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Does improved patient care lead to higher treatment costs? A multicentre cost evaluation of a blunt chest injury care bundle

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ARTICLE INFO

Precis: An evidence-based care bundle for chest injury was more costly but more effective for patient outcomes than standard care.

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ABSTRACT

Background: Blunt chest injury is associated with significant adverse health outcomes. A chest injury care bundle (ChIP) was developed for patients with blunt chest injury presenting to the emergency department. ChIP implementation resulted in increased health service use, decreased unplanned Intensive Care Unit admissions and non-invasive ventilation use. In this paper, we report on the financial implications of implementing ChIP and quantify costs/savings.
Methods: This was a controlled pre-and post-test study with two intervention and two non-intervention sites. The primary outcome measure was the treatment cost of hospital admission. Costs are reported in Australian dollars (AUD). A generalised linear model (GLM) estimated patient episode treatment costs at ChIP intervention and non-intervention sites. Because healthcare cost data were positive-skewed, a gamma distribution and log-link function were applied.
Results: A total of 1705 patients were included in the cost analysis. The interaction (Phase x Treatment) was positive but insignificant ($p = 0.45$). The incremental cost per patient episode at ChIP intervention sites was estimated at $964 (95 % CI, -966 – 2895). The very wide confidence intervals reflect substantial differences in cost changes between individual sites Conclusions: The point estimate of the cost of the ChIP care bundle indicated an appreciable increase compared to standard care, but there is considerable variability between sites, rendering the finding statistically non-significant. The impact on short- and longer-term costs requires further quantification.

Introduction

Blunt chest injury can include a direct blow to the ribs from a fall, assault, motor vehicle collision or contact sports, and may lead to significant morbidity and mortality [1,2]. For patients with blunt chest injury, complications, such as pneumonia and respiratory failure, frequently occur, causing long-term pulmonary impairment [3], delayed recovery and increased resource use, if not treated promptly with sufficient analgesia, physiotherapy and respiratory support [4,5]. We developed and implemented an evidence-informed blunt chest injury care bundle (ChIP), consisting of an early notification system and care bundle for patients presenting to the emergency department (ED) with isolated blunt chest injury, (Fig. 1) [6]. A care bundle is a set of evidence-based interventions that, when delivered together, improve

