

ORIGINAL ARTICLE

Optimisation of hospital resource use: A rapid review of the literature

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ABSTRACT

Project System Wide Integration for Transformation (SWIFT) is a programme of work supported by developments in technology that aims to improve the health of people in Counties Manukau through initiatives focused on community-based care and improving hospital systems. A “rapid review” of literature focussing optimisation of resource use in hospitals was carried out to support this programme. In total, 36 articles were considered in detail for inclusion in this rapid review, with many other articles considered briefly from title or abstract alone. Of the 36 articles, 24 (66.7%) were ultimately deemed relevant, and included. The review found reasonable evidence that patient length of stay can be reduced by using: (1) collaborative physician/nurse multidisciplinary care management of medical patients with expedited discharge, and assessment following discharge; (2) perioperative anaesthetic and pain management strategies for primary total hip (THA) and total knee arthroplasty (TKA); (3) the use of specialist nurses across a variety of roles, and team midwives who provide care for pregnant women from the beginning of care to the end of the post-natal period. It also found that there is potential for a reduction in adverse cardiac outcomes in hospitals through: (1) prescribing guideline discharge therapies in acute cardiac care, and (2) remote management of heart failure patients implanted with cardioverter defibrillators. The review also suggested that appointment cancellations or instances of non-attendance can be reduced by: (1) the establishment of pre-operative assessment and consultation clinics; (2) distributed access to scheduling systems; (3) preferentially loading appointments onto high-attendance days; and (4) the use of text messaging or automated phone calls to remind patients about appointments.

Key Words: Resources, Efficiency, Improvement, Hospital, Optimisation

1. INTRODUCTION

Project System Wide Integration for Transformation (SWIFT) is a programme of work supported by developments in technology, that aims to improve the health of people in Counties Manukau through initiatives focused on community-based care and improving hospital systems.^[1] It is being carried out by the Counties Manukau District Health Board (DHB) in New Zealand over a four-year period. Counties Manukau DHB has a population that is younger than the national average. It has a slightly higher proportion of Māori (16.3% vs. 15.4%), a much higher proportion of

Pacific people (23.2% vs. 6.7%), and more people in the most deprived section of the population (Ministry of Health, 2015). A literature review was carried out to contribute to an aim of Project SWIFT that was to optimise the use of resources in hospitals. These objectives required a review of New Zealand and international research literature to be carried out.

2. METHODS

A rapid review methodology was used for this literature review. This is a streamlined literature review process that

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may be shortened by, for example, limiting the number of databases searched, the types of study design included, the languages that articles are written in, the dates when articles were written, and the level of inclusion of “grey” literature. Also, the number of reviewers involved in decisions about inclusion and exclusion of articles, data extraction and quality assessment may be fewer than normal.^[2] Because of this streamlined procedure, the limitations of rapid review can include selection bias, publication bias and language of publication bias. However, the methodology was viewed as appropriate for this review due to the limited time and resources available, and it provided a good balance between costs and benefits.

The methodology consisted of identifying and selecting publications that were relevant to the area of focus, critically appraising publications, analysing the data reported, and describing results. First, inclusion and exclusion criteria were defined to guide which studies to include in the literature review. Articles included were those that reported research relating to reduction in length of stay; reduction in hospital staff downtime; reduction in appointment cancellations; and efficient use of the hospital building.

Any research with a publication date from 2005 to 2015 that was written in English, and with any study design, was included. Excluded studies included those relating to: services based in the community; improvements gained from staff learning new clinical or technical skills; non-peer-reviewed studies that were carried out outside of New Zealand; non-research articles; and articles reporting process or simulation models, or methods of analysis development, where the model or methods developed were not then applied to a real-life setting.

Several search engines (Medline Complete, Ebsco Health Business Elite, Cochrane, Health Foundation Research Scan, Health Improvement and Innovation Resource Centre portal, Google Scholar, Pub Med, Science Direct, Web of Knowledge) were used to search for articles using combinations of the following terms: “scheduling”, “hospital”, “reduction”, “length of stay”, “bed days”, “appointment”, “staff”, “cancellation”, “building”, “scheduling”, “resources”, “equipment”, and “efficiency”.

Titles or abstracts of papers found were checked and non-relevant literature was removed, with five percent of non-relevant articles being audited by a second reviewer to check for agreement. As articles were read, further references were also sought from any relevant papers found using a snowballing technique.

The papers included were then critically reviewed by provid-

ing a written summary of methods, findings and conclusions from each of the articles, and summarising the limitations of the research in terms of their applicability to the hospital context. The quality of evidence in each article was scored on a number of variables relevant to the project: study design, participant characteristics, health system in which the research was carried out, and population. Variables were scored from zero to three. Study design and health system were then rated by a factor of two, as these were considered the most important variables for the review. The scoring system resulted in a total score out of 18 for each article, where 0-6 was defined as weak evidence, 7-15 as moderate evidence, and 16-18 as strong evidence.

