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Impact of a prescriber and patient educational intervention on discharge analgesia prescribing and hospital readmission rates following elective unilateral total hip and knee arthroplasty

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ABSTRACT

Introduction Pain management after elective, unilateral total hip and knee arthroplasty (THA and TKA) should use a multimodal approach. At discharge, challenges include ensuring correct prescribing practices to optimise analgesia and rationalise opioid use as well as ensuring patients are adequately educated to take these medications safely and effectively in the community. This audit cycle reports on a prescriber and patient education intervention using printed guidelines, educational outreach and prescription standardisation along with a patient information sheet to address the high unplanned readmission rate following THA and TKA at our institution.

Methods Two cohorts of patients were identified before (2016) and after (2019) the introduction of the educational package. The primary outcome was the unplanned hospital readmission rate in the 42 days following discharge. Secondary outcomes were the compliance with the set prescribing standards and the prescription of strong opioid medications (morphine or oxycodone) on discharge.

Results There was a reduction in the readmission rate from 20.4% to 10.0% (p=0.004). Readmission rates for pain and constipation were also reduced. The prescribing of tramadol (p<0.001) and non-steroidal anti-inflammatory drugs (p<0.001) both increased while the number of patients who received a strong opioid at discharge decreased (p<0.001) as did the number of patients who received a sustained release strong opioid (p<0.001).

Conclusion We have observed significant improvement in discharge prescribing which coincided with a reduction in unplanned readmissions after elective TKA and THA. Our approach used prescriber guidelines, education and standardisation with printed information for patients to enhance understanding and recall.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Inappropriate analgesia prescribing at discharge after hip or knee arthroplasty can result in uncontrolled pain and adverse effects.
⇒ A multimodal analgesia strategy can reduce opioid requirements and adverse effects.

WHAT THIS STUDY ADDS

⇒ This study shows that a targeted educational intervention can effectively improve analgesia prescribing patterns.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study provides evidence for the effectiveness of a combined patient and prescriber educational intervention, and standardisation of practice, to improve analgesia prescribing.
⇒ This intervention may be implemented in other surgical departments and institutions in its current or a modified form.

INTRODUCTION

Hospital discharge following total hip (THA) or knee (TKA) arthroplasty presents challenges for the management of post-surgical pain. In hospital, analgesia is prescribed and dispensed under close supervision, whereas in the community this must be managed by the patient independently. At discharge, the patient or primary caregiver should receive education on how to take analgesia safely, taper medications and manage side effects.[1] Failure to offer adequate advice at the time of discharge can lead to confusion, drug errors and adverse drug effects which may lead to readmission to hospital.

The objective of a multimodal analgesia regime is to use a range of medications or techniques to improve analgesia and promote functional recovery while reducing opioid consumption and avoiding adverse effects.[2–4] The exact components of a multimodal analgesic regimen following primary, unilateral THA or TKA are often institution specific. International guidelines and randomised controlled trials suggest that

unless contraindications exist patients should routinely receive paracetamol and non-steroidal anti-inflammatory drugs (NSAIDs) following arthroplasty.[5–8] Data from meta-analyses and database studies suggest gabapentinoids should be avoided in the post-operative setting due to the risk of pulmonary complications and lack of efficacy as analgesics.[9 10]

THA and TKA are known to be painful procedures. In many patients, opioid based analgesia will be required during recovery and these drugs are often prescribed at discharge. Their use is not without risk and can lead to sedation or respiratory depression, constipation and an increased risk of falls.[4 11] If opioid drugs are used for sustained periods following surgery, patients may develop tolerance or opioid induced hyperalgesia, meaning increasing doses may be required to achieve the same analgesic effect while exposing patients to a greater risk of adverse effects.[12–16] Sedation and adverse respiratory events are particularly relevant with slow-release preparations of morphine and oxycodone. The Australian and New Zealand College of Anaesthetists (ANZCA) released a position statement in April 2018 recommending that slow-release opioids should not be used in the management of patients with acute pain.[17]

The purpose of this study is to report the impact of a targeted educational intervention to optimise discharge prescribing practices, including opioid prescribing, in patients who have undergone primary, unilateral THA or TKA at a hospital in Auckland, New Zealand.

