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Original Research

Service redesign for outpatient services: Strategies to improve the wait

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A R T I C L E I N F O

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A B S T R A C T

Objective: To assess the effectiveness of a multicomponent waitlist optimisation strategy on the proportion of patients overdue to be seen for a neurosurgical (spinal pain) outpatient service at an Australian public hospital.
Study design: An interrupted time series study in the outpatient department of a tertiary referral hospital in New South Wales, Australia.
Methods: We implemented and evaluated nine waitlist optimisation strategies. We compared a Pre-implementation phase (January 2015–January 2016), a Implementation phase (February 2016–December 2017), and a Post-implementation phase (January 2018–January 2020). We included data from all adults who had been referred for neck and back pain. We used three outcomes of interest; they were: (i) the proportion of patients overdue to be seen (based on their triage category) for a given month, (ii) the proportion of patients that were waiting longer than one year for an initial appointment each month and (iii) the total neurosurgical waitlist number.
Results: We included data from 11,520 unique individuals who had a mean age of 54 years (SD 17), 51 % (5900) were female, and 8·8 % (1004) identified as Aboriginal and/or Torres Strait Islander. Across the three phases, there were 26,928 monthly data points Pre-implementation, 36,009 Implementation, and 15,326 Post-implementation. The trend in the proportion of patients overdue to be seen in the Post-Implementation phase was 7 % lower (OR 0·93 [95 % CI 0·89, 0·97]) compared to Pre-implementation.
Conclusion: The waitlist optimisation strategies tested in this study led to a large reduction in the proportion of patients overdue to be seen on the neurosurgical waitlist. The tested strategies can be used by other services to address extended waits in outpatient services.

1. Introduction

Spinal pain, including low back pain (LBP) and neck pain, is a common disabling condition.[1–3] International data shows that large portions of the population will experience spinal pain at some time in their life; 48.5 % will experience neck pain[4] and 84.0 % will experience low back pain.[5] In 2017, there were approximately 577 million people globally living with LBP(2) and 289 million with neck pain.[3] The impact of spinal pain on these people's lives is reported as high levels of pain and disability, reduced quality of life and social participation, and inability to complete activities of daily living.[6,7]

People with spinal pain are often referred to specialist surgical services for consideration, even though there is limited evidence for surgery. Guidelines recommend the first-line management of spinal pain should occur in primary care;[6] however, many of these people are concurrently referred to public hospital outpatient specialist services

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(secondary care) for care.[8] As primary care and secondary care are funded and serviced by different clinicians, there is often a lack of continuity of care between the two.[9] In Australia, a study evaluating general practice activity reported that 1.5 % of people who see their General Practitioner with acute LBP are referred to specialists.[10] However, data from a self-management survey of people with LBP in Australia indicates that up to 7.8 % of people with first-time LBP and 14.0 % of people with recurrent LBP access care from specialists.[8] Similar high rates are reported internationally,[11] even though there is evidence that surgery has limited benefit to the majority of people with spinal pain.[12]

Irrespective of the appropriateness of surgery, most people referred for specialist consultation in the public system will wait for extended periods of time for an initial consultation. Extended wait times for non-urgent neurosurgical consultations are present across Australia, including New South Wales[13] (median wait time 560 days), Victoria[14] (median wait time 190 days) and Queensland[15] (48.5 % of patients waiting longer than clinically recommended time). Canadian data from 2009 shows that neurosurgery patients (including spinal pain) may wait 22.9 weeks from referral to consultation and 10.1 weeks from consultation to treatment.[16] Given the high referral and demand on specialist outpatient services leading to long and possibly unnecessary waiting time, there is a need to evaluate strategies that focus on minimising wait times and improving continuity of care.

A growing evidence base exists examining the best way to manage waiting lists for outpatient services to ensure referred patients receive high-quality and timely care.[17,18] One recent systematic review investigating factors for improving outpatient waiting times highlights three key areas of focus, including resource alignment, operational efficiency, and process improvement.[17] Although this review suggested extended waiting times have multiple determinants, previous studies have deployed strategies that only address single factors (e.g., waitlist audits to access patient's ongoing need for care).[17,18] These studies have also lacked a robust evaluation framework, using only case studies or non-interventional study designs, and do not provide meaningful information to inform decisions about the use of the strategies elsewhere.[17] In response to limited evidence to inform strategies to target growing waiting time pressures in a tertiary outpatient service, we aimed to design and assess the effects of a multicomponent waitlist optimisation strategy on a neurosurgical (spinal pain) outpatient service waiting list in an Australian public hospital.

