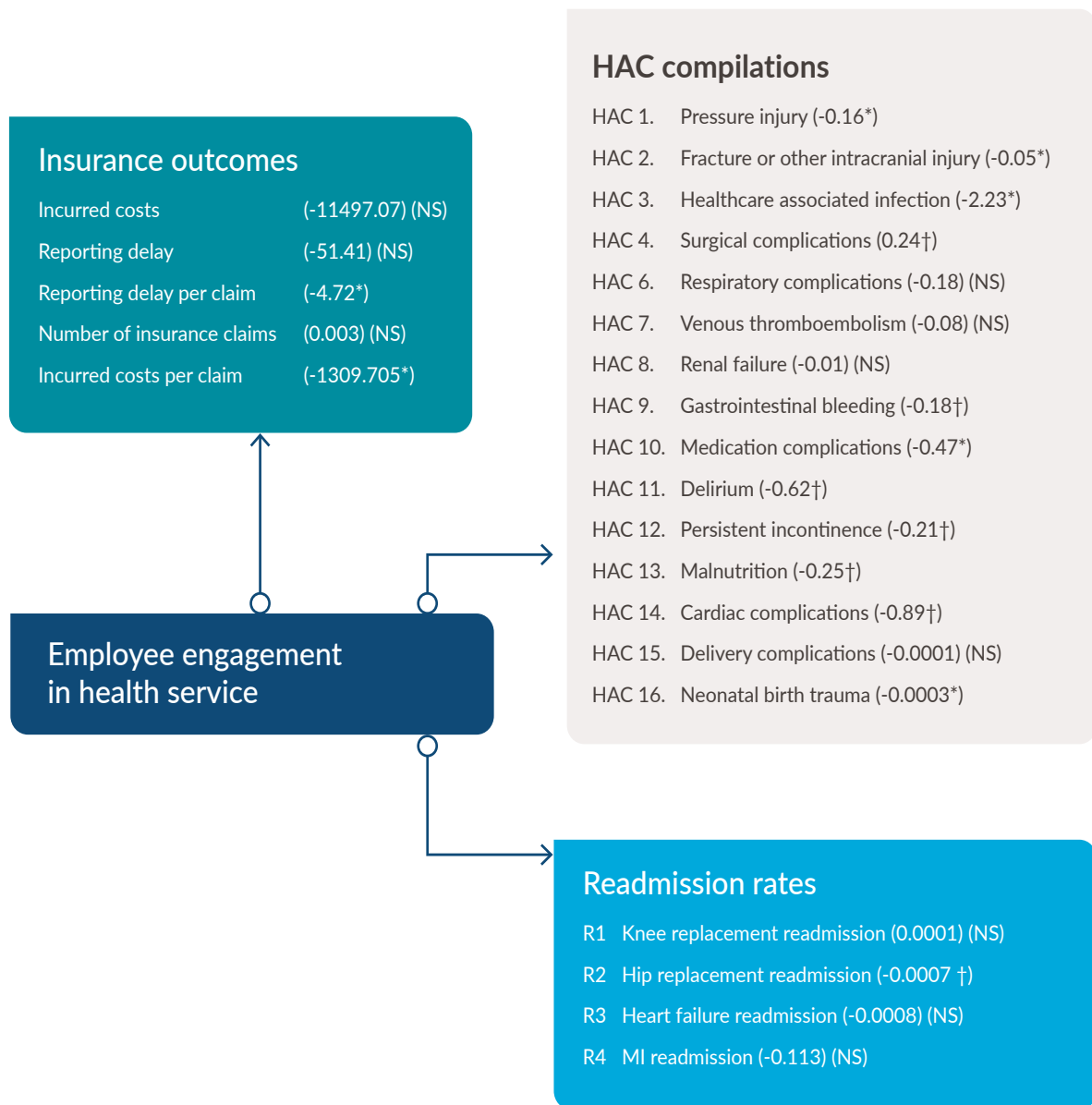
	Incurred costs	Reporting delay	Reporting delay per claim	Number of insurance claims	Incurred costs per claim
HAC 1. Pressure injury	18675.61***	93.95***	0.62	0.24***	369.53*
HAC 2. Fracture/other intracranial injury	52433.23***	251.42***	2.7**	0.73***	1237.6**
HAC 3. Healthcare associated infection	1097.55***	5.36***	0.05*	0.02***	25.12**
HAC 4: Surgical complication	9511.38***	48.36***	0.52*	0.12***	212.19**
HAC 6. Respiratory complications	9152***	44.48***	0.39*	0.13***	187.89*
HAC 7. Venous thromboembolism	13968.5***	74.76***	0.62†	0.21***	292.29*
HAC 8. Renal failure	39036.64***	216.48***	2.23	0.69***	738.1
HAC 9. Gastrointestinal bleeding	11246.39***	56.86***	0.54*	0.17***	265.71**
HAC 10. Medication complications	5430.69***	27.25***	0.25*	0.07***	113.02*
HAC 11. Delirium	2801.27***	14.23***	0.13*	0.04***	56.49*
HAC 12. Persistent incontinence	15291.75***	74.07***	0.5	0.21***	359.95**
HAC 13. Malnutrition	7666.61***	38.85***	0.34†	0.1***	165.65*
HAC 14. Cardiac complications	2302.74***	11.72***	0.11*	0.03***	47.68*
HAC 15. Delivery complications	4589997	16883.79	765.66	0.41	-401672.4
HAC 16. Neonatal birth trauma	9347435	33231.67	872.78	45.73	-106732.1
Knee replacements readmission	794953.1	1827.48	20.85	6.49	15371.9
Hip replacements readmission	-553502.7	-1324.69	-608.14	7.24	123608.7
Heart failure readmission	197023.1	-1890.03	43.78	-4.16	68832.81
Acute MI readmission	651.08	12.61	1.34	-0.05	-17.97

Note

- HAC = Hospital Acquired Complication
- All analyses presented here are using random effects panel models
- All predictor (independent) variables have a 1 year lag
- *** denotes $p < 0.001$; ** denotes $p < 0.01$; * denotes $p < 0.05$; † denotes $p < 0.01$

Figure 7, as well as Tables 3, 4 and 5 present the findings for the impact of employee engagement on insurance outcomes, HAC and readmission rates using individual models. Earlier models presented overall/average HACs (HAC categories were combined to calculate the averages), while the following models present the HAC categories individually.

