

# BMJ Open Quality Improving medical consults for surgical inpatients: a quality improvement project using an e-referral system linked to clinical pathways

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## ABSTRACT

Surgical inpatients referred to medicine with acute medical problems represent a complex patient population, vulnerable to fragmented care and suboptimal outcomes. They can also be a source of staff dissatisfaction in busy or understaffed departments. Comanagement by surgical and medical staff may improve outcomes but requires dedicated resources and the evidence for other interventions is scarce. We aimed to assess staff experience, demographics and clinical outcomes of this patient population at our hospital and develop an intervention aiming to improve medical staff experience, without compromising clinical outcomes.

Staff were surveyed before and after the intervention to measure staff experience. Demographics and clinical outcomes were collected for 60 referrals at baseline and 29 referrals postintervention (an e-referral system linked to locally developed clinical pathways). Clinical outcomes were delay time (time from referral submission to review), length of stay, 30-day mortality and 30-day readmissions. Medical staff experience improved from majority negative or neutral ratings to majority positive ratings postintervention and 100% of staff surveyed supported ongoing use of the intervention. There were no negative impacts on clinical outcomes, which acted as balancing measures.

Medical staff experience improved, without compromising clinical outcomes. The e-referral system doubles as a platform for ongoing quality improvement.

## PROBLEM

Medical consultations for surgical inpatients ('surgical consults') at Southland Hospital, Invercargill, New Zealand were traditionally requested by phone. Surgical house officers called the medical registrar assigned to surgical consults during the day. After-hours, the sole on-call medical registrar saw acute referrals in the emergency department (ED) in addition to receiving calls/referrals from general practitioners and inpatient teams. Surgical consults were often regarded as low priority due to acute workload and were frequently handed over. Documentation of phone conversations was seldom made. Concerns were raised regarding

## WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Inpatient e-referrals have been associated with improvement in staff experience, staff-reported patient safety and delays in the referral process.

## WHAT THIS STUDY ADDS

⇒ Important clinical outcomes such as length of stay, mortality and readmissions do not appear to be compromised with e-referrals. Improvement in staff experience is noted in a different clinical and demographic setting.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Inpatient e-referrals are a simple method of improving staff experience with the added benefit of creating educational and quality improvement opportunities.

missed referrals due to lack of handover. The absence of a formal record made auditing challenging.

Anecdotally, referrals were often not seen by senior surgical staff prior to referral and information such as comorbidities, illness severity and resuscitation status was lacking. Workup by junior surgical staff was often felt to be suboptimal. Clinical guidelines on the hospital intranet were difficult to access. Due to the steady flow of medical admissions with 'skeleton-staffing' after-hours, surgical consults were often an added burden to clinical duties and a common source of medical staff dissatisfaction. Prior to this study, we had no knowledge of the demographics or clinical outcomes of this patient population.

Southland Hospital, Invercargill, New Zealand is a 157-bed secondary care public hospital with 38 medical beds, 42 surgical beds and 6 critical care beds, serving a population base of 108 000, with approximately 5000 theatre operations performed annually.<sup>1 2</sup> The medical department is staffed by six consultant physicians (senior medical

officers—SMOs), some of whom are dual-trained as medical subspecialists. Junior staffing levels fluctuate—during 2019, there were a maximum of five surgical house officers (two house officers job-shared one position) and seven medical registrars at any one point in time. House officers rotated between surgical and medical runs during the year. The medical department provides acute care for inpatients including critical care, consulting for other disciplines (surgery, obstetrics and gynaecology, psychiatry) and outpatients (both general medical and medical subspecialties). There are no on-site services for medical subspecialties. The closest tertiary hospital is Dunedin Hospital, 2.5 hours by road. Southland Hospital and Dunedin Hospital are both managed by Southern District Health Board (SDHB), Ministry of Health, New Zealand Government.