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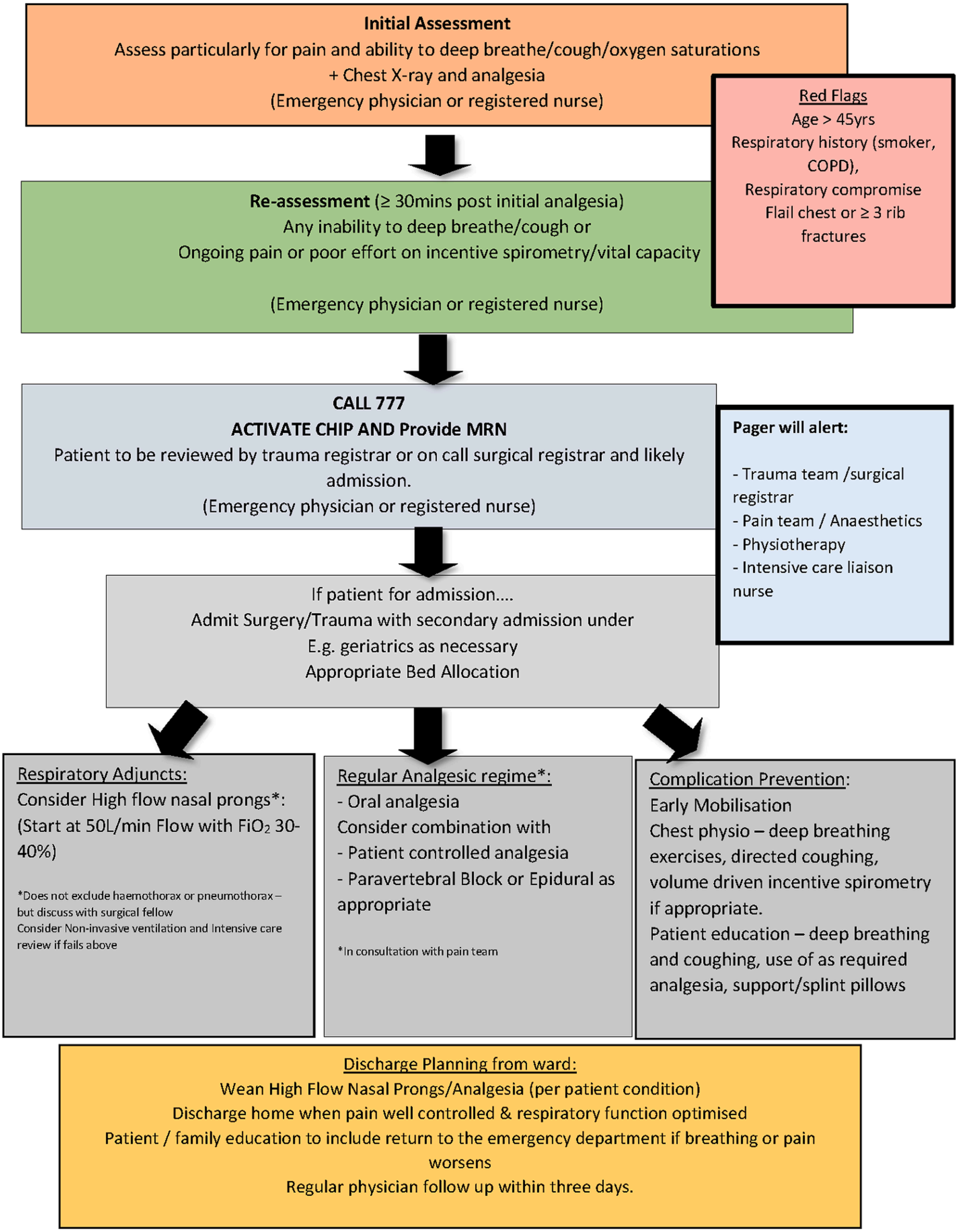

Fig. 1. Flowchart for the blunt chest injury care bundle (ChIP).

health outcomes more than if administered separately [7]. ChIP was implemented with a robust and effective implementation plan [8] informed by behaviour change theory [9].

The implementation of ChIP resulted in improved patient and health service outcomes including reduced intensive care unit (ICU) stay and reduced non-invasive ventilation (NIV) use in patients with clinically or radiologically confirmed rib or sternum fracture [10]. These improved outcomes were a result of improved coordinated care delivery, for example, there was increased physiotherapy, pain team, and surgical review. However, it is important to evaluate the cost-effectiveness of interventions, even those with positive patient outcomes and health service use results.

Cost can be a barrier to the implementation of interventions at scale in healthcare [11]. An intervention that demonstrates benefit for patient outcomes and that also is cost-effective is ideal, as these dual patient and financial benefits facilitate support from clinicians and administrators for changes in care protocols and future implementation of the intervention into practice. Cost-effectiveness evaluations can inform policy-makers and hospital leaders of priorities in identifying innovative, evidence-based care practices and allocating resources [12]. In this paper, we report the financial implications of implementing ChIP for patients with blunt chest injury and quantify additional costs/savings.

Implementation

The implementation of ChIP at two sites was achieved using existing resources, so costs were limited to staff time. The implementation strategies were: i) face-to-face educational sessions, including a video featuring local staff including managerial staff demonstrating their support: https://youtu.be/VlMz1PjzmBk; ii) audits and feedback to provide staff with data on their progress; iii) reminders in the form of flyers, an icon prompt on the electronic medical record, and email and newsletter notification and iv) a clinical champion at each site [10]. Estimated "in kind" implementation costs were collated, but as they were in-kind no outlay of additional funds occurred, and so were not incorporated into the analysis (Table 1).