Figure 8 Impact of employee engagement on insurance outcomes, HAC and readmission rates (individual effects)



Note	<ul style="list-style-type: none"> HS = Health Service NS = Not significant All analysis presented here uses the random effects panel model All predictor (independent) variables have a 1 year lag * denotes $p < 0.05$; † denotes $p < 0.01$; NS denotes not significant
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Table 3 indicates the relationship between employee engagement and HACs. Table 4 presents the impact of employee engagement on readmission rates. Table 5 shows the influence of employee engagement on insurance outcomes.

All findings in the above tables use the random effect model with lagged employee engagement as the independent variable. Employee engagement was found to negatively predict most of the HACs - that is, reduce the incidence of HACs. However, the effect of employee engagement on reduced HACs was only significant for HACs 1, 2, 3, 4, 10, 11, 12, 13, 14, and 16. In contrast, the effect of employee engagement on reduced readmission rates was only found to be significant for hip replacement readmission rates. The findings in Table 5 (without the inclusion of HACs) highlight that reporting delay per claim and incurred costs per claim are negatively influenced by employee engagement. Other insurance outcomes were not significantly impacted by employee engagement at the health service level. Hence, an increase in engagement reduces incurred costs per claim and incurred delay per claim.

However, as HACs are added, these effects become non-significant, indicating that employee engagement influences insurance outcomes via HACs. Therefore, we suggest that an increase in employee engagement within health service providers reduces the HACs and this reduction of HACs helps to reduce insurance costs and delays.

Table 3 Engagement and HAC

	HAC1	HAC2	HAC3	HAC4	HAC6	HAC7	HAC8	HAC9	HAC10	HAC11	HAC12	HAC13	HAC14	HAC15	HAC16
Engagement	-0.16*	-0.05*	-2.23*	-0.24†	-0.18	-0.08	-0.01	-0.18†	-0.48*	-0.62†	-0.21†	-0.25†	-0.89†	-0.0001	-0.0003*

Note

- All analysis presented here uses the random effects panel model
- All predictor (independent) variables have a 1 year lag
- * denotes $p < 0.05$; † denotes $p < 0.01$

Table 4 Engagement and readmission rates

	Readmission rates			
	Knee replacements	Hip replacements	Heart failure	Acute MI
Engagement	0.0001	-0.0007†	-0.0008	-0.11

Note	<ul style="list-style-type: none"> • All analysis presented here uses the random effects panel model • All predictor (independent) variables have a 1 year lag † denotes $p < 0.01$
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Table 5 Engagement and insurance outcomes

	Incurred costs	Reporting delay	Reporting delay per claim	Number of insurance claims	Incurred costs per claim
Engagement	-11497.07	-51.41	-4.72*	0.003	-1309.705*

Note	<ul style="list-style-type: none"> • All analysis presented here uses the random effects panel model • All predictor (independent) variables have a 1 year lag • * denotes $p < 0.05$
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Limitations & conclusions

We present these critical findings while acknowledging some limitations. Although we have established the robustness of the relationships using multiple methods, care should be taken interpreting the findings of the study for other health institutions.

- Due to limitations around the availability of data, the models do not control for all the potential confounding variables. Hence, the presence of other variables directly influencing the dependent variables might alter the significance and direct applicability of the analyses.
- The independent variable significantly explains a small yet important part of the variance in the dependent variable.
- The use of any statistical technique, including panel data analysis, is constrained by its underlying assumptions. Although we have tried to minimise any possible issues with the analysis technique by deploying the statistically sophisticated panel data analyses technique on the longitudinal dataset collected over years from multiple data sources, using lagged variables in the panel dataset to test causal effects, and conducting correlations as well as regression analyses, it is difficult to validate the assumptions completely.

In conclusion, health service employee behaviours are important factors in shaping health service outcomes and must be managed effectively by hospital management for enhancing hospital performance. This topic requires future study to produce further scientific recommendations enabling decision-makers in health services to practice evidence-based leadership in hospitals.

However, health service employee engagement and behaviours form part of the larger health service story where multiple other factors can influence the health service outcomes, as our exhaustive literature review reveals. We also thoroughly reviewed scientific studies and reports studying engagement and outcomes in the context of health services.

We are highly encouraged by the results and findings of this research, where we can clearly identify crucial relationships connecting individual health service employee behaviours to broader health outcomes in public health services in Victoria.

Table 6 Means and Standard Deviations

No	Variables	Mean	Standard Deviation
1	Incurred Costs	636701.60	1379217.00
2	Reporting Delay	3114.94	5701.81
3	Number of Claims	10.60	14.46
4	Reporting Delay Per Claim	238.05	268.09
5	Incurred Costs Per Claim	39310.86	77081.90
6	HAC1	9.68	23.62
7	HAC2	4.26	9.32
8	HAC3	205.75	465.12
9	HAC4	23.19	54.74
10	HAC6	19.81	50.99
11	HAC7	10.08	26.94
12	HAC8	1.65	5.92
13	HAC9	17.26	40.63
14	HAC10	33.22	84.89
15	HAC11	60.25	152.16
16	HAC12	11.31	30.22
17	HAC13	17.46	47.63
18	HAC14	85.17	205.44
19	HAC15	0.03	0.02
20	HAC16	0.01	0.01
21	Average HAC	38.39	90.04
22	Knee replacements readmission	0.05	0.05
23	Hip replacements	0.03	0.03
24	Heart failure readmission	0.08	0.13
25	MI readmission	2.71	8.50
26	PMS_Part1_6h	83.79	10.94
27	PMS_Part2_1a	74.40	10.59
28	PMS_Part2_1b	77.57	9.76
29	PMS_Part2_1c	70.06	8.99
30	PMS_Part2_1d	66.56	11.08
31	PMS_Part2_1e	77.09	13.06
32	PMS_Part1_2a	94.08	4.11
33	PMS_Part1_4b	66.68	13.34
34	PMS_Part1_6d	76.65	10.84
35	PMS_Part1_6g	83.96	9.97
36	PMS_Part2_2a	76.18	8.24
37	PMS_Part1_5e	74.51	11.60
38	Engagement	73.15	9.30