## BACKGROUND

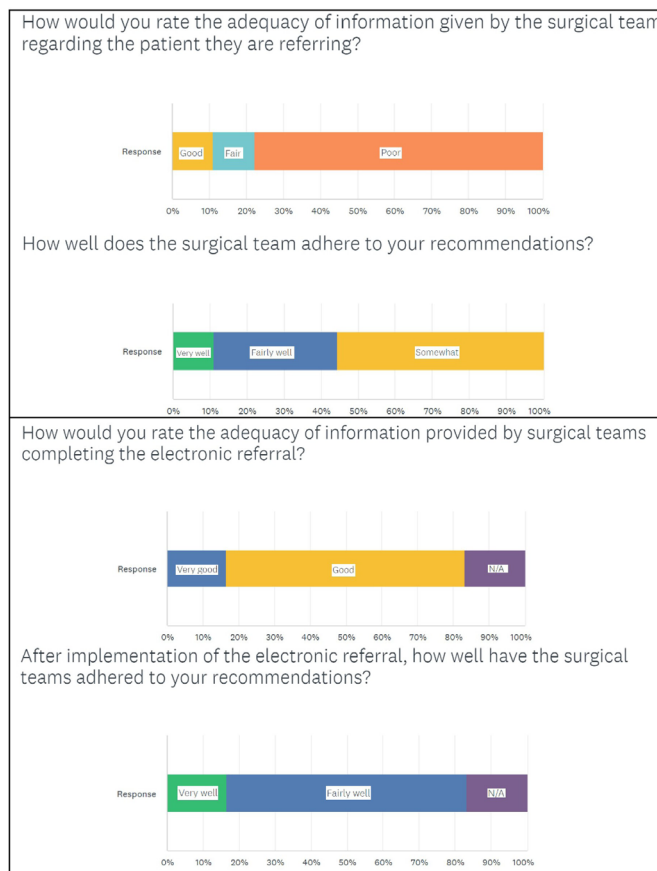
Caring for medically unwell surgical inpatients can be challenging for physicians and surgeons alike. Proactive interventions such as preoperative clinics and physician comanagement have been associated with improved outcomes. However, this requires dedicated resources<sup>3–5</sup> which is difficult in stretched health systems.

Electronic referrals have shown benefit over paper-based systems in the outpatient setting, where written advice and appointments can be rapidly actioned, resulting in improved communication,<sup>6</sup> clinic attendance and reduced healthcare costs.<sup>7–9</sup> Inpatient e-referrals are growing in use but the evidence base is limited to a handful of studies, mostly designed to assist resource allocation for busy departments.<sup>10–12</sup> A recent quality improvement study comparing inpatient e-referrals with paper-based referrals showed improved staff-reported patient safety, user experience and statistically significant reductions in referral time (time from decision to refer to referral submission) and review time (time from referral submission to review).<sup>13</sup>

## MEASUREMENT

We aimed to assess staff experience as the primary aim for improvement, given the anecdotally low satisfaction with the existing system within the medical department. We aimed to improve medical staff ratings of the referral system from a hypothesised majority negative rating, which was confirmed by the baseline survey results [figure 1](#). We recorded demographics to ensure the two patient samples (baseline and postintervention) were comparable. We also assessed clinical outcomes which acted as balancing measures for the primary aim of the study.

Staff were surveyed prior to data collection in February 2019 and after completion of the postintervention phase in October 2019, using an online survey platform.<sup>14</sup> Survey questions are located in online supplemental material S2. A five-point multichoice scale was provided (eg, excellent, very good, good, fair, poor) for answers



**Figure 1** Staff experience at baseline (top panel) and postintervention (bottom panel).

needing a rating. Responders were also able to provide feedback in free text.

Four (out of five) surgical house officers responded to the baseline survey.

- ▶ Fifty per cent referred 0–2 referrals/week and fifty per cent referred 3–5/week.
- ▶ Referred conditions showed considerable variability.
- ▶ One hundred per cent of surgical house officers rated medical reviews as ‘excellent’.
- ▶ Seventy-five per cent supported an e-referral trial.
- ▶ One hundred per cent supported a comanagement trial.

Nine medical registrars and SMOs (out of seven medical registrars and six SMOs) responded to the baseline survey.

- ▶ Fifty-six per cent received 0–2 referrals/week and forty-five per cent received 3–5/week.
- ▶ Referred conditions showed considerable variability.
- ▶ Seventy-eight per cent rated referral adequacy as ‘poor’, eleven per cent ‘fair’ and eleven per cent ‘good’.
- ▶ Fifty-six per cent rated surgical team adherence as ‘somewhat’, thirty-three per cent ‘fairly well’ and eleven per cent ‘very well’.
- ▶ One hundred per cent supported an e-referral trial.
- ▶ Fifty-six per cent supported a comanagement trial.