METHODS

The conduct of this study conforms to the Standards for Quality Improvement Reporting Excellence (SQUIRE) guideline for reporting the outcomes of quality improvement interventions.[18]

The Counties Manukau District Health Board provides tertiary and quaternary healthcare services for approximately 560 000 people living in the southern part of Auckland (Tāmaki Makaurau), New Zealand. Orthopaedic Surgical services are provided through Middlemore Hospital (elective and emergency surgery) and at the Manukau Surgical Centre (elective surgery only). The catchment population is multicultural and includes some of the most impoverished patients in New Zealand. This means access to primary care is often sub optimal, as such the hospital system is left to deal with issues such as mild to moderate pain, nausea, or constipation following elective surgical procedures.

In July 2017, the Quality Assurance groups within the Departments of Anaesthesia and Pain Medicine and Orthopaedic Surgery noted that the readmission rate following primary unilateral THA and TKA was greater than 15%. At this time, a multifaceted programme was instigated to reduce hospital readmission. This focused on improved communication with both the patient and the patient's general practitioner at the time of discharge, routine in person and/or telephone reviews at 10 days following hospital discharge and standardisation of analgesic prescribing to reduce readmission for pain, constipation or nausea and vomiting.

This manuscript summarises the outcome of a complete audit cycle focusing on the medications (analgesics, antiemetics and aperients) prescribed at the time of hospital discharge in patients who underwent primary, unilateral THA or TKA at the Manukau Surgical Centre in Auckland, New Zealand. In late 2017, a steering group consisting of orthopaedic surgeons (two), anaesthetists (two), nursing and pharmacy staff met to plan a multifaceted programme to reduce hospital readmissions. Following this meeting, a review of the literature was completed by two study authors (DW and NL) and a hospital clinical pharmacist to identify the best practice standards for analgesia at the time of hospital discharge in patients who have undergone primary unilateral THA or TKA. These standards are summarised in online supplemental appendix 1.

DW conducted a review of literature pertaining to educational interventions and guideline dissemination in the setting of hospital prescribing and a draft patient information sheet was prepared. The draft was reviewed and refined by the steering group. Neither patients nor members of the public were involved with the development of this information sheet or conduct of this research.

The intervention period commenced in February 2018 and consisted of evidence based, written guidelines for Orthopaedic Surgery interns who were the doctors responsible for medication prescribing at the time of hospital discharge including appropriate analgesic selection. These guidelines were reinforced through a 30 min, in-person education session conducted by DW which introduced and explained the rationale and content of the guidelines. These sessions were held every 3 months at the commencement of intern rotations in orthopaedic surgery. At discharge, the patient information sheet was completed and signed by the prescribing doctor, indicating which of a prepared listed of medicines had been prescribed, before being presented to the patient. This included instructions for taking analgesic, aperient and antiemetic medications. This information sheet therefore also served as a prompt or reminder of best-practice to the prescriber, see online supplemental appendix 2.

During the two study periods, the conduct of the anaesthetic and surgical components of the arthroplasty procedure was at the discretion of the treating teams. Patients were reviewed on the first postoperative day by the acute pain service and advice provided to the surgical team with regards to the management of medications. No major changes in hospital enhanced recovery after surgery guidelines took place during the two study periods.

Patients who underwent primary, unilateral THA or TKA were identified through their semi-anonymous National Health Index number using the hospital's Patient Information Management System. Demographic, operative and prescribing data were collated from the electronic data warehouse, managed by the Health Alliance. The preintervention or baseline period was from

1 January 2016 to 31 December 2016. Each patient was assigned a computer-generated random number and then sequenced. Data were extracted for the first 50% of the patient list giving a workable sample size.

The postintervention period was from 1 July 2019 to 31 December 2019, using data from the latter 6 months of this 12-month period allowed a longer period for the intervention to be imbedded with the orthopaedic team members, senior doctors and nursing staff.