Methods

Method design and setting

This was a controlled pre-and post-test study with two intervention and two non-intervention sites conducted between 1 July 2015 – 21 Nov 2017 (pre) and 22 November 2017 and 30 June 2019 (post). Research conducted as part of this study adhered to the National Statement on Ethical Conduct in Human Research by the Australian National Health and Medical Research Council [13], and was approved by the NSW Population & Health Services Research Ethics Committee (HREC/17/CIPHS/56).

The four study sites had ICU, surgical, pain and physiotherapy services [14]. The two intervention sites were matched to two non-intervention sites in metropolitan Sydney with similar bed numbers, staffing, case-mix, resources, and chest injury case numbers. The two intervention sites were a 500-bed regional trauma centre with approximately 70,000 emergency presentations annually (Site A) [15] and a 200-bed rural/regional hospital with approximately 40,000 emergency presentations annually (Site B) [16]. ChIP was implemented at the intervention sites on the 22 November 2017. The non-intervention sites continued with standard care. One non-intervention site was a 300-bed centre metropolitan centre with 36,000 presentations annually (Site C) and a 200-bed hospital with 32,000 emergency presentations annually (Site D) [17].

Patient identification

Patient case inclusion criteria were:

1. Any mechanism of injury suggesting blunt chest trauma;
2. 18 years or older;
3. admitted to hospital; and
4. had either a radiological or clinical diagnosis of rib or sternum fracture.

The following patients were excluded:

1. injury occurred while in hospital as this made the activation system not possible;
2. had cognitive impairment rendering patients unable to participate in the care bundle;
3. intubated prehospital or in the ED; and
4. had an injury requiring urgent operative intervention.

Blunt chest injury patients were included regardless of whether they received a ChIP call to account for expected implementation flow on effects onto standard care [18]. The intubated and urgent operative patients were excluded as they may have received other pain management in the ICU or after operating theatre relating to the operation rather than for blunt chest injury.

Outcome measures

The primary outcome measure was the treatment cost of an admission. Costs are reported in Australian dollars (AUD).

Data sources and processes

Patients were identified through the NSW Admitted Patient Data Collection (APDC) according to preselected International Statistical Classification of Disease version-10 Australian modification (ICD-10-AM) codes (Supplementary file 1). The NSW Admitted Patient Data Collection includes information on demographics, length of stay and procedures. Costing data were obtained through the Activity Based Management. The Activity-based management cost data included cost per encounter.

Table 1
ChIP initial set-up time commitments.

	Initial outlay hours and line activity cost estimate						Ongoing outlay hours and line activity cost estimate							
Development and Production Activity	Hrs CNC	Hrs NE	Hrs SS	Hrs RN3	Hrs CNE	Hours by line activity	Hrs CNC	Hrs NE	Hrs SS	Hrs RN3	Hrs HSM2	Hrs CNE	Hours by line activity	Comment
RN 1hr training				220	24	244				220		24	244	In kind
Teaching materials	8	8			8	24	8	8				8	24	In kind
Promotional video	10					10	25						25	In kind
Altering of policy	5					5	5						5	In kind
CNE, NUM time / meet	4	4				8	4	4					8	In kind
Total Hours	27	12	0	0	8	47	42	12	0	0	0	8	306	

CNC: Clinical nurse consultant, NE: Nurse educator, SS: Staff Specialist – Emergency Physician, RN: Registered Nurse, HSM: Health service manager, CNE: Clinical Nurse Educator.

Patient medical records were obtained from each site and were screened retrospectively by researchers for inclusion and manual data collected from the electronic medical record. The Centre for Health Record Linkage (CHeReL) used probabilistic linkage to link the APDC to the activity-based management cost dataset and to site-based patient medical records. Demographic data such as age and sex, ICU, hospital length of stay (LOS) and procedures were obtained from the APDC and other clinical data, such as trauma call activation and non-invasive ventilation, were obtained from the site medical records.