Table 7 Correlations

No.	Variable Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Incurred Costs	1															
2	Reporting Delay	0.80*	1														
3	Number of Claims	0.64*	0.75*	1													
4	Reporting Delay Per Claim	0.33*	0.45*	0.15*	1												
5	Incurred Costs Per Claim	0.60*	0.34*	0.20*	0.35*	1											
6	HAC1	0.48*	0.63*	0.60*	0.2*	0.14*	1										
7	HAC2	0.48*	0.61*	0.64*	0.2*	0.16*	0.77*	1									
8	HAC3	0.54*	0.67*	0.69*	0.21*	0.17*	0.87*	0.92*	1								
9	HAC4	0.56*	0.72*	0.67*	0.23*	0.17*	0.89*	0.88*	0.96*	1							
10	HAC6	0.48*	0.62*	0.62*	0.18*	0.14*	0.84*	0.87*	0.96*	0.94*	1						
11	HAC7	0.42*	0.57*	0.59*	0.17*	0.11*	0.83*	0.85*	0.94*	0.91*	0.93*	1					
12	HAC8	0.29*	0.44*	0.45*	0.13*	0.07	0.74*	0.70*	0.8*	0.79*	0.81*	0.9*	1				
13	HAC9	0.50*	0.64*	0.65*	0.21*	0.16*	0.86*	0.94*	0.97*	0.94*	0.93*	0.95*	0.82*	1			
14	HAC10	0.50*	0.65*	0.63*	0.2*	0.14*	0.85*	0.88*	0.97*	0.94*	0.96*	0.92*	0.82*	0.94*	1		
15	HAC11	0.45*	0.6*	0.61*	0.19*	0.13*	0.85*	0.91*	0.96*	0.94*	0.95*	0.97*	0.87*	0.98*	0.95*	1	
16	HAC12	0.54*	0.62*	0.60*	0.2*	0.18*	0.8*	0.82*	0.89*	0.85*	0.83*	0.82*	0.66*	0.86*	0.86*	0.86*	1
17	HAC13	0.39*	0.50*	0.52*	0.15*	0.11	0.76*	0.83*	0.91*	0.86*	0.91*	0.87*	0.70*	0.87*	0.89*	0.89*	0.82*
18	HAC14	0.49*	0.66*	0.63*	0.22*	0.15*	0.86*	0.9*	0.97*	0.96*	0.97*	0.96*	0.85*	0.96*	0.97*	0.98*	0.87*
19	HAC15	0.16*	0.24*	0.28*	0.09	-0.08	0.19*	0.2*	0.20*	0.2*	0.15*	0.17*	0.13*	0.19*	0.15*	0.19*	0.19*
20	HAC16	0.08	0.10	0.25*	-0.07	-0.05	0.13*	0.15*	0.13	0.11	0.09	0.06	0.04	0.12	0.10	0.09	0.04
21	Average HAC	0.52*	0.66*	0.66*	0.21*	0.16*	0.88*	0.92*	0.99*	0.97*	0.97*	0.96*	0.83*	0.98*	0.98*	0.98*	0.89*
22	Knee readmission	0.02	0.05	0.11	0.00	0.00	0.10	0.10	0.12	0.12	0.17*	0.13	0.14	0.12	0.14*	0.13	0.07
23	Hip readmission	0.12	0.09	0.16*	0.01	0.04	0.13	0.13	0.16*	0.16*	0.18*	0.13	0.08	0.15*	0.17*	0.15*	0.13
24	Heart readmission	0.05	0.09	0.12	0.21*	0.03	0.04	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.05	0.05	0.05
25	MI readmission	-0.02	0.01	0.00	0.06	-0.02	-0.05	-0.03	-0.04	-0.05	-0.04	-0.04	-0.05	-0.04	-0.05	-0.04	-0.05
26	PMS_Part1_6h	0.07	0.06	-0.10	0.18*	0.03	-0.08			-0.08		-0.07	-0.02				-0.06
27	PMS_Part2_1a	0.02	-0.05	0.03	-0.11	-0.03	-0.02	-0.03	-0.02	-0.02	-0.02	0.00	0.02	-0.02	-0.03	-0.01	-0.02
28	PMS_Part2_1b	-0.05	-0.10	-0.01	-0.12	-0.10	-0.05	-0.08	-0.05	-0.03	-0.03	0.01	0.03	-0.06	-0.06	-0.03	-0.04
29	PMS_Part2_1c						-0.2*						-0.08				
30	PMS_Part2_1d			-0.13									-0.07				
31	PMS_Part2_1e	-0.07	-0.13	-0.06									-0.07				-0.1*
32	PMS_Part1_2a	0.10	0.08	-0.10	0.24*	0.09	-0.08			-0.09		-0.09	-0.06				-0.06
33	PMS_Part1_4b	-0.05	-0.04	-0.03	-0.01	-0.10	-0.07	-0.11	-0.11	-0.10	-0.09	-0.07	-0.05	-0.12	-0.11	-0.10	-0.12
34	PMS_Part1_6d	0.16*	0.15*	-0.06	0.26*	0.14*	-0.06	-0.07	-0.07	-0.04	-0.08	-0.06	-0.04	-0.06	-0.07	-0.06	-0.03
35	PMS_Part1_6g	0.10	0.09		0.22*	0.06							-0.09				-0.08
36	PMS_Part2_2a	-0.02	-0.09	-0.11	-0.01	-0.05							-0.08				
37	PMS_Part1_5e	0.18*	0.14*	0.00	0.14*	0.13*	-0.06	-0.05	-0.05	-0.03	-0.06	-0.03	-0.02	-0.05	-0.06	-0.05	-0.02
38	Engagement	-0.08		-0.07								-0.07	-0.03				-0.09