For study design, three points were awarded to systematic reviews that included at least one randomised controlled trial (RCT), or research or evaluation studies with experimental designs that included randomisation; two points were awarded to systematic reviews that did not include RCTs, prospective cohort studies, or evaluations with an experimental design but without randomisation; one point was awarded to retrospective cohort studies, case-control studies or evaluations with before/after designs, or that described baseline data; and no points were awarded to cross sectional surveys, evaluations without comparison groups and qualitative research.

The participant characteristics category was rated according to the type of participants reported in the article. Articles that featured participants who were hospital staff from a range of clinical disciplines and that featured patient perspectives were awarded three points, while two points were awarded to articles which featured participants that were staff from a range of clinical disciplines only. One point was awarded to articles which featured staff participants from a single clinical discipline, and studies which did not define their participants were awarded zero points.

If the article featured patients only as participants, then more points were awarded to studies featuring patients that had most relevance to the types of patient at Counties Manukau DHB. So, three points were awarded if an article contained participants that were multicultural or multiethnic, and from medium to low socioeconomic urban areas. Two points were awarded if participants were from low socioeconomic urban areas only. One point was awarded if participants were from medium-high socioeconomic areas, or if ethnic or cultural diversity was not specified. Finally, zero points were awarded if there was no description of participants, if they were from a high income population, if they received care from private facilities, or if they received care from a facility in the developing world.

For the health system category, studies which reported research that was carried out in settings most similar to those found in New Zealand were awarded higher scores. Therefore, three points were awarded to studies carried out in public hospitals, two points were awarded to studies that were carried out in hospitals that were publicly funded but privately run, and zero points were awarded to studies carried out in private hospitals, or where there was no description of the setting (there was no one point score available for this category).

For the population category, three points were awarded to studies that demonstrated an impact across an entire hospital, two points were awarded to studies that demonstrated an impact across a number of healthcare domains within a hospital, one point was awarded to studies that demonstrated an impact in a single healthcare domain within a hospital, and no points were awarded to studies that poorly defined the type of healthcare domain in which the research had occurred.

Scores were interpreted cautiously, and were mainly used as a way of presenting the strength of the evidence in an easy-to-read format. A further audit of the scores from 10% of the included articles was carried out by a second reviewer, to check for agreement.

3. RESULTS

In total, 36 articles were read in full to assess their relevance for inclusion in this review, with many other studies being considered briefly from title or abstract alone. Of these 36 articles, 24 (66.7%) were judged relevant and included. Of the 24 studies, six were systematic literature reviews, three were RCTs or quasi-experimental but involving randomisation, nine had pre-post designs or compared with baseline data, one was a prospective cohort study, two were retrospective observational studies, one was a “narrative” literature review (where results were not quantified nor study design considered), and two were descriptive studies without comparison groups.

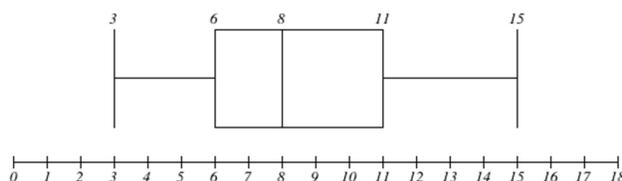


Figure 1. Flow chart of search results of studies from searching and screening

Studies were carried out in a diverse range of international hospitals in Australia, the Netherlands, UK, USA, Canada,

Ireland, Scotland, Norway, Trinidad, Denmark and Iran. The average score out of 18 for these articles was eight, and the range of scores is illustrated in the box plot in Figure 1.

A summary of the articles is included in Table 1 below.

A number of articles suggested strategies for reducing patient length of stay:^[3-5]

3.1 Collaborative physician/nurse practitioner multidisciplinary care management

Cowan *et al.*^[3] suggested that there is potential for using collaborative physician/nurse practitioner multidisciplinary care management of patients alongside team-based planning, with assessment after expedited discharge. Their study compared two groups of general medicine patients with 581 patients in the experimental group and 626 patients in the control group. The experimental group received care through a daily multidisciplinary round, as well as from an advanced practice nurse during hospitalisation and for a month after discharge, and from a hospitalist medical director and another hospitalist, while the control group received usual care. Both the means and medians indicated that the experimental group stayed a day less in the hospital than the control group (3 vs. 4 days, $p < .0001$), and there were no significant group differences in mortality or readmissions.