Clinical information included injury(s), mechanism of injury, injury date and time, injury severity and whether patients received a trauma call activation. Injury data were categorised according to the Abbreviated Injury Scale 2008 [19]. The injury severity score (ISS) and the New Injury Severity Score (NISS) are internationally recognised scoring systems for the combined effects of trauma and were calculated using the Abbreviated Injury Scores [20]. The injury severity score ranges from 1 to 75, with a score $\geq$15 indicating severe injuries. The NISS was included as it may be a better predictor for blunt injury and does not discriminate for body region in the score [21].

The Charlson comorbidity index identifies and assigns weights for 17 pre-existing comorbidities based on their association with mortality [22]. Polytrauma was defined as a patient with $\geq$2 Abbreviated Injury Scores $\geq$2 in two or more body regions. If a trauma call was activated in the ED for patients presenting with severe injuries or a high-risk mechanism of injury per local policy this was noted as an additional team response had been activated and that these patients had the potential for severe injury.

Analysis

Statistical analyses were performed using SPSS v26 (SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp). The relevant population contained 1798 observations (i.e., patient encounters). A few records had missing data. 70 were missing patient cost data and a further 23 were missing data for one or more control variables. Missing data accounted for 6.4 % of the treatment group and 3.5 % of the control group data. The final sample used in the analysis included 1705 observations.

Descriptive statistics were used to describe the patient and health service use characteristics at the intervention versus usual care sites. Several patient level characteristics that may influence patient episode costs were included as covariates. Patient age measured in years), patient gender, the *Charlson comorbidity index* (CCI), the *Injury Severity Score* (ISS), whether the patient was a re-presentation, and whether the patient presented with polytrauma, were all controlled for in the analysis. Major diagnostic category are included as fixed effects, while hospital site was treated as a random effect to account for unobserved effects of different facilities on patient treatment costs.

A generalized linear model (GLM) was used to estimate patient episode treatment costs at ChIP intervention and non-intervention sites. Because healthcare cost data are positive-skewed, a gamma distribution and log-link function were applied [23,24]. To assess the treatment effect on patient cost, an interaction term between the intervention period (post-and pre-intervention period) and whether the patient attended a hospital with or without the ChIP intervention is included in the model. As the model is a non-linear function, the incremental cost of ChIP intervention was separately estimated through a marginal effects analysis. The incremental cost is the average difference in patient cost between intervention and non-intervention sites. To account for variations in the values of control variables (e.g., age) between intervention periods and intervention and non-intervention sites, we examined the marginal effects at the average values of the control variables [23,24].

Results

A summary comparison of the intervention compared to the non-intervention sites at pre and post implementation is in Table 2. Visually, the overall cost at intervention sites post-implementation is slightly higher then both pre-implementation and non-intervention sites. However, to test whether ChIP intervention is associated with a significant change in patient cost we examine the interaction term between intervention phase (Phase) and treatment sites (Treatment), with the GLM analysis (Table 3).

As can be seen in Table 3, the interaction term (Phase x Treatment) is positive but insignificant ($p = 0.45$). To calculate the difference in average patient cost at ChIP treatment and non-treatment sites, we conduct a marginal effects analysis. The incremental cost per patient episode at ChIP intervention sites is estimated to be $964 (95 % CI, -966 − 2895). However, as the interaction term is insignificant, we do not find any evidence for ChIP intervention being associated with a change in patient cost.

Two additional tests were conducted to assess the robustness of our results. Although GLM is relatively robust to the presence of outliers, we note a small number of observations that can be categorized as having outlying values on the dependent variable. Excluding observations with particularly large treatment costs does not substantively change the results as presented in Table 3, with the interaction term remaining insignificant. While visual assessment of residual plots does not indicate any significant departure from linearity between the transformed expected values of patient cost and the predictor variables, we consider the possibility that there may still be nonlinear associations between some of our predictor variables and patient cost. We add to the model in Table 3 quadratic terms for continuous predictor variables (Age, CCI, ISS). The untabulated results of the model including quadratic terms also shows an insignificant interaction term between Phase and Treatment variables. Overall, we find no significant evidence that ChIP intervention is significantly associated with a change in patient cost per episode.