Note

• * denotes p<0.05

Table 7 (continued). Means, Standard Deviations and Correlations

No.	Variable Name	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
17	HAC13	1																					
18	HAC14	0.91*	1																				
19	HAC15	0.14*	0.18*	1																			
20	HAC16	0.05	0.09	0.09	1																		
21	Average HAC	0.92*	0.99*	0.19*	0.11	1																	
22	Knee readmission	0.12	0.15*	0.09	-0.06	0.13	1																
23	Hip	0.19*	0.15*	0.01	0.17*	0.16*	0.15*	1															
24	Heart readmission	0.04	0.05	0.04	-0.04	0.05	0.10	0.07	1														
25	MI	-0.04	-0.04	-0.07	0.07	-0.05	-0.01	-0.02	0.03	1													
26	PMS_Part1_6h	-0.13*	-0.09	-0.05	-0.21*	-0.11*	-0.02	-0.16	-0.07	-0.07	1												
27	PMS_Part2_1a	-0.02	-0.02	0.04	-0.06	-0.02	0.06	-0.11	0.00	-0.06	0.55*	1											
28	PMS_Part2_1b	-0.02	-0.03	-0.02	-0.15	-0.04	0.04	-0.13	0.00	-0.06	0.61*	0.88*	1										
29	PMS_Part2_1c	-0.16*	-0.19*	-0.03	-0.22*	-0.19*	0.01	-0.11	-0.03	-0.06	0.49*	0.74*	0.81*	1									
30	PMS_Part2_1d	-0.13*	-0.15*	-0.03	-0.16*	-0.15*	-0.02	-0.12	0.00	-0.09	0.52*	0.84*	0.86*	0.85*	1								
31	PMS_Part2_1e	-0.11*	-0.13*	0.02	-0.07	-0.13*	0.00	-0.11	0.03	-0.18*	0.46*	0.52*	0.51*	0.49*	0.56*	1							
32	PMS_Part1_2a	-0.13*	-0.10*	-0.04	-0.23*	-0.11*	-0.07	-0.16	-0.03	-0.06	0.68*	0.32*	0.38*	0.27*	0.33*	0.35*	1						
33	PMS_Part1_4b	-0.08	-0.10	0.07	-0.21	-0.10	0.12	0.16	0.09	-0.17	0.64*	0.84*	0.82*	0.77*	0.85*	0.67*	0.37*	1					
34	PMS_Part1_6d	-0.08	-0.05	0.03	-0.22*	-0.07	-0.01	-0.14	-0.04	-0.09	0.73*	0.43*	0.42*	0.29*	0.38*	0.44*	0.66*	0.74*	1				
35	PMS_Part1_6g	-0.14*	-0.12*	0.00	-0.23*	-0.13*	-0.01	-0.09	-0.03	-0.11	0.8*	0.47*	0.51*	0.40*	0.49*	0.47*	0.71*	0.83*	0.83*	1			
36	PMS_Part2_2a	-0.13*	-0.13*	0.00	-0.17*	-0.14*	-0.06	-0.14	0.01	-0.06	0.59*	0.81*	0.77*	0.71*	0.80*	0.57*	0.50*	0.84*	0.56*	0.63*	1		
37	PMS_Part1_5e	-0.07	-0.05	0.04	-0.11	-0.05	-0.09	-0.07	-0.02	-0.09	0.66*	0.59*	0.54*	0.43*	0.59*	0.47*	0.57*	0.82*	0.72*	0.78*	0.67*	1	
38	Engagement	-0.10*	-0.11*	0.00	-0.15*	-0.11*	0.02	-0.14	0.01	-0.12	0.60*	0.90*	0.92*	0.88*	0.94*	0.74*	0.38*	0.87*	0.45*	0.54*	0.84*	0.61*	

Note

- Engagement = variable created using five engagement items
- Knee readmission = knee replacements readmission rates
- Hip readmission = hip replacements readmission rates
- Heart readmission = heart failure readmission rates
- MI readmission = acute Myocardial Infarction readmission rates
- * denotes p < 0.05

Appendices

Appendix 1 Key research on effects on healthcare outcomes due to healthcare employee and/or team level factors

No.	Study	Key predictor variables
1	Clark & Huckman, 2012	Effects of focused operations through focused teams and groups
2	Tucker, Nembhard & Edmondson, 2007	Implementation of new managerial practices and organizational learning
3	Kc & Terwiesch, 2009	Effects of employee workloads
4	Kc & Terwiesch, 2011	Management and organizing of medical and technical staff
5	Goldstein & Naor, 2005	Investing in managerial practices
6	El-Jardali et al., 2009	Human resources in hospitals
7	Harper, 2002	Financial resources in hospitals
8	Young, Charns, Shortell, 2001	Top manager and network effects
9	Dobrzykowki & McFadden, 2015	Effects of autonomy and motivation
10	Barnum & Kutzin, 1993	Effects of allocation of public resources, usage, cost and financing
11	Leonard, Rauner & Schaffhauser-Linzatti, 2003	Effects of funding policy
12	Baxter et al., 2015	Activity based funding and pay for performance hospital funding models
13	Jha et al., 2009	Hospitals costs, efficiency, quality of care
14	Oliveira & Bevan, 2008	Hospitals costs, equity, efficiency
15	Koenig et al., 2003	Mission related costs of hospitals
16	Crilly & Le Grand, 2004	Motivations and behaviours of hospital trusts
17	Epstein & Mason, 2006	Costs and pricing models for inpatient care

Appendix 2 Key prior research on effects of healthcare employee engagement on healthcare outcomes

Study	Predictor variables	Sample/ participants/ data source	Outcome variables and findings	Measurement for outcome variables
Toffolutti, V., & Stuckler, D. (2019). A culture of openness is associated with lower mortality rates among 137 English National Health Service acute trusts. <i>Health Affairs</i> , 38(5), 844-850.	1. Openness – (“To what extent do you agree or disagree with the following (a) ‘My organisation encourages us to report errors, near misses or incidents’ [to measure error]; (b) ‘We are informed about errors, near misses and incidents that happen in the organisation’ [to measure disclosure]; (c) ‘I would feel secure raising concerns about unsafe clinical practice’ [to measure safety]; and (d) ‘If you were concerned about unsafe clinical practice, would you know how to report it?’ [to measure report].”)	NHS National Staff members, UK	Mortality rate – Significant (-)	1.Summary Hospital-level Mortality Indicator (SHMI) from NHS Digital that represents ratio between number of patients who died after hospitalization at a trust and the number expected to die based on average figures for England, adjusted for the characteristics of patients treated.
Prottas, D. J., & Nummelin, M. R. (2018). Behavioral integrity, engagement, organizational citizenship behaviour, and service quality in a healthcare setting. <i>Journal of Healthcare Management</i> , 63(6), 410-424.	1. Work engagement – (3 items, such as “At my work, I feel bursting with energy.”)	Full- and part-time employees of 10 different entities belonging to a 28on- profit, religiously affiliated integrated healthcare organization	Service quality – Significant (+) Organisational citizenship Behaviour – Significant (+) 3. Entity assessment – Significant (+)	Service quality of the participant's unit (measured using 2 items adapted from Schneider, White, and Paul (1998), “How would you rate the overall quality of service provided by your unit?”, “How would you rate the performance of your unit with respect to the quality of its work and service?” Organisational Citizenship Behaviour (measured OCB of co-workers in participants' work units using 15 items adapted from Podsakoff et al. (1990), 5 items were adapted from the altruism, dedication, and conscientiousness subscales, such as “They help others who have heavy workloads” Entity assessment (measured assessment of the employer organization (hospital or other entity) by 2 items taken from HCAHPS survey, such as “How would you rate [the entity] as a hospital (or other type of entity)?”, “Would you recommend [the entity] to your friends and family?”