At baseline, all surgical consults seen in the previous 24 hours were discussed at the daily medical handover.

**Table 1** Demographics at baseline

|                               | Baseline (n=60)  |
|-------------------------------|--|
| Age – mean (SE)               | 67.8 years (2.6)   |
| Sex                           | 55% (33) male, 45% (27) female   |
| Admission type                | 92% (55) acute 8% (5) elective   |
| Referring team                | 46.7% (28) general surgery<br>46.7% (28) orthopaedics<br>6.6% (4) urology                          |
| Unnecessary referrals         | 12% (7)  |
| Review by surgical consultant | 40% (20) not yet seen<br>42% (21) seen same day<br>18% (9) seen $\geq 1$ day ago (range 1–20 days) |
| Resuscitation status          | 50% (25) not documented<br>12% (6) documented<br>38% (19) deemed ‘not applicable’                  |
| Referral rate                 | 0.5 /day (60/116)  |

National Health Index numbers (New Zealand’s unique patient identifier) were taken during handover and recorded in an excel document. Paper notes were retrieved from clinical records to record demographic data into the excel document: age, sex, admission type, referring surgical team, medical sub-type (ie, main organ system involved), date of most recent review by surgical consultant prior to referral and resuscitation status (table 1). The latter two variables were included in demographic data collection as referrals anecdotally lacked consistency in these. Resuscitation status refers to documentation of cardiopulmonary resuscitation (CPR) provision (yes/no) in case of cardiac/respiratory arrest.

Referrals by medical subtype: cardiology 18% (11), respiratory 12% (7), renal 15% (9), neurology 12% (7), gastroenterology 7% (4), rheumatology 3% (2), endocrine 2% (1) and other 19% (11). The remainder of referrals had no acute medical problem and were termed ‘unnecessary referrals’.

Clinical outcomes were defined a priori to act as balancing measures for the primary aim of the study (improvement of medical staff experience). The four clinical outcomes (delay time, length of stay (LOS), 30-day mortality and 30-day readmissions) were relevant to everyday practice and could influence ongoing use of the intervention (online supplemental table 2). We chose medians for delay time and LOS (rather than means) as medians were less likely to be affected by outliers in our small data set. Patients and the public were not involved in any way in this study.

## DESIGN

Our intervention was developed to address medical staff dissatisfaction with the existing referral system, as reflected in the baseline survey. The baseline survey showed that most surgical and medical staff respondents backed an e-referral system as the intervention. Comanagement was

deemed too resource intensive and received less support from medical staff. Given the low ratings for referral quality and adherence to recommendations, the intervention had to assist surgical house officers in adequate work up of referrals and use of clinical guidelines. We surveyed the referrers (surgical house officers) to ensure their experience was not compromised by the intervention.

We reviewed published interventions for inpatient referrals and collected baseline demographics. Demographic data showed that a significant proportion of referrals had not yet seen a surgical consultant and/or had no documentation of resuscitation status at the time of referral. Therefore, prompts were incorporated into the e-referral to improve these findings, as a secondary aim. Clinical outcomes at baseline showed a median LOS of 7 days, longer than the national average of 2.49 days for all admissions and 6.7 days when day cases were excluded.<sup>15 16</sup> The e-referral form required documentation of key clinical details and enabled rapid access to clinical resources with guidance regarding care escalation.

The e-referral form (online supplemental material S3) was developed with assistance from SDHB Information Systems using existing intranet software. We gathered suggestions for the e-referral from medical staff at teaching sessions and informal discussions. Several draft e-referral templates were reviewed prior to roll-out in August 2019 (online supplemental figure 2—study timeline). The project team consisted of a medical advanced trainee and two SMOs, one of whom was the project supervisor. The data collection team consisted of eight medical registrars and house officers (see acknowledgements).

The information below was mandatory on the e-referral to ensure patients were stable, adequately assessed and the clinical question clearly specified in referrals. We felt this would help improve medical staff experience. The e-referral contained a hyperlink to clinical flowcharts that we developed and referred to as ‘pathways’ (online supplemental material S3) with the aim of rapidly assisting the referrer in managing the acute medical problem. There was clear guidance on the pathways regarding escalation of care for patients with early symptoms/signs of critical illness. The e-referral form contained a second hyperlink to 35 existing management guidelines for common inpatient problems (eg, hyponatraemia, pulmonary embolism, GI bleeding) to enable easy access.