2. Methods

We completed an interrupted time series study. Ethics approval was granted by the Hunter New England Local Health District (HNELHD) Human Research Ethics Committee (2019/ETH01034).

2.1. Study setting and participants

Our study was completed at the John Hunter Hospital in HNELHD of New South Wales (NSW), Australia. The hospital is a tertiary referral centre and is the largest (899 beds) in the health district. The neurosurgical outpatient department is the only neurosurgical service within the health district and receives approximately 2500 referrals annually. Within the health district, there is an orthopaedic surgical service that also sees people with low back and neck pain; however, with much lower referral numbers (approximately 330 annually for back and neck pain). The health district has a catchment area of approximately 131,785 km^2 and an estimated population of 942,374.[19] We included data from all adult referrals for neck and back pain to the neurosurgical outpatient service between January 2015 and January 2020.

2.2. Development of waitlist optimisation strategies

The waitlist optimisation strategy was developed in order to address a growing neurosurgical waitlist. The individual strategies, their aim, and their timing are outlined in Table 1. Strategy development was a

Table 1
Waitlist optimisation strategies.

Strategy	Strategy Aim	Implementation date	Strategy Details
Neurosurgery Spinal Fellow clinic	To increase the capacity of clinics by offering more appointments	February 2016	Introduction of a weekly clinic led by Neurosurgery Spinal Fellow
Audit and feedback of waitlists	Increase clinician awareness of waitlist size and time for an appointment	February 2016	Monthly audit of clinician's outpatient waitlists completed by administration staff and fed back to Neurosurgery Staff Specialists
Collaborative parallel Physiotherapy clinic	To increase the capacity of clinics by offering more appointments	November 2016	Design and implementation of a weekly clinic led by Senior Physiotherapists to assess people referred with spinal pain in collaboration with Neurosurgical teams
Additional clinics and review of clinic templates (appointment slots)	To increase the capacity of clinics by offering more appointments	May 2017	Initial review of clinics identified opportunities to update clinic templates and offer more appointments by introducing additional clinics
Internal clinical triage guidelines	To reduce clinician variation in patient triage	May 2017	The development and implementation of a internal clinical triage guideline was co-led by Neurosurgery Staff Specialists and Outpatient Service Managers to reduce variation in triage decisions
Neurosurgery-specific referral resource (*HealthPathways* website)	To encourage evidence-based management and appropriate referrals to the outpatient service	July 2017	The Neurosurgery-specific *HealthPathways* website was co-designed with stakeholders. Referring General Practitioners were then made aware of the updated website and encouraged to refer to it when developing a client management plan
General Practitioner 'Spinal Referral Form' for all non-urgent back pain referrals.	To ensure adequate information for screening and triage and to improve the efficiency of initial appointments + - reduce the need for subsequent appointments	November 2017	The introduction and mandated used of the 'Spinal Referral Form' was used to ensure adequate information was provided regarding physical examination and investigations (as needed). The form was co-designed with a range of stakeholders. The referral form was initially piloted before being updated based on feedback and rolled out as a requirement for all referrals
Discharge referral option	To offer an alternative pathway for patients not requiring ongoing neurosurgical care	November 2017	People with low back pain who did not require ongoing neurosurgical input were referred to a Healthy Lifestyle program for Pain and received physiotherapy over a 12-week period
Routine administrative audits	To assess patients' ongoing needs for a neurosurgical appointment and ensure waitlist accuracy was maintained	December 2017	Patients on the waitlist were contacted to confirm if they would like to remain on the waitlist for an appointment

collaborative process between members of the research team, clinicians, hospital executives, and outpatient service team members.