Study	Predictor variables	Sample/ participants/ data source	Outcome variables and findings	Measurement for outcome variables
<p>Abdelhadi, N., & Drach-Zahavy, A. (2012). Promoting patient care: work engagement as a mediator between ward service climate and patient-centred care. <i>Journal of Advanced Nursing</i>, 68(6), 1276-1287.</p>	<p>Work engagement – (3 factors / sub- scales adapted from Salanova and Agut (2005). Vigour, the first scale, consisted of six items. An example item is 'At work, I feel full of energy'. Dedication, the second scale, consisted of five items. An example item is 'My job inspires me'. Absorption, the third scale, consisted of five items. An example item is 'Time flies when I'm working'.)</p> <p>Global service climate – (8 item scale, such as "How would you rate the job knowledge and skills of department employees to deliver superior quality service")</p>	<p>Nursing staff</p>	<p>Nurses' patient-centred care behaviours (PCC) – Significant (+)</p> <p>Ward service climate (testing if nurses' work engagement mediated the association between the ward's service climate and PCC) – Significant (+)</p> <p>Effect of Global Service Climate on Work Engagement – Significant (+)</p>	<p>Observers recorded nurse's PCC in the course of three separate guidance encounters: patient admission, provision of treatment and guidance, each averaging 20 minutes. These encounters were chosen because they afford nurse- patient interaction evaluated on 9-item structured observation sheet was used (Schirmer et al.2005, Drach-Zahavy 2009)</p> <p>Service climate (measured using 8-item global service-climate scale developed by Schneider et al. (1998), items refer to a collection of behavioural features of the wards, all focusing explicitly on service quality, such as 'How would you rate the job knowledge and skills of department employees to deliver superior quality service?')</p> <p>Work engagement (measured using 3 item scale adapted from Salanova and Agut (2005) using dimensions of Vigour (6 items, such as 'At work, I feel full of energy'; Dedication (5 items such as 'My job inspires me'); Absorption (5 items such as 'Time flies when I'm working')</p>
<p>Zadow, A. J., Dollard, M. F., Mclinton, S. S., Lawrence, P., & Tuckey, M. R. (2017). Psychosocial safety climate, emotional exhaustion, and work injuries in healthcare workplaces. <i>Stress and Health</i>, 33(5),558-569.</p>	<p>1. Psychological safety climate (12 items adopted from Hall, Dollard & Doward, 2010; uses four subscales: management commitment, organizational communication, management priority, and organizational participation.)</p>	<p>Employees from clinical and non-clinical work teams</p>	<p>Work injuries – Significant (-)</p> <p>Self-reported injuries – testing if team psychological safety and work injuries are mediated by emotional exhaustion – Significant mediator (+)</p>	<p>Self-reported work injuries were the number of safety accidents (i.e., accidents that have caused a physical injury) or an injury causing psychological or emotional harm experienced in the last 12 months that were reported to the safety risk management system. Organisation registered work injuries were the organisation registered work injuries were recorded on the safety risk management system database across three time points, T1 (2012), T2 (2013), and T3 (2014). Injury data, both physical (e.g., needlestick injuries) and psychological (e.g., experiencing psychological harm through violence or bullying) for each work team in each of the 3 calendar years was collected. Underreported work injuries were not measured directly but following Probst (2015) and was operationalized statistically, determined as the residual by using the number of self-report unreported work injuries as the dependent measure, and controlling for the number of reported work injuries measured as (a) self-report work injuries at the individual level, and (b) registered work injuries (T2, 2013) at the organisational level.</p> <p>Emotional exhaustion (measured using 5-item scale from Maslach burnout inventory (Schaufeli, Leiter, Maslach, & Jackson, 1996) such as "I feel tired when I get up in the morning and have to face another day on the job")</p>
<p>Kammerlind, P., Dahlgaard, J. J., & Rutberg, H. (2004). Climate for improvement and the effects on performance in Swedish healthcare— a survey in the county council of Östergötland. <i>Total Quality Management & Business Excellence</i>, 15(7), 909-924.</p>	<p>Employee satisfaction (scale adopted from Swedish Quality Award (SIQ, 2002; FFC, 2003)</p> <p>Climate for improvement indexes (43 items, measured using six factors – enablers' criteria – Leadership Policy & Strategy and partnership & Resources, Employee, Process, Customer, and Learning and Creativity)</p>	<p>Leaders in ward units, clinical departments and at the medical division level</p>	<p>Patient satisfaction – Significant (+) from both predictor variables</p>	<p>1. Patient Satisfaction (measured through customer orientation and employee satisfaction that reflect the operations oriented dimension via questionnaire (Rahmqvist, 2001)</p>