Mandatory information on the e-referral form:

- ▶ NHI (name, age, ward/bed number and team were autofilled).
- ▶ Name of medical registrar informed of referral.
- ▶ Clinical information (free-text box).
- ▶ Request/question (one line).
- ▶ Vital signs and Early Warning Score (EWS).
- ▶ Tick-box to confirm reviewed by senior if EWS >7.
- ▶ Primary surgical problem (upper gastrointestinal tract, colorectal, hepatobiliary, breast, urological, fracture, joint infection or other).
- ▶ Admission date and type (acute or elective).

- ▶ Seen by surgical consultant (yes/no) and date last seen if yes.
- ▶ Resuscitation status (full cardiopulmonary resuscitation - CPR/no CPR/undecided).
- ▶ Requesting consultant.

Surgical house officers had to inform the on-call medical registrar that an e-referral was about to be submitted and document this as above—but there was no need to discuss the entire referral over the phone. The requirement to inform the medical registrar was a safety precaution to ensure referrals were not missed. Referrals were electronically accepted or declined by the medical registrar. If declined, a reason had to be documented. After the referral was accepted/declined, a system-generated email was sent to the referrer to inform them.

Roll-out of the e-referral occurred in mid-August 2019 after announcements at morning handover, teaching sessions, email/group messages and a notice on the hospital intranet homepage. Surgical house officers also received a dedicated information session prior to roll-out. The link to the e-referral was added to an existing drop-down menu of e-referrals for other requests (eg, endoscopies, echocardiograms). All e-referrals were treated as part of the patients' medical record and saved on a searchable page accessible to medical and surgical staff.

A nominated medical registrar assisted with queries after roll-out and liaised with IT if any technical issues arose. Instructions regarding the e-referral process have been incorporated into the Southland Hospital medical orientation handbook to ensure continuity. A 'maintenance checklist' was created to ensure the clinical pathways and guidelines are reviewed on a biennial basis by the medical team.

## STRATEGY

Our quality improvement study consisted of two 'Plan-Do-Study-Act' (PDSA) cycles with continuous improvement within the second cycle. We measured staff experience, demographics and clinical outcomes with the primary aim of improving medical staff experience.

### PDSA cycle 1

We surveyed surgical house officers and medical staff to assess baseline experience, and to gather suggestions for quality improvement. The baseline survey also included questions on common conditions referred, to help assess referral demographics—which was not successful as the variability in responses meant that we needed to objectively gather this data during our second PDSA cycle.

The reportedly poor adequacy of referrals at baseline and suboptimal adherence to recommendations provided by the medical team highlighted the need for a more robust referral system with rapidly accessible clinical resources. There was good support for an electronic referral system from both parties surveyed. We hypothesised that a two-pronged intervention consisting of an

e-referral and clinical resources would improve medical staff experience without compromising clinical outcomes.

At baseline, the top four problems referred were cardiology, respiratory, renal and neurology conditions. Demographic data also showed that a high proportion of cases had not been reviewed by a surgical consultant prior to referral and documentation of resuscitation status was infrequent. We included specific prompts in the e-referral template to address these two findings.

We developed single-page clinical pathways based on common subspecialty problems: fast atrial fibrillation, acute asthma, acute exacerbation of chronic obstructive pulmonary disease (COPD), hyperkalaemia and delirium. We also created a folder on the hospital intranet containing copies of selected hospital guidelines—again mainly cardiology, respiratory, renal and neurology conditions. The e-referral form contained hyperlinks to the clinical pathways and hospital guidelines folder to enable rapid access. A large proportion of 'delay time' data was missing at baseline, so by using an e-referral that saved the time of referral submission and medical review, we hypothesised that this would reduce the amount of missing data.

### PDSA cycle 2

Several draft versions of the e-referral were peer-reviewed by medical staff, instead of risking clinical disruption due to repeated modification of the intervention after roll-out. After roll-out, we encouraged staff to report technical issues or suggestions to enable ongoing quality improvement. For example, the free-text boxes in the e-referral were enlarged after suggestions by multiple surgical house officers, to enable inclusion of adequate clinical information.

We surveyed staff after the intervention phase to reassess staff experience. The post intervention survey also contained questions to gauge uptake of the intervention. We collected demographics and analysed clinical outcomes postintervention to compare with baseline.