Discussion

In this study, we reported the cost implications of a blunt chest injury care bundle (ChIP). There was no evidence that ChIP was associated with change in cost. ChIP was associated with improved outcomes without related increased costs - a result of improved coordinated care delivery, despite increased physiotherapy, surgical review, and the pain team/anaesthetics [10].

Decisions for patient care are multi-factorial. Although clinicians strive for best practice, there are many factors that may impact on the real-world implementation of evidence-based practice and whether it can be implemented sustainably relying on organisational support [25]. ChIP did not lead to increased costs, however, this still raises questions if ChIP and other targeted care bundles can be implemented in a way that reduce costs to the health service while maintaining high quality care and differences in patient outcomes [12]. Clinicians are often the ones driving change to improve care; however, may not consider the impacts of costs to the organisation.

The impact of ChIP on patient quality of life post-discharge is unknown and whether the cost in hospital has longer term beneficial effects for patients, for example, earlier return-to-work or fewer representations. Patients with rib fractures may continue to have pain and other long-term effects from the injury post their hospital stay [26]. The burden of injury is greater than the direct and indirect monetary costs associated with medical outcomes [27]. Australian studies of adult trauma patients have shown that an ICU admission following injury is predictive for high levels of depression, anxiety and stress at 6 months [28] and that most (81 %) injured patients report pain in the first few weeks after hospital discharge that impacted normal work, general activity and enjoyment of life [29]. Further, insufficient information and analgesics at hospital discharge, and inconsistent and incomplete discharge processes fail to equip trauma patients to effectively manage their pain at home [30]. It is plausible that patients who received ChIP were better equipped at discharge to manage their pain because of

Table 2
Comparison of treatment and control groups. All costs in Australian dollars (AUD).

Group	Non-intervention sites						Intervention sites						TOTAL	
	Pre		Post		Total		Pre		Post		Total			
Count (n=)	**327**		**247**		**574**		**544**		**587**		**1131**		**1705**	
Total Cost AUD mean (SD)	7056 (8246)		7619 (9137)		7298 (8638)		8115 (12,211)		9169 (11,789)		8662 (12,000)		8203 (11,000)	
Median [IQR]	4655 [1724 - 8617]		4680 [1667 - 9915]		4415 [1576 - 9622]		4263 [1481 - 9686]		5531 [2744 - 11,200]		4900 [2018 - 10,285]		4877 [1977 - 10,047]	
Age (mean, SD)	75.4	16.6	76.3	16.0	75.8	16.3	65.8	20.0	67.1	18.7	66.5	19.4	69.6	18.9
Male (n,%)	181	61 %	115	39 %	296	40 %	200	45 %	243	55 %	443	60 %	739	
Length of Stay (mean, SD)	5.4	6.1	5.4	5.7	5.4	5.9	5.3	5.6	5.5	5.3	5.4	5.4	5.4	5.6
Hours Intensive care unit (mean, SD)	2.7	13.7	4.1	23.7	3.3	18.7	3.4	25.8	3.0	21.2	3.2	23.5	3.2	22.0
Charlson comorbidity index total (mean, SD)	4.5	2.6	4.3	2.4	4.4	2.5	3.6	2.9	3.5	2.6	3.5	2.8	3.8	2.7
Injury severity score (mean, SD)	6.0	4.2	5.7	4.1	5.9	4.2	6.9	5.7	7.4	5.3	7.2	5.5	6.8	5.1
Mechanical ventilation (hours) (mean, SD)	0	0	0	0	0	0	0.4	6.9	0.5	12.1	0.4	10.0	0.3	8.1
Representation (n,%)	17	43 %	23	58 %	40	47 %	15	33 %	30	67 %	45	53 %	85	
ChIP calls (n,%)	0		0		0	0 %	1	0 %	401	100 %	402	100 %	402	
Trauma call (n,%)	5	83 %	1	17 %	6	2 %	151	58 %	109	42 %	260	98 %	266	
Polytrauma (n,%)	1	50 %	1	50 %	2	8 %	11	46 %	13	54 %	24	92 %	26	

ChIP- Chest injury pathway, SD – standard deviation.