Study	Predictor variables	Sample/ participants/ data source	Outcome variables and findings	Measurement for outcome variables
Van Bogaert, P., Clarke, S., Willems, R., & Mondelaers, M. (2013). Staff engagement as a target for managing work environments in psychiatric hospitals: Implications for workforce stability and quality of care. <i>Journal of Clinical Nursing</i> , 22(11-12), 1717-1728.	1. Hospital management-organisational support (measured with 15 items as one of three dimensions of the previously validated Dutch translation of the Revised Nursing WorkIndex (Aiken & Patrician 2000) (NWI-R-vl))	Registered nurses, licensed practical nurses, and non-registered caregivers	1. Work engagement – Non-significant 2. Quality of care – Significant (-)	Utrecht Work Engagement Scale (UWES) (measured using 9-item scale adopted by Schaufeliet al.2002,2006; Schaufeli & Bakker 2004; as a positive affective-motivational state of fulfilment manifested as vigour, dedication and absorption) Care quality (measured using ratings of care on the last shift, on the unit and by the interdisciplinary team along a continuum of poor, fair, good, and excellent)
Baird, K. M., Tung, A., & Yu, Y. (2019). Employee organizational commitment and hospital performance. <i>Health Care Management Review</i> , 44(3), 206-215.	Employee organisational commitment (EOC) (measured using affective commitment scale of 9 items, includes items on organizational identification, organizational involvement, and organizational loyalty adopted from Su, Baird, and Blair, 2009) Provision of adequate support facilities (measured using 10-item scale to gather employees' perception of the provision of adequate facilities where five factors were cleanliness of wards, hospital security, quality of IT facilities, provision of patient support facilities, and provision of staff training) Adequate staff resources (measured using 10-item scale used to measure employees' perception of the provision of adequate facilities where three factors were Nurse-Doctor ratio, Bed-Nurse ratio, and Patient-Doctor ratio)	Hospital managers	Hospital performance – Significant (+) Testing if EOC mediates relationship between provision of adequate support facilities and hospital performance – Significant mediator (+) Testing if EOC mediates relationship between adequate staff resources and hospital performance – Significant mediator (+)	1. Hospital performance (measured using 7-item scale focusing on "quality of patient care is an important performance outcome for health care" (AIHW, 2015; Grosskopf & Valdmanis, 1987; Organization & Hospital, 2008; Voelker et al., 2001; Bartram, Karimi, Leggat, & Stanton, 2014, p. 2407), and effectiveness due to the increased focus on effectiveness and efficiency)
Bulkapuram, S. G., Wundavalli, L., Avula, K. S., & Reddy, T. K. (2015). Employee engagement and its relation to hospital performance in a tertiary care teaching hospital. <i>Journal of Hospital Administration</i> , 4(1), 48-56.	1. Employee engagement (measured using the Employee Experience Survey (EES) from Ontario Hospital Association's Quality Healthcare Workplace Model; questions on 36 features of their job, training and development opportunities, their team, their supervisor, senior management and the organization support its employees)	Hospital staff- heads of departments, clinical faculty, nursing staff,technical staff and administrative staff	Patient centred work environment (PCWE) – Significant (+) Patient safety culture (PSC) – Significant (+)	Survey items included outcomes of quality, patient safety, low employee turnover, enrolment, organizational stature, employee productivity and costs (where the PCWE and PSC measures were taken from)

Study	Predictor variables	Sample/ participants/ data source	Outcome variables and findings	Measurement for outcome variables
<p>Dobrzykowski, D. D., & McFadden, K. L. (2019). Examining Governance in Hospital Operations: The effects of trust and physician employment in achieving efficiency and patient satisfaction. <i>Decision Sciences</i>, 0(0), 1-36.</p>	<p>1. Lean strategy (measured using items on Process improvement, Elimination of waste, understanding of patient needs, Adapting to change, Providing personalized care)</p>	<p>Executives from AHA (American Hospital Association), Employed and non-employed physicians</p>	<p>1. Process integration – testing if trust enhances the relationship between lean strategy and process integration – Significant moderator (+)</p>	<p>Process integration is defined as the extent to which the activities of the people involved in healthcare delivery are streamlined and coordinated; psychometric measure collected via survey. Measured by: In our hospital – Cross-functional teams that include admitting/ attending physicians are integrated for process design and improvement. There is a high level of coordination among all functions. There is a high level of communication among all functions. Information systems are integrated. (deleted) Trust – The willingness to rely on an admitting/attending physician in whom one has confidence and a belief of integrity. Measured with 4 items: Our Admitting/ attending physicians have: Been honest in dealing with our staff. Been open in dealing with our staff. Respect for the confidentiality of patient information. Earned our confidence through their clinical practices.)</p>
<p>Frag, A. A., & Anthony, M. K. (2015). Examining the relationship among ambulatory surgical settings work environment, nurses' characteristics, and medication errors reporting. <i>Journal of PeriAnesthesia Nursing</i>, 30(6), 492- 503.</p>	<p>Leadership (measured using 36 items by Avolio & Bass focusing on 3 kinds of leadership styles of transformational (5 subscales), transactional (2 subscales), passive avoidant (2 subscales) Safety climate (measured using 6 subscales by Nieva & Sorra focusing on manager's safety actions (4 items), organizational learning (3 items), teamwork (4 items), communication openness (3 items), feedback and communication about errors (3 items), and nonpunitive response to errors (3 items)</p>	<p>Nurses</p>	<p>1. Willingness to report medication errors – Significant (+) from both predictor variables</p>	<p>Nurses' willingness to report medication errors was measured by using one outcome scale of Patient Safety Climate in Healthcare Organizations tool to reflect nurses' willingness to report errors instead of frequency of errors. Measured by: 1. If a mistake is made, but caught and corrected before affecting patient, how likely you are going to report this error 2. If a mistake is made, but has no potential harm to the patient, how likely you are going to report this error 3. If a mistake is made and could harm the patient, but does not, how likely you are going to report this error</p>
<p>Poghosyan, L., Norful, A. A., Liu, J., & Friedberg, M. W. (2018). Nurse practitioner practice environments in primary care and quality of care for chronic diseases. <i>Medical care</i>, 56(9), 791-797.</p>	<p>Nurse practitioners' (NP) practice environments (measured using 29-item Nurse Practitioner Primary Care Organizational Climate Questionnaire (NP- PCOCQ) with 4 subscales: NP-Physician Relations (NP-PR), Independent Practice and Support (IPS), Professional Visibility (PV), and NP-Administration Relations (NP-AR))</p>	<p>Nurse practitioners</p>	<p>Clinical performance-medication management for patients with asthma – Significant (+) Clinical performance-LDL-C screening for cardiovascular disease – Significant (+) 3. Clinical performance –</p>	<p>HEDIS measures, from 5 health plans in Massachusetts, are a nationally standardized reporting system for health plans to measure performance on important dimensions of care delivery. Four of the 5 plans provide MHQP with de-identified data at the individual patient level and 1 health plan reports the data at the PCP-level. For each HEDIS measure, a higher score reflects higher quality of care in the practice and is calculated by dividing the number of eligible patients who received the recommended care by the number of patients eligible for inclusion for the measure. Obtained clinical performance datasets from MHQP for the 118/163 primary care practices involved in the study</p>