## RESULTS

Five (out of five) surgical house officers responded to the postintervention survey:

- ▶ Sixty per cent rated medical reviews as 'excellent' and forty per cent 'very good'.
- ▶ Eighty per cent used the e-referral and twenty per cent did not use the e-referral.
- ▶ Twenty per cent used the pathways/hospital guidelines 'frequently', forty per cent 'sometimes' and forty per cent 'rarely'.
- ▶ Forty per cent rated the pathways as 'extremely useful', forty per cent 'somewhat useful' and twenty per cent 'very useful'.
- ▶ Forty per cent rated the hospital guidelines as 'extremely useful', forty per cent 'somewhat useful' and twenty per cent 'not so useful'.

- ▶ Sixty per cent were unaware of any referrals made after the roll-out without using the e-referral.
- ▶ Twenty per cent were aware of 3–4 referrals and twenty per cent were aware of  $\geq 4$  referrals.
- ▶ Sixty per cent rated the e-referral process as ‘easy’, twenty per cent ‘very easy’ and twenty per cent ‘indifferent’.

Six medical registrars and consultants (out of seven medical registrars and six consultants) responded to the postintervention survey. Responses were used to measure medical staff experience postintervention are shown in figure 1.

- ▶ Sixty-seven per cent rated adequacy of referrals as ‘good’, seventeen per cent ‘very good’ and sixteen per cent ‘not applicable’
- ▶ Sixty-seven per cent rated adherence to recommendations ‘fairly well’, seventeen per cent ‘very good’ and sixteen per cent ‘not applicable’.
- ▶ Sixty-seven per cent ‘usually remembered’ to acknowledge the e-referral at the time of patient review and thirty-three per cent ‘never remembered’.
- ▶ One hundred per cent supported ongoing use of the e-referral.

The proportion of missing data at baseline versus postintervention was 17% vs 17% for ‘review by surgical consultant’; 17% vs 0% for ‘resuscitation status’; 0.02% vs 10% for ‘medical diagnosis’ and 45% vs 31% for ‘delay time’. Data were 100% complete for all other variables.

Referral demographics postintervention are shown in online supplemental table 3. Compared with baseline, the proportion of patients not seen by a surgical consultant prior to referral and lacking documentation of resuscitation status decreased. Referrals termed as ‘unnecessary’ also decreased. During the intervention phase, the average rate of referrals/day did not decrease, suggesting that our intervention did not create a barrier to referrals.

Referrals by medical subtype postintervention: cardiology 31% (8), respiratory 23% (6), renal 11% (3), neurology 8% (2), gastroenterology 4% (1), rheumatology 0% (0), endocrine 4% (1) and other 11% (3). The remainder of referrals had no acute medical problem and were termed ‘unnecessary referrals’ (online supplemental table 3).

A statistically significant decrease in median LOS from 7 days to 6 days was observed postintervention. There was no difference in delay time, 30-day readmissions or mortality (table 2). P values were calculated using the

Kruskal-Wallis test for continuous variables and Fisher’s exact test for categorical variables.

Post hoc power analysis<sup>17</sup> showed that our LOS outcome had 74.6% power and for the remaining outcomes statistical power was <50%. Due to the lack of similar studies, we could not calculate statistical power a priori.

Run charts for delay time are shown in online supplemental figure 3 and LOS in online supplemental figure 4. Data for all referrals are represented in online supplemental figures 3–6. When more than one referral occurred on the same date, data are represented as individual time points. Both delay time and LOS showed significant data variability, however the variability in LOS appears to have decreased during the intervention phase. Run charts for 30-day mortality and readmissions are shown in online supplemental figures 5 and 6.

Due to the time taken for manual data collection during the baseline phase, we collected data for 60 consecutive referrals only, rather than continuous data collection until the intervention phase began. This explains the time-gap between the baseline and intervention phases on the run-charts’ x-axis. We analysed data for 29 consecutive referrals after intervention roll-out (rather than 60 referrals) due to time constraints—the annual staff changeover period was nearing and multiple registrars including the primary author (MA) needed to rotate to a different hospital to meet training requirements. Data collection continued as the e-referral system automatically saves completed referrals.