2.3. Sources of data

All data were obtained from the John Hunter Hospital Outpatient Services electronic waitlist. Patients are added to the waitlist upon receipt of their referral. Referrals coded as 'Awaiting triage', 'Not ready for care' or with a triage category of 'Rapid Access' were excluded from analysis. Patients triaged as 'Rapid Access' are considered urgent or emergency cases and were not the target of the implemented waitlist optimisation strategies. Patients were removed from the waiting list once they had an initial appointment booked. However, their data up to that point was included in the analysis. We included all neurosurgical clinicians in the data set, as well as three triage categories: Category 1-Urgent, recommended to be seen within 30 days, Category 2- Semi-urgent, recommended to be seen within 90 days, and Category 3-Non-urgent, recommended to be seen within 365 days.[20] Data extraction was performed by the Outpatient Services data manager.

2.4. Outcome measures

We used three outcomes to assess the success of the waitlist optimisation strategies. They were: (i) the proportion of patients on the waitlist overdue to be seen (based on the number of days since referral, with respect to their triage category) each month, (ii) the proportion of patients that were waiting longer than one year for an initial appointment each month and (iii) the total neurosurgical waitlist number, defined as the number of patients on the waitlist on the last day of each month.

2.5. Statistical analysis

We compared neurosurgical waitlist data from three time periods. Phase 1 (Pre-implementation phase) was from January 2015 to January 2016. During Phase 1, we had not implemented any strategies. Phase 2 (Implementation phase) was from February 2016 to December 2017. We gradually implemented the waitlist optimisation strategies during this time. The first strategy was implemented in February 2016 and the final strategy in December 2017. Phase 3 (Post-implementation phase) was from January 2018 to January 2020. We had implemented all strategies by the beginning of Phase 3.

An independent statistician completed all analyses using SAS v9.4 (SAS Institute, Cary, North Carolina, USA). We present descriptive statistics for patient characteristics across all phases using monthly aggregated values. Count outcomes are expressed as n (%), and continuous outcomes are expressed as mean (SD) if normally distributed; otherwise, median (IQR) if skewed. We compared neurosurgical waitlist data from the three phases using: (i) logistic segmented regression analysis for outcomes related to proportions, expressed as odds ratios (OR) with 95 % confidence intervals (95 % CI) or (ii) negative binomial segmented regression for outcomes related to counts, expressed as rate ratios (RR) with 95 % CI. The primary pairwise comparison was Post- to Pre-implementation. We determined the trend, indicated by the slope of the data (slope), and used the Durbin-Watson statistic to test autocorrelation. We compared the magnitude of change in trends (slope difference) between each phase using ORs or RRs and their 95 % CI. An OR or RR of less than one indicates a reduced incident rate in the exposed study phase. We also evaluated 'step change' of a trend (level step change) between the start of a phase, and the point predicted by the trend line of a previous phase, with the corresponding 95 % CI and considered statistical significance. Step changes were assessed for the: (i) start of phase 2 and the trend line of phase 1, (ii) start of phase 3 and the phase 1 trend line, and (iii) start of phase 3 and phase 2 trend line.

For the purposes of analysis, triage categories within the same clinician were assumed to be independent of each other. Observations in the same triage category and with the same clinician were assumed to be correlated over time. This correlation was accounted for using an autoregressive 1 covariance structure, as exploratory graphs did not indicate any seasonality in the time series.

We completed two analyses and models for each outcome. The primary analysis considered influential observations (outliers) on the fit of models. We defined potentially influential observations as having a Cook's distance[21] greater than 4/n, where n is the number of observations used in the model. Observations that fulfilled this condition were removed, and the model refit. The secondary analysis did not consider the effect of influential observations and included all observations.

3. Results

We included data on 11,520 unique patients across the study period with 78,263 monthly observations of the neurosurgical waitlist (Pre-implementation: 26,928, Implementation: 36,009, and Post-implementation: 15,326). Patients had a mean (SD) age of 54 (17) years, 51 % were female, and 8.8 % identified as Aboriginal and/or Torres Strait Islander. Gender, age and Aboriginality remained stable across the three study periods, see Table 2 for further details.