Study	Predictor variables	Sample/ participants/ data source	Outcome variables and findings	Measurement for outcome variables
<p>Bosch, M., Dijkstra, R., Wensing, M., van der Weijden, T., & Grol, R. (2008).</p>	<p>1. Team climate (measured with 14 item short version of 'Team Climate Inventory' (TCI), characterized by 1) focusing on clear and realistic objectives in which the team members are committed (vision), 2) interaction between team members in a participative and inter-personally non- threatening climate (participative safety), enacted support for innovation attempts including, e.g., cooperation to develop and apply new ideas (support for innovation)</p> <p>commitment to high standards of performance and, thus, preparedness for basic questions and appraisal of weaknesses (task orientation), and finally, Organizational culture, team climate and diabetes care in small office-based practices. BMC Health Services Research, 8(1), 180.</p> <p>2. Team culture (measured using 5 questions from Competing Values Framework (CVF), where one is asked to distribute 100 points across 4 sets of organisation description statements that best fit the org)</p>	<p>Healthcare professionals involved in diabetes care- general practitioners, practice nurses, and practice assistants</p>	<p>Team climate on Clinical outcomes – Non-significant</p> <p>Team culture on Clinical outcomes – Non-significant</p> <p>Team culture on Quality of diabetes care – Significant (-)</p>	<p>Clinical outcomes were HbA1c level, systolic blood pressure and total cholesterol levels. Fourth measure for clinical outcomes was measured with a sum score of 10 process indicators of diabetes care quality, based on national guidelines on diabetes care</p>
<p>Benzer, J. K., Young, G., Stolzmann, K., Osatuke, K., Meterko, M., Caso, A., ... & Mohr, D. C. (2011).</p>	<p>Organizational climate (measured using Employee Survey (AES), in 3 parts focusing on individual, workgroup, and facility organizational levels, using task and relational climate measures from the workgroup-focused section; adapted from the U.S. Office of Personnel Management employee survey (Gowing and Lancaster 1996)) Relational climate (measured using 3 items using workgroup reference about management focus on mutual support, respect and employing relationship- oriented strategies)</p> <p>The relationship between organizational climate and quality of chronic disease management. Health Services Research, 46(3), 691- 711.</p>	<p>Direct care providers</p>	<p>Org climate on Diabetes care – Significant (+)</p> <p>Relational climate on Diabetes care – Non-significant</p>	<p>Data were collected as part of the VA External Peer Review Program on dichotomous measures (1=adherence) where care processes were measured with adherence to annual HbA1c test requirements and foot examinations; measured intermediate outcomes through adherence to clinical standards for HbA1c<9, LDL-C<120, and blood pressure <140/90.</p>

Study	Predictor variables	Sample/ participants/ data source	Outcome variables and findings	Measurement for outcome variables
Wake, M., & Green, W. (2019). Relationship between employee engagement scores and service quality ratings: analysis of the National Health Service staff survey across 97 acute NHS Trusts in England and concurrent Care Quality Commission outcomes (2012–2016). <i>BMJ Open</i> ,9(7), e026472.	Employee engagement (measured using NHS survey items on 3 dimensions of motivation, advocacy and involvement)	Staff from 97 NHS acute Trusts in England	Care Quality Commission (CQC) ratings – Significant (+)	Perceived quality of the provider organisation as reported by the Care Quality Commission, Department of Health and Social Care which rated each organisation as: outstanding, good, requires improvement or inadequate
West, M. A. & Dawson, J. F. (2012). Employee engagement and NHS performance. UK: The King's Fund.	Employee engagement (measured using NHS survey items on 3 dimensions of motivation, advocacy and involvement)	Staff from NHS acute, mental health, ambulance, and primary care trusts	1. Patient satisfaction – Significant (+) Mortality – Significant (-) Quality of services – Significant (+) 4. Financial performance – Mixed results – involvement and advocacy were significantly related to financial performance, but motivation was not.	Patient satisfaction (indicated in NHS acute inpatient survey; Picker Institute Europe 2011) Standardised mortality ratio, published by Dr. Foster Quality of services provided by Annual Health Check Ratings (from previous year, published in 2009) Financial performance provided by the Annual Health Check Ratings (from the last year of the Annual Health Check, published in 2009)
Hafner, M., Stepanek, M., Iakovidou, E., & Stolk, C. (2018). Employee engagement in the NHS: A secondary data analysis of the NHS Healthy Workforce and Britain's Healthiest Workplace surveys. Cambridge, UK: RAND Corporation.	Employee engagement (measured using NHS survey items on 3 dimensions of motivation, advocacy and involvement)	Data are from two surveys-one that did not ask staff to specify their occupation and one that did. In the one where staff could specify. All health professionals and allied professionals' management were all included.	1. Patient satisfaction – Significant (+) Financial performance – Significant (+) Operational surplus – Significant (+)	Patient satisfaction score from Care Quality Commission (CQC) patient surveys Financial performance reported by the organization Operational surplus/deficit calculated using account data for Foundation Trusts and Trusts