Table 3
Results of generalised linear model for comparison of intervention and non-intervention sites.

Variable	Coefficient	Standard Error	z stat	p value	95 % Confidence Interval	
					Lower	Upper
Constant	7.588	0.315				
Phase	0.134	0.129	1.04	0.298	-0.118	0.386
Treatment	0.065	0.154	0.42	0.674	-0.227	0.366
Phase x Treatment	0.121	0.161	0.76	0.450	-0.194	0.436
Age (years)	0.004	0.004	0.91	0.362	-0.004	0.011
Gender	0.089	0.057	1.57	0.116	-0.022	0.200
CCI	0.130	0.016	8.35	<0.001	0.099	0.160
ISS	0.068	0.007	8.35	<0.001	0.055	0.082
Representations	-0.223	0.071	-3.12	0.002	-0.363	-0.083
Polytrauma	-0.097	0.192	-0.50	0.614	-0.473	0.279

Dependent variable: Cost per patient encounter. Robust standard errors reported. MDC fixed effects included but not reported. Abbreviations: CCI = Charlson's comorbidity index, ISS = injury severity score.

enhanced pain service engagement during admission [31]. However, it was beyond the scope of this study to investigate this further.

Methodological considerations and limitations

Retrospective data was used for comparative purpose which may have led to reduced accuracy of data. In particular, our estimates of the incremental patient cost at treatment sites lack precision because our study is limited to two intervention and two non-intervention sites. Though efforts were made to choose hospital sites that were similar for comparisons, we acknowledge there would be differences between sites or increases in cost at implementation sites over time that were not foreseen and therefore not accounted for in this study. There was, however, no statistically significant difference in comparing pre to post phases at intervention ($p = 0.62$) or non-intervention ($p = 0.26$) sites in a *t*-test comparison.

Inclusion of additional sites and observations may also have allowed for greater model precision and statistical power. Finally, costs related to consumables are generally incorporated and calculated on by AR-DRG and LOS in the cost bucket "Ward&ED" Supplies. However, we did not have access to this level of data, and it is highly possible that consumables used in ICU were reduced as a result of the reduced ventilator and ICU time, and our results are underestimated.

Conclusions

The point estimate of the cost of the ChIP care bundle indicated an appreciable increase compared to standard care. However, considering the variability between sites, this finding is rendered statistically non-significant. The impact on short- and longer-term costs requires further quantification. From our previous studies ChIP had benefits to patient outcomes including reduced ICU stay and reduced NIV use. We strongly recommend longitudinal future research that considers factors beyond fiscal savings such as quality of life, function, and long-term effects work and consideration of cost as a societal issue, not solely a hospital admission.

Declaration of funding

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Ethical approval

Research conducted as part of this study adhered to the National Statement on Ethical Conduct in Human Research by the Australian National Health and Medical Research Council, and was approved by the NSW Population & Health Services Research Ethics Committee (HREC/17/CIPHS/56)

Data availability

For ethical reasons, the data used is not publicly available. However, data can be made available at request to authors and ethics committee

CRediT authorship contribution statement

Sarah Kourouche: Writing – review & editing, Writing – original draft, Visualization, Project administration, Investigation, Formal analysis, Data curation, Conceptualization. **Kate Curtis:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Funding acquisition, Conceptualization. **Julie Considine:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization. **Margaret Fry:** Writing – review & editing, Validation, Methodology, Investigation, Conceptualization. **Rebecca Mitchell:** Writing – review & editing, Validation, Resources, Methodology. **Ramon Z. Shaban:** Writing – review & editing, Validation, Resources, Methodology, Investigation, Funding acquisition, Conceptualization. **Prabhu Sivabalan:** Writing – review & editing, Validation, Resources. **David Bedford:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis.

Declaration of competing interest

The authors have nothing to disclose.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.injury.2024.111393.