3.1. Proportion of patients overdue to be seen

The primary analysis model showed that the slope in the post-implementation phase was 7 % lower (OR 0.93 [95 % CI 0.89,0.97]) than the slope in the pre-implementation phase (the monthly increase in overdue proportion was 5 % in the pre-implementation phase, along with a monthly decrease in overdue proportion of 2 % in the post-implementation phase). An increasing trend in the proportion of patients overdue to be seen was evident in the Pre-implementation slope (1.05, +5 %), while the Implementation phase (0.94, −6 %) and Post-implementation phase (0.98, −2 %) showed a decreasing trend. See Table 3 for phase comparisons of all outcomes and Fig. 1 for a visual representation of the primary model for the proportion of patients overdue to be seen. A phase comparison table and visual representation of the secondary model are included in Appendix One.

3.2. Proportion of patients waiting >1 year

Improvement was also observed in the proportion of patients waiting longer than one year for an appointment. The slope in the post-implementation phase was 18 % lower (0.82 [0.77, 0.87]) than the slope in the pre-implementation phase. See Appendix Two for visual representation.

3.3. Total waitlist number

In regard to the total neurosurgery waitlist number, there was a significant reduction in the mean number of patients on the neurosurgical waitlist from Pre-implementation (2071 [SD 171]) to Post-implementation (613 [SD 96]). The slope difference in the number of patients on the waitlist was 4 % lower in the Post-implementation phase, compared to Pre-implementation for the primary model (0.96 [0.94, 0.98]). See Appendix Two for visual representation.

4. Discussion

Our study investigated the combined effect of several waitlist optimisation strategies to address extended waiting times for people awaiting an initial outpatient neurosurgical appointment. From Pre-to Post-implementation, the average number of patients on the waitlist overdue for an appointment decreased from 1550 (SD 205) to 227 (SD 81). The implemented strategies led to an overall reduction in the monthly rate of being overdue for an initial neurosurgical appointment

Table 2
Participant characteristics and outcomes.

Characteristics	Pre- phase (n = 26,928)	Implementation phase (n = 36,009)	Post- phase (n = 15,326)
Age (years), mean (SD)	55 (16)	54 (16)	55 (16)
Gender (female), % (n)	52 % (14,000)	51 % (18,323)	51 % (7,763)
Aboriginal and/or Torres Strait Islander, % (n)	9.1 % (2,442)	9.4 % (3,349)	8.9 % (1,350)
Triage Category, % (n)			
−30 day	10.6 % (2,856)	14.4 % (5,173)	14.4 % (2,200)
−90 day	62.9 % (16,947)	67.7 % (24,373)	66.4 % (10,180)
−365 day	26.5 % (7,125)	18.0 % (6,463)	19.2 % (2,946)
Outcomes			
Number of patients on waitlist*, mean (SD)	2071 (171)	1566 (519)	613 (96)
Number of patients overdue*, mean (SD)	1550 (205)	1165 (545)	227 (81)
Number of patients waiting >1 year*, mean (SD)	789 (178)	532 (368)	6 (4)

Notes: *Summaries represent the mean/median monthly value for each characteristic.
SD= Standard deviation.

in the Post-implementation phase by approximately 7 %, compared to the Pre-implementation phase. The proportion of patients waiting more than a year for an initial appointment was 18 % less per month in the Post-implementation phase compared to Pre-implementation, with the average number of patients waiting more than a year decreasing from 789 (SD 178) to 6 (SD 4) from Pre- to Post-implementation. The total number of patients on the wait list also decreased by a rate of approximately 4 % each month in the Implementation phase and by 2 % in the Post-implementation phase, which equates to an average waitlist count of 2071 (SD 171) during Pre-implementation, compared to 613 (SD 96) in Post-implementation.

A previous systematic review focusing on the Australian healthcare system identified three overarching themes that significantly affect outpatient waiting times. The identified themes were: (i) resource alignment, (ii) operational efficiency, and (iii) process improvement.[17] Many of our waitlist optimisation strategies align with the identified themes. We updated internal clinical triage guidelines, and undertook waitlist audits, aligning with strategies supporting resource alignment. We introduced a Neurosurgery Spinal Fellow clinic and a Parallel Physiotherapy clinic to support operational efficiency. Finally, to address process improvement, we co-designed a Spinal Referral Form with referring clinicians (General Practitioners) and introduced it to the service to optimise processes. We are unable to identify which of the strategies were most and least effective, as there were not sufficient time points between the implementation of each waitlist optimisation strategy within the Implementation phase to allow comparison.