3.2 Perioperative anaesthetic and pain management strategies for primary total hip (THA) and total knee arthroplasty (TKA)

Literature also suggested that patient length of stay could be reduced by perioperative anaesthetic and pain management strategies for THA and TKA. Peters *et al.*^[4] compared two cohorts of 50 consecutive THA and 50 TKA patients before and after initiation of new strategies that used regional rather than general anaesthesia, avoided intravenous narcotics, provided scheduled oral medications, and carried out physical therapy beginning on the day of surgery. The authors found that for TKA patients, length of stay reduced from an average of 3.1 to 2.5 days ($p = .002$) while THA patients’ length of stay reduced from an average of 3.7 days to 2.5 days ($p = .000005$) after initiation of the strategies. However, which of the strategies were the most important contributors to the results was not identified.

3.3 Use of specialist nurses and team midwives

The review also found that patient length of stay could be reduced by the use of specialist nurses and team midwives who provide care for pregnant women from the beginning of care to the end of the post-natal period. In a systematic review, Butler *et al.*^[5] suggested that that the addition of spe-

cialist nurses to nursing staff across a variety of roles resulted in shorter patient hospital stays (RR: -1.35, 95% CI -1.92 to 0.78; Z = 4.61, $p < .00001$). The authors also described an impact of introducing team midwifery (where the same midwife provides care from the beginning of a woman's care

to the end of the post-natal period) resulting in shorter length of stay in hospital (RR -0.30, 95% CI -0.54, -0.06; Z = 2.41, $p = .02$) and in special care nursery (SCN) (RR -2.00, 95% CI -2.07, -1.93; Z = 5.946, $p < .00001$).

Table 1. Summary of the main findings from each paper included in literature review

Article	Strategy used	Main result	Score out of 18 awarded
Cowan <i>et al.</i> [3]	Collaborative physician/nurse practitioner multidisciplinary care management of general medicine patients alongside team-based planning, with assessment after expedited discharge		8
Peters <i>et al.</i> [4]	Perioperative anaesthetic and pain management strategies for primary total hip (THA) and total knee arthroplasty (TKA)	Reduced patient length of stay	3
Butler <i>et al.</i> [5]	Use of specialist nurses and "team" midwives who provide care for pregnant women from the beginning of care to the end of the post-natal period		15
Astley <i>et al.</i> [6]	Clinicians reminded to prescribe guideline discharge therapies in acute cardiac care, and adequate levels of cardiac care staff to patient ratios	Reduction in adverse outcomes	10
Landolina <i>et al.</i> [7]	Remote management of heart failure patients with implanted cardioverter defibrillators (ICDs)		10
Knox <i>et al.</i> [8]			11
Farasatkish <i>et al.</i> [9]	Establishment of pre-operative assessment and consultation clinics	Reduction in cancellations of operations	3
Holvid <i>et al.</i> [10]	Redesign of a pathway for elective surgery, including improved communication and management systems, a new day-surgery centre, earlier assessment of patients, and increased involvement of patients in the scheduling of surgeries		13
Dexter <i>et al.</i> [16]	Distributed access to timetabling systems	Increase in anaesthetics performed in allocated time	7
Hasvold & Wootton [11]			13
Taylor <i>et al.</i> [12]	Use of text messaging or automated phone call reminders to patients	Reduction in appointment cancellations	14
Downer <i>et al.</i> [13]			21
LaGanga [14]	Preferentially loading appointments onto more popular day-time slots	Increased patient attendance	6
Ellis & Jenkins [15]			6
Ryckman <i>et al.</i> [17]			7
Breen <i>et al.</i> [18]			7
Hersh <i>et al.</i> [19]	Studies with one of the following issues:		8
Dubois & Singh [20]	(1) did not report quantifiable results or the statistical significance of their findings		4
Moffatt & Eley [21]			6
Nancarrow <i>et al.</i> [22]	(2) design limitations such as lack of randomisation or biased samples		6
Koshy <i>et al.</i> [23]			9
Hariharan <i>et al.</i> [24]	(3) a lack of detail about methodologies used to obtain findings		6
Thiel <i>et al.</i> [25]			8
Leggat <i>et al.</i> [26]			11

3.4 Clinicians reminded to prescribe guideline discharge therapies in acute cardiac care, and adequate levels of cardiac care staff to patient ratios

Other articles suggested how the incidence of adverse outcomes in hospitals could be reduced, which one would expect to lead to more optimal use of resources.^[6,7] In an "Acute Coronary Syndrome Prospective Audit", Astley *et al.*^[6] found rates of adverse cardiac outcomes among Aus-

tralian hospitals were lower in hospitals where clinicians were reminded to prescribe guideline discharge therapies in acute cardiac care, and where there were adequate levels of cardiac care staff to patient ratios ($p < .05$).