References

[1] Dogrul BN, Kiliccalan I, Asci ES, Peker SC. Blunt trauma related chest wall and pulmonary injuries: an overview. Chin J Traumatol 2020;23(3):125–38. https://doi.org/10.1016/j.cjtee.2020.04.003.
[2] Caragounis EC, Xiao Y, Granhed H. Mechanism of injury, injury patterns and associated injuries in patients operated for chest wall trauma. Eur J Trauma Emerg Surg 2019. https://doi.org/10.1007/s00068-019-01119-z.
[3] Leone M, Ragonnet B, Alonso S, Allaouchiche B, Constantin JM, Jaber S, et al. Variable compliance with clinical practice guidelines identified in a 1-day audit at 66 French adult intensive care units. Crit Care Med 2012;40(12):3189–95. https://doi.org/10.1097/CCM.0b013e31826571f2.
[4] Sharma OP, Oswanski MF, Jolly S, Lauer SK, Dressel R, Stombaugh HA. Perils of rib fractures. Am Surg 2008;74(4):310–4. https://doi.org/10.1177/000313480807400406.
[5] Todd SR, McNally MM, Holcomb JB, Kozar RA, Kao LS, Gonzalez EA, et al. A multidisciplinary clinical pathway decreases rib fracture–associated infectious morbidity and mortality in high-risk trauma patients. Am J Surg 2006;192(6):806–11. https://doi.org/10.1016/j.amjsurg.2006.08.048.
[6] Kourouche S, Buckley T, Munroe B, Curtis K. Development of a blunt chest injury care bundle: an integrative review. Injury 2018;49(6):1008–23. https://doi.org/10.1016/j.injury.2018.03.037.
[7] Lavallée JF, Gray TA, Dumville J, Russell W, Cullum N. The effects of care bundles on patient outcomes: a systematic review and meta-analysis. Implement Sci 2017;12(1):142. https://doi.org/10.1186/s13012-017-0670-0.
[8] Kourouche S, Buckley T, Van C, Munroe B, Curtis K. Designing strategies to implement a blunt chest injury care bundle using the behaviour change wheel: a multi-site mixed methods study. BMC Health Serv Res 2019;19(1):461. https://doi.org/10.1186/s12913-019-4177-z.
[9] Michie S, van Stralen MM, West R. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. Implement Sci 2011;6(1):42. https://doi.org/10.1186/1748-5908-6-42.
[10] Curtis K, Kourouche S, Asha S, Considine J, Fry M, Middleton S, et al. Impact of a care bundle for patients with blunt chest injury (ChIP): a multicentre controlled implementation evaluation. PLoS One 2021;16(10):e0256027. https://doi.org/10.1371/journal.pone.0256027.
[11] Correa VC, Lugo-Agudelo LH, Aguirre-Acevedo DC, Contreras JAP, Borrero AMP, Patiño-Lugo DF, et al. Individual, health system, and contextual barriers and facilitators for the implementation of clinical practice guidelines: a systematic metareview. Health Res Policy Syst 2020;18(1):74. https://doi.org/10.1186/s12961-020-00588-8.
[12] Burns CL, Wishart LR, Kularatna S, Ward EC. Knowing the costs of change: an introduction to health economic analyses and considerations for their use in implementation research. Speech, Language and Hearing. 2020;23(1):30–6. https://doi.org/10.1080/2050571X.2019.1693750.
[13] National Health and Medical Research Council (NHMRC). The national statement on ethical conduct in human research. updated 2018 ***Australia: Australian government*** 2017. 2018.
[14] NSW Health. Hospitals. Health Services 2017 [Available from, https://www.health.nsw.gov.au/Hospitals/Pages/default.aspx.
[15] NSW Health. Wollongong Hospital 2019 [Available from: https://www.islhd.health.nsw.gov.au/hospitals/wollongong-hospital.
[16] NSW Health. Shoalhaven Hospital 2019 [Available from: http://www.islhd.health.nsw.gov.au/hospitals/shoalhaven.