The results of our study align with findings from two systematic reviews examining service re-design strategies for musculoskeletal conditions.[17,18] A number of Australian studies have implemented clinical pathways for the management of low back pain in outpatient spinal services.[22–24] A study[22] assessing the effect of a physiotherapy-led triage clinic for low back pain found a considerable difference in the wait times of patients referred to the physiotherapy-led triage clinic (nine weeks), compared to 23 weeks for the spinal orthopaedic clinic and 26 weeks for the general orthopaedic clinic. Implementation of the clinic also resulted in a reduction in the mean waiting time for the general orthopaedic clinic by 11 % and the spinal orthopaedic clinic by 25 %.[22] Positive results were also seen in a study evaluating the implementation of a Back pain Assessment Clinic (BAC) model.[24] Mean (SD) waiting times for the BAC model were 9.8 (4.3) weeks compared to 101.3 (42.4) weeks for a neurosurgical clinic appointment and 70.5 (40.1) weeks for an orthopaedic clinic appointment.[24] While these studies showed positive benefits, they were predominantly limited to strategies addressing operational efficiency and were not as wide-reaching as our range of service re-design strategies.[22–24]

Our study has several strengths. The project was based on routinely collected service-level data over extended periods, includes a large number of observations, and does not rely on participant recall, which allows us to have high confidence in our findings. Our waitlist optimisation strategies were also developed to address multiple obstacles faced by outpatient services, unlike other similar studies that have tended to target a single issue.[22–24] We believe the use of a three-phase interrupted time series is a strength of our study, compared to the commonly used two-phase series (pre and post). A seminal paper by Wagner et al.[25] described the issue of a 'lag' period that can occur during intervention before the intervention effects are apparent, especially in health system

Table 3
Phase comparisons.

Comparison	Proportion of patients overdue to be seen Odds Ratio (95 % CI)	p-value	Proportion of patients waiting >1 year Odds Ratio (95 % CI)	p-value	Total neurosurgery waitlist number Rate Ratio (95 % CI)	p-value
Pre- (Slope)	1.05 (1.03, 1.08)	<0.001	1.07 (1.03, 1.10)	<0.001	1.02 (1.01, 1.04)	0.003
Implementation (Slope)	0.94 (0.92, 0.96)	<0.001	0.92 (0.89, 0.96)	<0.001	0.96 (0.94, 0.97)	<0.001
Post- (Slope)	0.98 (0.95, 1.01)	0.165	0.87 (0.83, 0.91)	<0.001	0.98 (0.97, 1.00)	0.024
Slope difference						
Post- vs Pre-[a]	0.93 (0.89, 0.97)	0.001	0.82 (0.77, 0.87)	<0.001	0.96 (0.94, 0.98)	<0.001
Implementation vs Pre-	0.90 (0.87, 0.92)	<0.001	0.87 (0.84, 0.89)	<0.001	0.93 (0.91, 0.95)	<0.001
Post- vs Implementation	1.04 (0.99, 1.09)	0.094	0.94 (0.88, 1.01)	0.082	1.03 (1.01, 1.05)	0.002
Level step change						
Trend line at start of Post- phase (01/2018) vs estimated Pre- trend line	0.34 (0.21, 0.55)	<0.001	0.15 (0.06, 0.38)	<0.001	0.36 (0.27, 0.48)	<0.001
Trend line at start of Implementation phase (02/2016) vs estimated Pre- trend line	1.15 (1.02, 1.30)	0.023	1.20 (1.01, 1.42)	0.035	1.02 (0.97, 1.07)	0.420
Trend line at start of Post- phase (01/2018) vs estimated Implementation trend line	1.20 (1.08, 1.33)	<0.001	0.91 (0.85, 0.98)	0.011	1.03 (0.98, 1.09)	0.180

N.B.: CI= Confidence Interval.
The slope Rate Ratio shows the change in the proportion of patients overdue to be seen during the specified phase. A Rate Ratio of less than one indicates a reduced rate in the exposed study phase. For example, a Rate Ratio of 0.95 indicates that the odds of being overdue to be seen decreased by an estimated 5 % per month.
The slope difference refers to the difference between the slope of the line between the two phases. It represents the sustained effect of the intervention.
The level step change refers to the change in level between the observed level at the start of the specified phase and the point predicted by the comparator phase trend line. This provides the effect size difference in estimated means. It represents the immediate effect of the intervention.
[a] Primary pairwise comparison.

