SHORT REPORT

Effect of a simplified billing form and the SARS-CoV-2 pandemic on compensable billings in an Australian metropolitan emergency department: An interrupted time series analysis

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Abstract

Objective: To evaluate the effect of a simplified billing form on billings recovery.

Methods: An interrupted time series analysis of weekly presentations and billings between 1 April 2019 and 14 June 2020.

Results: Notably, 3228 patients were included (2030 Overseas Visitor Agreement, 359 Transport Accident Commission and 839 Work Cover). There was a $208.34 (95% CI 155.44–261.23, P < 0.0001) increase in billings per episode, that is, 59% (95% CI 44–74, P < 0.0001), from a baseline of $351.75/episode. There was no significant change in the actual billing rate during the pandemic.

Conclusion: Total billings did not change. Less patients were identified, but each generated 59% more billings.

Key words: Australia, emergency service, hospital, interrupted time series analysis, pandemic, SARS-CoV-2.

Introduction

Compensable billings in the Australian ED setting have received little attention and have only been examined in the context of an economic evaluation to identify missed compensable billings.1 Since the previous study,1 which examined billings recovery in the context of a voluntary, multi-screen data entry process, the hospital has adopted a new simplified billings form (Fig. S1) with prompts in the context of a wider digital transformation. No studies have addressed the effect of neither a digital transformation nor a pandemic on billings recovery.

Methods

The present study is a before-and-after observational cohort comparison measuring the effect of two events, a hospital-wide digital transformation, and the SARS-CoV-2 pandemic, using interrupted time series analysis.2 All adult compensable patients (Transport Accident Commission, Work Cover or Overseas Visitor Agreement) presenting between 1 April 2019 and 14 June 2020 were eligible (n). Outcomes measured were weekly compensable presentations (n), total billings ($AUD) and billing rate ($AUD/n).

Exposures were defined as a hospital-wide digital transformation on 14 October 2019 and the declaration of the SARS-CoV-2 pandemic on 11 March 2020. Statistics were performed in R Studio with the aid of the fpp3 package.3 Autoregressive integrated moving average (ARIMA) errors corrected for autocorrelation. The present study was approved by the Monash Health Human Research and Ethics Committee (reference number RES-20-0000-2371).

Results

A total of 108 470 patients presented of which 3228 (2.98%) patients were eligible for inclusion (2030 Overseas Visitor Agreement, 359 Transport Accident Commission and 839 Work Cover). Total billings were $1 527 174 ($1 243 150 Overseas Visitor Agreement, $127 685 Transport Accident Commission and $156 339 Work Cover). Baseline characteristics and results are presented in Table 1 and Figure 1. There was no significant difference in total billings in the before and after periods of the digital transformation. There was a significant reduction in compensable patients identified: −25.3 (95% CI −37.3 to −13.2, P < 0.001), and increase in $AUD per episode: 208.34 (95% CI 155.44–261.23, P < 0.0001). This represents a 59% (95% CI 44–74, P < 0.0001) increase in billings per compensable patient. After the pandemic declaration, total billing did not change, and billing per patient held constant.

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### TABLE 1. Baseline characteristics and results of interrupted time series analysis