Appendix 3 Variables from the People Matter Survey dataset

PMS factor	PMS variable name	PMS survey item	Created variables
Part 1 – Workplace behaviours/ 6. Patient Safety/ h.	PMS_Part1_6h	I would recommend a friend or relative to be treated as a patient here.	Employee Recommendation
Part 2 – Engagement and job satisfaction/ 1. Engagement/ a.	PMS_Part2_1a-e	I would recommend my organisation as a good place to work.	Engagement
Part 2 – Engagement and job satisfaction/ 1. Engagement/ b.	PMS_Part2_1a-e	I am proud to tell others I work for my organisation.	Engagement
Part 2 – Engagement and job satisfaction/ 1. Engagement/ c.	PMS_Part2_1a-e	I feel a strong personal attachment to my organisation.	Engagement
Part 2 – Engagement and job satisfaction/ 1. Engagement/ d.	PMS_Part2_1a-e	My organisation motivated me to help achieve its objectives.	Engagement
Part 2 – Engagement and job satisfaction/ 1. Engagement/ e.	PMS_Part2_1a-e	My organisation inspires me to do the best in my job.	Engagement
Part 1 – Workplace behaviours/ 2. Your workgroup/ a.	PMS_Part1_2a	My workgroup strives to achieve client satisfaction.	Client Satisfaction Focus
Part 1 – Workplace behaviours/ 4. Senior managers/ b.	PMS_Part1_4b	Senior managers model my organisations values.	Senior Manager Values
Part 1 – Workplace behaviours/ 6. Patient safety/ d.	PMS_Part1_6d	The culture in my work area makes it easy to learn from the errors of others.	Learning Culture
Part 1 – Workplace behaviours/ 6. Patient safety/ g.	PMS_Part1_6g	Management is driving us to be a safety-centred organisation.	Patient Safety Focus
Part 2 – Engagement and job satisfaction/ 2. Satisfaction/ a.	PMS_Part2_2a	Considering everything, how satisfied are you with your current job?	Employee Satisfaction
Part 1 – Workplace behaviours/ 5. Your organisation/ e.	PMS_Part1_5e	Bullying* is not tolerated in my organisation	Bullying

Appendix 4 Victorian health services represented in this research

Albury Wodonga Health	Maldon Hospital
Alexandra District Health	Mallee Track Health and Community Service
Alfred Health	Mansfield District Hospital
Alpine Health	Maryborough District Health Service
Austin Health	Melbourne Health
Bairnsdale Regional Health Service	Monash Health
Ballarat Health Services	Moyne Health Services
Barwon Health	Nathalia District Hospital
Bass Coast Health	Northeast Health Wangaratta
Beaufort and Skipton Health Service	Northern Health
Beechworth Health Service	Numurkah District Health Service
Benalla Health	Omeo District Health
Bendigo Health Care Group	Orbost Regional Health
Boort District Health	Otway Health & Community Services
Casterton Memorial Hospital	Peninsula Health
Castlemaine Health	Peter MacCallum Cancer Centre
Central Gippsland Health Service	Portland District Health
Cobram District Health	Robinvale District Health Services
Cohuna District Hospital	Rochester and Elmore District Health Service
Colac Area Health	Royal Victorian Eye and Ear Hospital
Corryong Health	Royal Women's Hospital
Dental Health Services Victoria	Rural Northwest Health
Djerriwarrh	Seymour Health
East Grampians Health Service	South Gippsland Hospital
East Wimmera Health Service	South West
Eastern Health	Stawell Regional Health
Echuca Regional Health	Swan Hill District Health
Edenhope and District Memorial Hospital	Tallangatta Health Service
Gippsland Southern Health Service	Terang and Mortlake Health Service
Goulburn Valley Health Services	The Queen Elizabeth Centre
Heathcote Health	Timboon and District Healthcare Service
Hepburn Health Service	Tweddle Child and Family Health Service
Hesse Rural Health Service	Victorian Institute of Forensic Mental Health
Heywood Rural Health	West Gippsland Healthcare Group
Inglewood and Districts Health Service	West Wimmera Health Service
Kerang District Health	Western District Health Service
Kilmore and District Hospital	Western Health
Kooweerup Regional Health Service	Wimmera Health Care Group
Kyabram and District Health Services	Yarram and District Health Service
Kyneton District Health Service	Yarrowonga Health
Latrobe Regional Hospital	Yea and District Memorial Hospital
Lorne Community Hospital	

Appendix 5 List of HACs and readmission rates

HAC Main category	HAC Subcategory
1 Pressure injury	1.1 Stage III ulcer 1.2 Stage IV ulcer 1.3 Unspecified decubitus and pressure area
2 Falls resulting in fracture or other intracranial injury	2.1 Intracranial injury 2.3 Other fractures
3 Healthcare associated infection	3.1 Urinary tract infection 3.2 Surgical site infection 3.3 Pneumonia 3.4 Blood stream infection 3.5 Central line and peripheral line associated blood stream infection 3.6 Multi-resistant organism 3.7 Infection associated with prosthetics/ implantable devices 3.8 Gastrointestinal infections
4 Surgical complications requiring unplanned return to theatre	4.1 Postoperative haemorrhage/ haematoma requiring transfusion and/or return to theatre 4.2 Surgical wound dehiscence 4.3 Anastomotic leak 4.4 Vascular graft failure 4.5 Other surgical complications requiring unplanned return to theatre (data not available)
5 Unplanned intensive care unit admission	5.1 Unplanned intensive care unit admission (data not available)
6 Respiratory complications	6.1 Respiratory failure including acute respiratory distress syndromes requiring 6.2 Aspiration pneumonia
7 Venous thromboembolism	7.1 Pulmonary embolism 7.2 Deep vein thrombosis
8 Renal failure	8.1 Renal failure requiring haemodialysis or continuous
9 Gastrointestinal bleeding	9.1 Gastrointestinal bleeding
10 Medication complications	10.1 Drug related respiratory complications/ depression 10.2 Haemorrhagic disorder due to circulating anticoagulants 10.3 Hypoglycaemia
11 Delirium	11.1 Delirium
12. Persistent incontinence	12.1 Urinary incontinence
13 Malnutrition	13.1 Malnutrition
14 Cardiac complications	14.1 Heart failure and pulmonary oedema 14.2 Arrhythmias 14.3 Cardiac arrest 14.4 Acute coronary syndrome including unstable angina, STEMI and NSTEMI
15 Third- and fourth-degree perineal laceration during delivery	15.1 Third- and fourth-degree perineal laceration during delivery / Vaginal births
16 Neonatal birth trauma	16.1 Neonatal birth trauma / Newborns
READMISSION RATES	Readmission rates for the following conditions were used in this research: <ul style="list-style-type: none"> • Acute Myocardial Infarction (MI) • Heart failure • Hip replacements • Knee replacements • Tonsillectomy and Adenoidectomy

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