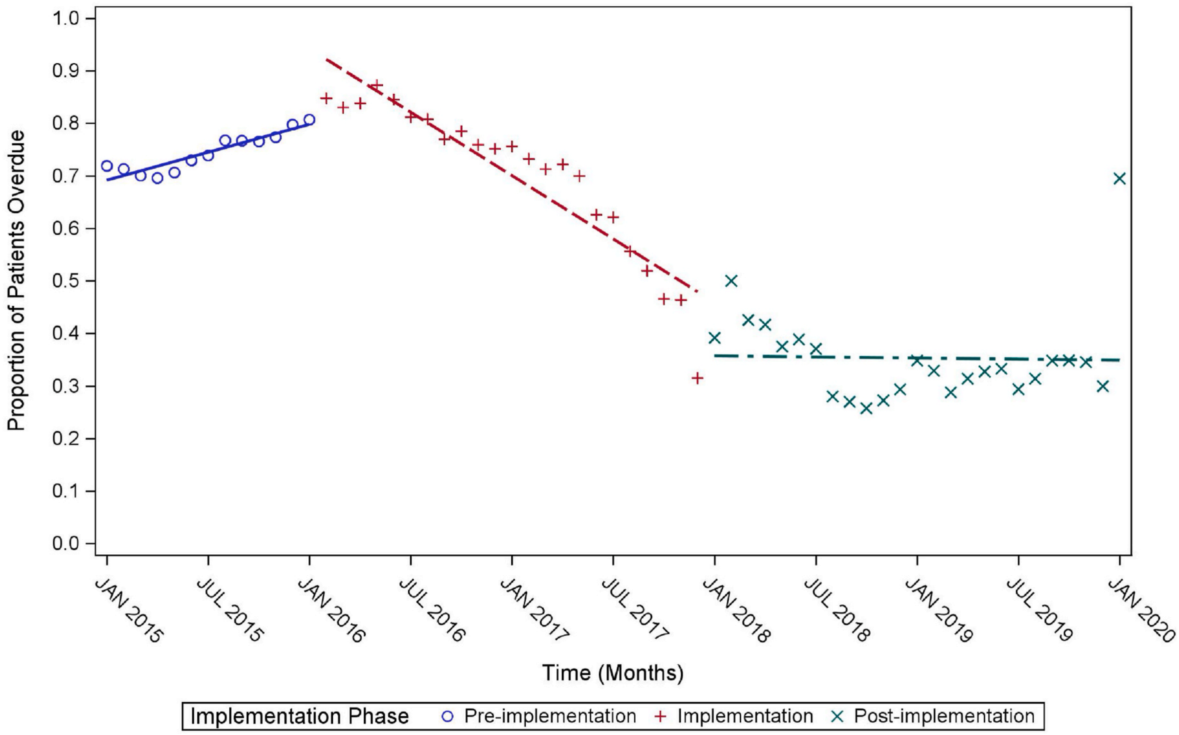

Fig. 1. Visual representation of phase comparisons for the proportion of patients overdue to be seen (Primary Model).
Notes- Phase 1 = Jan 2015–Jan 2016, Phase 2 = Feb 2016–Dec 2017, Phase 3 = Jan 2018–Jan 2020.
Phase-specific slopes were estimated using logistic segmented regression analysis.

studies. With enough data points, Wagner et al.[25] proposed that one could model the 'lag' or 'during intervention' period as a separate segment. The use of a three-phase series allows us to capture and present any 'lag' that may have occurred during the implementation phase of our study.