| Variable                     | Before  | After  | \( P \) (t-test) | Rate change (95% CI)       | \( P \) (ITS) | Fitted model                      |
|------------------------------|---------|--------|-------------------|---------------------------|--------------|-----------------------------------|
| **Digital transformation**   |         |        |                   |                           |              |                                   |
| Billing ($AUD/week)          | 24 936.98 | 23 683.595 | 0.34 | \(-1121.17 (-5264.66 to 3022.32)\) | 0.60 | LM with ARIMA (1,0,0) errors     |
| Overseas                     | 20 088.25 | 19 447.97 | 0.57 | \(-426.61 (-3849.08 to 2995.85)\) | 0.80 | LM with ARIMA (1,0,0) errors     |
| Work Cover                   | 2475.85  | 2486.15 | 0.98 | \(10.29 (-649.73 to 670.32)\) | 0.97 | LM                               |
| TAC                          | 2372.88  | 1855.89 | 0.17 | \(-661.71 (-1538.19 to 214.77)\) | 0.14 | LM with ARIMA (1,0,0) errors     |
| Count (\(n/week\))          | 71.0     | 44.1   | \(<0.0001\) | \(-25.3 (-37.3 to -13.2)\) | \(<0.001\) | LM with ARIMA (1,0,1) errors     |
| Overseas                     | 42.6     | 23.9   | \(<0.0001\) | \(-16.1 (-23.7 to -8.4)\) | \(<0.001\) | LM with ARIMA (1,0,0) errors     |
| Work Cover                   | 15.7     | 11.4   | \(<0.0001\) | \(-4.3 (-2.2 to -6.3)\) | \(<0.001\) | LM                               |
| TAC                          | 12.8     | 9.0    | 0.001 | \(-4.0 (-7.3 to -1.1)\) | \(<0.01\) | LM with ARIMA (1,0,0) errors     |
| Rate ($AUD/\(n/week\))      | 351.75   | 560.15 | \(<0.0001\) | \(208.34 (155.44 to 261.23)\) | \(<0.0001\) | LM with ARIMA (0,0,1) errors     |
| Overseas                     | 471.37   | 887.42 | \(<0.0001\) | \(416.04 (311.40 to 520.68)\) | \(<0.0001\) | LM                               |
| Work Cover                   | 154.32   | 219.60 | 0.001 | \(68.12 (19.17 to 117.07)\) | \(<0.01\) | LM with ARIMA (1,0,0) errors     |
| TAC                          | 185.63   | 194.90 | 0.71 | \(-4.29 (-67.59 to 59.02)\) | 0.89 | LM with ARIMA (1,0,0) errors     |
| **SARS-CoV-2 pandemic**      |         |        |                   |                           |              |                                   |
| Billing ($AUD/week)          | 25 684.82 | 19 186.97 | 0.003 | \(-6379.45 (-3001.91 to -9756.99)\) | \(<0.001\) | LM with ARIMA (0,0,1) errors     |
| Overseas                     | 20 820.25 | 15 925.55 | 0.0067 | \(-4975.62 (-1970.21 to -7981.03)\) | \(<0.01\) | LM with ARIMA (0,0,1) errors     |
| Work Cover                   | 2473.29  | 2510.57 | 0.92 | \(37.28 (-751.55 to 826.12)\) | 0.93 | LM                               |
| TAC                          | 2391.28  | 875.99 | \(<0.0001\) | \(-1640.44 (-2436.54 to -844.33)\) | \(<0.01\) | LM                               |
| Count (\(n/week\))          | 62.9     | 32.1   | \(<0.0001\) | \(-12.5 (-29.9 to 4.8)\) | 0.16 | LM with ARIMA (0,1,1) errors     |
| Overseas                     | 36.4     | 17.6   | \(<0.0001\) | \(-6.4 (-18.3 to 5.5)\) | 0.30 | LM with ARIMA (0,1,2) errors     |
| Work Cover                   | 14.4     | 9.3    | \(<0.0001\) | \(-5.1 (-7.6 to -2.6)\) | \(<0.001\) | LM                               |
| TAC                          | 12.0     | 5.5    | \(<0.0001\) | \(-6.9 (-9.3 to -4.5)\) | \(<0.0001\) | LM                               |
| Rate ($AUD/\(n/week\))      | 426.22   | 612.10 | \(<0.0001\) | \(10.94 (-104.56 to 126.44)\) | 0.85 | LM with ARIMA (0,1,1) errors     |
| Overseas                     | 619.62   | 992.62 | \(<0.001\) | \(108.41 (-160.58 to 377.39)\) | 0.43 | LM with ARIMA (0,1,1) errors     |
| Work Cover                   | 169.09   | 265.80 | \(<0.001\) | \(169.09 (52.08 to 141.34)\) | \(<0.0001\) | LM                               |
| TAC                          | 198.44   | 158.82 | 0.29 | \(198.44 (-119.54 to -5.06)\) | 0.04 | LM                               |

ARIMA, autoregressive integrated moving average; \$AUD, Australian dollars; ITS, interrupted time series analysis; LM, linear model; Overseas, Overseas Visitor Agreement; TAC, Transport Accident Commission.
Discussion

The present study measured no significant difference in total billings in the before and after periods of the digital transformation at a major Australian metropolitan ED after the implementation of a simplified one-page data entry form that features on the main screen and prompts users if incomplete. However, a 59% increase in billings recovery per compensable patient was noted, suggestive of a new system that perhaps was more sensitive in identifying patients accurately. The increased billings per patient held true despite the occurrence of the SARS-CoV-2 pandemic. Strengths and limitations

The present study included the adjustment for time-varying confounders, and as a result produced methodologically stronger results to that of simple t-testing. Measuring the outcome after randomisation of complex versus simple form use for compensable patients would be much more robust, but this was not practical or possible. Therefore, the best available evidence to answer the study question was a quasi-experimental method. Additionally, there were no data about how compensation was calculated per individual, so it is not possible to ascertain whether compensation increased per patient, or if the pre-transformation data were merely a dilutional effect from falsely identifying too many compensable patients.

Interpretation

An increase in billings rate could be explained by increasing complexity of patients, hence requiring more consultations, procedures, and resuscitation time, or it could be explained by a pre-existing system that did not effectively identify patients or capture these item numbers. The latter has already been demonstrated in published literature, and would be a more likely explanation. Perhaps this new upgrade is simply better at identifying patients who can be billed appropriately, without increasing overall billings. Billings per patient holding true throughout the pandemic also appear to be a plausible finding. Although pandemic preparations have been shown to have reduced the ability of emergency physicians to see many patients themselves, the actual work involved with each patient has not been demonstrated to have changed.

Generalisability

Departments that are already using a simple form or other cost recovery
methods may not see similar effects. Also, billings here were largely driven by overseas visitors, which made up more than half of the study population. Departments that service different demographics may experience different recovery increases when simplifying their billings processes.

Conclusion
A simplified billing form, albeit in the context of an organisation-wide digital transformation, made no significant difference in total billings at a major Australian metropolitan ED, but was associated with a 59% increase in billings per patient. This persisted despite the SARS-CoV-2 pandemic.

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Competing interests
None declared.

Data availability statement
The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Supporting information
Additional supporting information may be found in the online version of this article at the publisher’s web site:

Figure S1. New billings form.