[17] The Bureau of Health Information. Healthcare observer 2019 [updated 07/11/19]. Available from, http://www.bhi.nsw.gov.au/Healthcare_Observer.
[18] Efficacy and safety of very early mobilisation within 24h of stroke onset (AVERT): a randomised controlled trial. The Lancet 2015;386(9988):46–55. https://doi.org/10.1016/S0140-6736(15)60690-0.
[19] Van Ditshuizen JC, Sewalt CA, Palmer CS, Van Lieshout EMM, Verhofstad MHJ, Den Hartog D, et al. The definition of major trauma using different revisions of the abbreviated injury scale. Scandinavian J Trauma, Resuscitation Emerg Med. 2021;29(1):71. https://doi.org/10.1186/s13049-021-00873-7.
[20] Moon SH, Kim JW, Byun JH, Kim SH, Choi JY, Jang IS, et al. The thorax trauma severity score and the trauma and injury severity score: do they predict in-hospital mortality in patients with severe thoracic trauma?: a retrospective cohort study. Med (Baltimore) 2017;96(42):e8317. https://doi.org/10.1097/MD.0000000000008317.
[21] Tohira H, Jacobs I, Mountain D, Gibson N, Yeo A. Systematic review of predictive performance of injury severity scoring tools. Scand J Trauma Resusc Emerg Med 2012;20:63. https://doi.org/10.1186/1757-7241-20-63.
[22] Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40(5):373–83. https://doi.org/10.1016/0021-9681(87)90171-8.
[23] Dodd S, Bassi A, Bodger K, Williamson P. A comparison of multivariable regression models to analyse cost data. J Eval Clin Pract 2006;12(1):76–86. https://doi.org/10.1111/j.1365-2753.2006.00610.x.
[24] Mihaylova B, Briggs A, O'Hagan A, Thompson SG. Review of statistical methods for analysing healthcare resources and costs. Health Econ 2011;20(8):897–916. https://doi.org/10.1002/hec.1653.
[25] Cowie J, Nicoll A, Dimova ED, Campbell P, Duncan EA. The barriers and facilitators influencing the sustainability of hospital-based interventions: a systematic review. BMC Health Serv Res 2020;20(1):588. https://doi.org/10.1186/s12913-020-05434-9.
[26] Gordy S, Fabricant L, Ham B, Mullins R, Mayberry J. The contribution of rib fractures to chronic pain and disability. Am J Surg 2014;207(5):659–62. https://doi.org/10.1016/j.amjsurg.2013.12.012.
[27] Lyons RA, Finch CF, McClure R, van Beeck E, Macey S. The injury List of All Deficits (LOAD) Framework–conceptualizing the full range of deficits and adverse outcomes following injury and violence. Int J Inj Contr Saf Promot 2010;17(3):145–59. https://doi.org/10.1080/17457300903453104.
[28] Wiseman TA, Curtis K, Lam M, Foster K. Incidence of depression, anxiety and stress following traumatic injury: a longitudinal study. Scand J Trauma Resusc Emerg Med 2015;23:29. https://doi.org/10.1186/s13049-015-0109-z.
[29] Goldsmith H, Curtis K, McCloughen A. Incidence, Intensity, and Impact of Pain in Recently Discharged Adult Trauma Patients: an Exploratory Study. J Trauma Nursing: the Official J the Soci Trauma Nurses 2017;24(2):102–9. https://doi.org/10.1097/jtn.0000000000000273.
[30] Goldsmith H, McCloughen A, Curtis K. Using the trauma patient experience and evaluation of hospital discharge practices to inform practice change: a mixed methods study. J Clin Nurs 2018;27(7–8):1589–98. https://doi.org/10.1111/jocn.14230.
[31] Kourouche S, Curtis K, Munroe B, Asha SE, Carey I, Considine J, et al. Implementation of a hospital-wide multidisciplinary blunt chest injury care bundle (ChIP): fidelity of delivery evaluation. Aust Crit Care 2021. https://doi.org/10.1016/j.aucc.2021.04.003.