Our findings are plausible as our intervention should logically lead to improved medical staff experience without compromising clinical outcomes. Statistical power may have been lacking for clinical outcomes but the limitations of post hoc power calculations are well documented.<sup>18</sup> The improvement in staff experience is similar to that observed in the study by Shephard *et al.*<sup>13</sup>

The observed reduction in LOS may seem contradictory to the lack of improvement in delay time—however, we did not measure the time between decision to refer and referral submission. Additionally the reduction in LOS could be due to other factors, such as improved junior staff education/experience resulting in earlier and more effective management.

**Table 2** Clinical outcomes at baseline versus postintervention

|                           | Baseline (n=60)                    | Intervention (n=29)                | P value |
|---------------------------|------------------------------------|------------------------------------|---------|
| Delay time—median (IQR)   | 89 mins (37.5–156)                 | 139 mins (37–235)                  | 0.30    |
| Hospital LOS median (IQR) | 7 days (4.3–16.8)                  | 6 days (2–10)                      | 0.03    |
| 30-day mortality          | 5% (3)                             | 0% (0)                             | 0.55    |
| 30-day readmissions       | 0.23 readmissions/referral (14/60) | 0.38 readmissions/referral (11/29) | 0.21    |
| LOS, length of stay.      |                                    |                                    |         |

## LESSONS AND LIMITATIONS

Strengths of our study include measurement of staff experience before and after the intervention, demographics to ensure the two samples were comparable and clinical outcomes, which acted as balancing measures for our primary outcome (medical staff experience). Staff feedback was also used to guide study design. Demographic data collection identified shortfalls in patient care that were anecdotally observed prior to the study (low rates of senior surgical review prior to referral and low documentation of resuscitation status). These shortfalls were addressed in the intervention in addition to the primary outcome. Our intervention included an educational component in the form of rapidly accessible clinical pathways/guidelines. Clinical outcomes suggested that the improvement in medical staff experience did not come at the cost of worse patient outcomes. Surgical house officer experience also remained positive.

Limitations include our small study sample and reliance on subjective self-reported survey responses by the small number of participants to assess staff experience. Randomisation of referrals into baseline and e-referral arms could have improved the statistical quality of our study but may have led to unintended clinical disruption, low uptake and adverse patient outcomes. Blinding was not possible to implement.

Our aim of improving medical staff experience risked doing so at the expense of surgical house officers' experience, however the survey responses of surgical house officers do not suggest this was the case. Anecdotally, surgical house officers felt more prepared to approach common inpatient medical problems using the e-referral system; however, this should be formally assessed in a future quality improvement project. Relying on self-reported survey data has its limitations but we feel it would have been impractical and time-consuming to assess staff experience by a third party or via face-to-face interviews. The survey responses were anonymous and it was not possible to identify individual staff members' responses.

We did not set an objective improvement target for our primary outcome given it was qualitative (medical staff experience). We avoided measuring medical staff experience based on a single survey question asking for a 'rating' of the referral system but instead we asked specific questions to help identify the reasons for staff dissatisfaction at baseline. This helped to develop our intervention with these reasons in mind and likely explains the significant improvement in medical staff experience postintervention.

Anecdotally, most medical staff respondents were medical registrars and therefore the survey results are likely to be representative of staff involved in the referral process (SMOs saw referrals at least once but were not directly involved in the referral process). In retrospect, we could have made the surveys available to surgical house officers and medical registrars only but this would have prevented the opportunity for SMOs to voice their opinions.

The data collection team consisted of four medical registrars and four house officers who also participated in the clinical care of the patients involved, which introduces the risk of observer bias. To minimise this risk, there was an equal proportion of potential reviewers and potential referrers (house officers rotated between medical and surgical teams throughout the year). There was no pressure from seniors to roll out the intervention or to provide positive feedback.

Some variables for example, 'unnecessary referrals' were prone to classification bias as we didn't have a specific definition for them. Having said so, the term used in the data collection file was self-explanatory: 'no medical problem' and the majority of referrals termed 'unnecessary' were for patients with stable comorbidities referred for 'medical optimisation' despite having no acute medical problem. Using pre-defined criteria and a less pejorative term for these referrals is important for future PDSA cycles.

We relied on observational data so the possibility of residual confounding cannot be excluded. Inclusion of more variables for example, ethnicity, comorbid burden would have helped to minimise the risk of confounding and enabled comparison of the study population with other patient groups. We attempted to minimise confounding by prospective data collection and undertaking our study away from the annual staff changeover periods (November–December 2018 and November–December 2019).