3.5 Remote management of heart failure patients with implanted cardioverter defibrillators (ICDs)

Landolina *et al.*^[7] also suggested that reductions in adverse outcomes among cardiac patients could be achieved by re-

remote management of heart failure patients with ICDs. In a prospective multicentre randomized trial with 200 patients, Landolina *et al.* found that remote monitoring reduced the number of healthcare visits for patients, as compared with standard management (4.40 vs. 5.74 events per year; $p = .001$). In addition, the time from an ICD alert to review of the data was reduced from 24.8 days to 1.4 days ($p = .001$).

3.6 Establishment of pre-operative assessment and consultation clinics

The literature review also found that there is potential for reduction in cancellations of surgery or operations through the establishment of pre-operative assessment and consultation clinics, which allow time for further testing and medical evaluation of patients and increased involvement of patients in the scheduling of surgeries. Knox *et al.*^[8] carried out a retrospective review of all surgical cases over a one year period prior to and one year after the establishment of a pre-operative assessment clinic, and found that pre-assessment resulted in a significant reduction in case cancellations (114 vs. 256, $p < .001$). Similarly, Farasatkish *et al.*^[9] prospectively studied the cancellation rates for 866 patients scheduled for an operation before establishment of a pre-anaesthesia consultation clinic in a teaching hospital, and 850 cases that were scheduled for after. The cancellation rate in the first group was 146/866 (16.8%) but in the second group was only 113/850 (13.29%) ($p = .046$).

3.7 Redesign of pathway for elective surgery

Holvid *et al.*^[10] carried out a pre-post study over five years that looked at the redesign of a pathway for elective surgery in a Norwegian hospital, involving all surgical departments. As well as improved communication and management systems, and a new day-surgery centre, the changes included earlier assessment of patients, and increased involvement of patients in the scheduling of surgeries. The mean cancellation rate was reduced from 8.5% to 4.9% (95% CI for mean reduction 2.6-4.5, $p < .001$).

3.8 Reminders to patients and loading appointments onto popular day-time slots

Other articles suggested that the use of text messaging or automated phone call reminders to patients can significantly reduce appointment cancellations,^[11-13] while still others suggested that preferentially loading appointments onto more popular day-time slots can better increase the likelihood of patient attendance.^[14,15] Another finding from the literature review was that distributed access to timetabling systems can increase efficiency. For example, Dexter *et al.*^[16] carried out an observational study of an intervention where an anaesthesia department gave staff in other departments permission

to schedule non-operating room anaesthesia teams through distributed access to their time management system. A key finding was that anaesthetics performed in allocated time increased progressively from 0% to 75% ($p < .00001$).

3.9 Studies of limited value

The findings from other articles considered by this review were of limited value to our context, because they had one or more of the following issues: (1) they did not report quantifiable results or the statistical significance of their findings; (2) they had design limitations such as lack of randomisation or biased samples; or (3) they had a lack of detail about methodologies used to obtain findings.^[17-26]

4. DISCUSSION

The priority of this review was to find articles that reported either a high quality of evidence or summarised a large quantity of evidence. However, it is acknowledged that not all articles of relevance may have been identified due to the rapid review methodology employed. Nevertheless, this literature review found that there is potential for reducing patient length of stay by using: (1) collaborative physician/nurse practitioner multidisciplinary care management of patients alongside team-based planning, with assessment after expedited discharge; (2) perioperative anaesthetic and pain management strategies for THA and TKA; (3) specialist staff such as specialist nurses and team midwives who provide care for pregnant women from the beginning of care to the end of the post-natal period. It also found that there is potential for a reduction in adverse outcomes in hospitals through: (1) prescribing guideline discharge therapies in acute cardiac care; and (2) remote management of heart failure patients implanted with cardioverter defibrillators.

Furthermore the review suggested that numbers of appointment cancellations can be reduced by: (1) the establishment of pre-operative assessment and consultation clinics, to allow time for further testing and medical evaluation of patients, alongside (2) increased involvement of patients in the scheduling of surgeries. Finally, the review suggested that distributed access to scheduling systems, and preferentially loading appointments onto high-attendance days can increase the efficiency of hospital scheduling, while the use of text messaging or automated phone calls to remind patients about appointments can also make them more likely to attend.

While other measures that contribute to optimal use of hospital resources may also exist, this review suggested that the evidence for those interventions reported was strongest, as they had direct effects on either patient length of stay, reductions in adverse outcomes, or reductions in appointment cancellations.

5. CONCLUSION

The findings from this literature review will be considered in context alongside many other initiatives that contribute to Project SWIFT, such as quality improvement investigations, evaluations of systems and services, engagement with

patients, and improvements to IT systems. This literature review will contribute to the project's "detailed design" phase, which involves developing the overall SWIFT program of work: the phase ends with the presentation of a number of business cases for change to the Counties Manukau DHB.

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