A limitation of our study is that while the waitlist optimisation strategies were developed by a range of stakeholders, there was limited consumer advice integrated into the design of the strategies. We, therefore, do not know if consumers agree that the tested waitlist optimisation strategies are the optimal way to address extended wait times for specialist consultation. The strategies did, however, receive cultural advice during development. Clinic processes were reviewed by an Aboriginal Project Officer, and their recommendations adopted (e.g., Aboriginal patients were notified that due to capacity constraints, an Aboriginal Liaison Officer might not be available and that they could bring a family member along to the appointment). The back pain specific conservative management trial was reviewed as part of cultural governance audits, and the resources were assessed for cultural safety/appropriateness, with changes made on recommendations. Another limitation is our inability to rule out other unknown explanations or confounding as a potential source of bias that may be responsible for some or all of the observed effects. This should be considered when analysing our findings. There were not, however, any changes in the way waitlist data was collected, reductions in the catchment population for the studied service, or any other public surgical services for back or neck pain that became available and thus increased the local capacity, across the study period that may have contributed to the improvements in waiting list outcomes. A final limitation that should be considered is our inability to present data relating to the wait time until a neurosurgery appointment. This limitation is due to the real-world constraints of the health service in which the study took place. Issuing appointments further into the future may be one way to reduce the size of the waitlist and lead to an overestimation of the success of our waitlist optimisation strategies. While unable to present wait time data, we can confirm that there were no changes to the appointment scheduling process during any of the three study phases.

The waitlist optimisation strategies tested in our study had a positive effect on all aspects of the neurosurgical outpatient waitlist. As populations grow and age,[26] outpatient services may see ongoing referral growth and will need to explore ways to ensure people are seen in a timely manner that reflects their clinical condition. The set of waitlist optimisation strategies tested in our study can provide an evidence base for effective strategy design by other services aiming to address this ongoing need.

The results of our study may be applicable to other specialist waitlists or other facilities struggling with outpatient waiting times. Our strategies target broad determinants of waitlist problems that are relevant across multiple specialties. The local context of health services should be considered when implementing the tested waitlist optimisation strategies to ensure they are fit for purpose at that particular health service. Our strategies targeted increasing capacity to reduce wait time, as well as administrative improvements and alternative care pathways based on clinical need to improve waitlist accuracy and reduce the waitlist size. While we cannot evaluate the differences between the two targets (wait time vs waitlist size), they should be considered when assessing local context. Not every strategy tested in our study may be appropriate or needed within other services. However, we cannot be sure if removing or modifying the strategies will not change their overall effect.

Although our study was not designed to assess the effectiveness of individual strategies, future research should explore which components of the tested package produce the greatest benefit. This information would inform the optimisation of the strategies and ensure resources are not wasted on ineffective components. Future studies could undertake adaptive clinical trials to test the success of individual waitlist optimisation strategies before they are added to a broader package of strategies. It is also important to understand the best way to implement and sustain effective strategies. Future studies should examine if the implemented strategies can be adopted and sustained by health services. This may require longer post-implementation phases and the use of relevant outcome measures to adequately assess sustainability.

4.1. Conclusion

The waitlist optimisation strategies tested in this study reduced the proportion of patients overdue to be seen on the neurosurgical waitlist, as well as the proportion of patients waiting longer than one year for an initial appointment and the total neurosurgical waitlist number. Further research is warranted to ensure the ongoing implementation and sustainability of the tested service re-design strategies.

Author statements

Ethical approval

This study was approved by the Hunter New England Research Ethics Committee (Approval Number 2019/ETH01034).

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Competing interests

SD, RH and CW were involved in both the strategy development and implementation, as well as the evaluation of the strategies. However, an independent statistician completed the analysis of all evaluation data.

Availability of data

Access to the data used for analysis will be considered on request. The data used in the present study is under the custody of New South Wales Health and also requires their approval to be accessed. Proposals for data use may be submitted to the principal/corresponding author.

Authors contributions

RH, BI, RG, DS, BD, CB, JH and CW contributed to the design and implementation of the waitlist optimisation strategies. SD, RH and CW designed and developed the study. SD coordinated data extraction and analysis. SD and RH have accessed and verified the data. SD prepared the initial draft of the manuscript. All authors provided critical appraisal and approved the final version. All listed authors meet authorship criteria, and no others that meet the criteria have been omitted.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2025.03.011.

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