Due to time constraints, we were unable to complete data collection for the entire baseline phase given the need for manual data retrieval. However, we collected baseline data for twice the number of referrals compared with the intervention phase, so our baseline sample is likely to be representative. We did not objectively measure changes in clinical knowledge or behaviour as the primary aim of our study was to assess medical staff experience. There were no incident reports related to the intervention to our knowledge.

Our intervention could be split into two separate 'subinterventions'—the e-referral and the clinical pathways. We did not examine the effect of each subintervention on medical staff experience or clinical outcomes. We feel such an analysis would have had low clinical significance as the pathways/hospital guidelines largely assisted the referrers whereas the e-referral largely assisted the reviewers. Our two-pronged intervention was designed to benefit both parties so if one subintervention was removed, we feel that staff experience and uptake would have been compromised. However, incrementally rolling out the two subinterventions would have allowed an extra PDSA cycle.

One-third of medical staff who completed the postintervention survey never remembered to click 'acknowledge referral' at the time of reviewing the patient—which explains why the proportion of missing data for 'delay time' did not significantly change postintervention, as time of review was only recorded when the e-referral

was acknowledged. Future PDSA cycles should address this, such as using an electronic reminder sent to the accepting doctor for example. Uptake was good but could be improved further, as nearly half the surgical house officers were aware of referrals made without using the e-referral.

The median LOS in our study at baseline and postintervention was comparable to the national average for admissions excluding day cases (6.7 days), and our study did not include day cases either. However, comparing a median with a mean assumes normal distribution of data. We felt that calculating median LOS was more representative of our data given the small samples. The observed reduction in LOS was statistically significant but given it was a secondary outcome, it deserves dedicated study to confirm this change. Delay time appeared to increase postintervention but this did not reach statistical significance. Delay time was shorter than Shephard *et al's* study<sup>13</sup> during both study phases (1.5 hours vs 21.75 hours at baseline and 2.3 hours vs 18.55 hours postintervention). However, this is probably reflective of the different study setting and context. Change in 30-day readmissions and mortality were also non-significant.

Our study's findings support ongoing use of the intervention, but longer-term data are needed to consolidate this. The e-referral system enables future quality improvement projects without the need for manual data extraction as all referral data are saved. At the time of writing this manuscript, further PDSA cycles or quality improvement projects using the e-referral system have not yet occurred due to the COVID-19 pandemic and staffing.

If we were to repeat this study, we would have included more PDSA cycles to enhance our intervention further. We feel that staff experience should continue to be the primary improvement outcome for future projects, with clinical outcomes acting as balancing measures. An additional clinical outcome of interest is 'ED waiting time' for admitted patients awaiting a ward bed—to confirm whether the observed reduction in LOS is associated with decreased ED congestion. Inclusion of patient perspectives would also be worthwhile and this has not been studied before in this patient population to our knowledge. Adding more clinical pathways is another opportunity for future improvement.

## CONCLUSION

We developed an e-referral system for surgical inpatients referred to medicine, resulting in improved medical staff experience and no compromise in clinical outcomes.

While electronic outpatient referral systems have been shown to improve efficiency, the evidence for inpatient e-referral systems is scarce, aside from a similar study which showed improvement in user experience and delays.<sup>13</sup> We believe our project is the first to study inpatient e-referrals with inclusion of important clinical outcomes such as LOS, 30-day readmissions and patient mortality. These outcomes served as balancing measures

for the primary outcome (staff experience). Our study provides benchmarks for audits in an understudied area of quality improvement. Longer-term data will help to confirm whether our findings are sustained. We identified aspects of our intervention that deserve further quality improvement.

Replicating our intervention elsewhere does rely on existing IT software for inpatient referrals, which is not available in many hospitals. Given the benefits, we believe our study will encourage hospital managers to invest in IT software to enhance inpatient care. In the meantime, clinicians can use existing resources (eg, setup a hospital email account and use an e-referral document template). The gradual roll-out of Hospital Health Pathways<sup>19</sup> (an online manual developed by clinicians for over 500 medical conditions) throughout New Zealand is likely to replace the clinical pathways/guidelines used in our study. We feel that linking Hospital Health Pathways to inpatient e-referrals will be an opportunity to enhance future inpatient care and staff education.

We believe our intervention is sustainable as staff experience improved and uptake was satisfactory. We also included measures to ensure ongoing use of the intervention and encourage future quality improvement initiatives.

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