The primary outcome was the rate of hospital readmission at 42 days following discharge after either THA or TKA. Reasons for readmission were classified as those which could be linked to analgesic therapy (eg, constipation, nausea, pain or gastrointestinal bleeding secondary to NSAID therapy) or to reasons beyond the scope of this intervention (eg, joint dislocation, wound infection or readmission unrelated to the arthroplasty procedure). Comparisons were made between the two time periods for demographic, operative and discharge prescribing information as described in the standards outlined in online supplemental appendix 1. The total amount of strong opioid dispensed, expressed in oral morphine equivalents (OME) was calculated using the methods specified by the ANZCA Faculty of Pain Medicine.[19] For this study, a strong opioid was defined as either immediate or sustained/controlled release preparations of either morphine or oxycodone. The surgical, anaesthetic and ward-based care was at the discretion of the practitioners caring for the patients during both study periods.

Statistical analyses were completed in SPSS V.26 (IBM). Results are presented as number (percentage), median (IQR) and ORs with associated 95th percent confidence intervals as appropriate. Comparisons were made with either the χ^2 test with an appropriate Yates correction or the Fisher's exact test and the Mann Whitney U-test for categorical and continuous variables respectively. A two-tailed p value of less than 0.05 was used to define statistical significance.

RESULTS

During the preintervention period (1 January 2016–31 December 2016) 422 patients underwent either THA or TKA at the Manukau Surgical Centre, of whom the records of 211 (50.0%) were randomly selected for review. During the post-intervention period (1 July 2019–31 December 2019) 201 patients underwent surgery.

There was no difference in the proportion of patients who underwent THA or TKA between the two time periods (2016 TKA: 58.8%; 2019 TKA: 65.2%, p=0.19). The demographic and operative characteristics of the patients are further detailed in table 1. The ASA scores between the two time periods were significantly different (p=0.007). This was driven by an increase in medical complexity of patients undergoing TKA (p=0.007) rather than THA (p=0.28). There were more patients undergoing surgery in 2019 with diabetes mellitus (p=0.02). The use of ACE inhibitors and angiotensin receptor antagonists increased

Table 1 Demographic and operative characteristics (table created by the authors)

	2016	2019	P value
Total	211	201	0.19
Hip replacement	87 (41.2)	70 (34.8)	
Knee replacement	124 (58.8)	131 (65.2)	
Gender—female (percent)	119 (56.4)	122 (60.7)	0.42
Hip replacement	53 (60.9)	41 (58.6)	0.87
Knee replacement	66 (53.2)	81 (61.8)	0.21
Age (years)	68 (61–77)	70 (62–75)	0.89
Hip replacement	69 (61–78)	67 (57–75)	0.33
Knee replacement	68 (62–76)	70 (64–75)	0.53
Calculated eGFR (mL/min)	73 (62–82)	78 (63–90)	0.02
Hip replacement	71 (60–83)	80 (62–96)	0.05
Knee replacement	75 (64–81)	75 (63–90)	0.22
CKD stage (percent)			0.01
1	29 (13.7)	51 (24.4)	
2	138 (65.4)	115 (57.2)	
3A	40 (19.0)	28 (13.9)	
3B	4 (1.9)	7 (3.5)	
ASA score (per cent)			0.007
1	7 (3.3)	1 (0.5)	
2	130 (61.6)	100 (49.8)	
3	73 (34.6)	99 (49.3)	
4	1 (0.5)	1 (0.5)	
ASA score—hip replacement (per cent)			0.28
1	6 (6.9)	1 (1.4)	
2	46 (52.9)	37 (52.9)	
3	34 (39.1)	32 (45.7)	
4	1 (1.1)	0 (0.0)	
ASA score—knee replacement (per cent)			0.007
1	1 (0.8)	0 (0.0)	
2	84 (67.7)	63 (48.1)	
3	39 (31.5)	67 (51.1)	
4	0 (0.0)	1 (0.8)	
Preoperative medication use (per cent)			
Diuretics	40 (19.0)	44 (21.9)	0.46
ARB/ACEi	92 (43.6)	121 (60.2)	0.001
Anticoagulants/Clopidogrel	56 (26.5)	22 (10.9)	<0.001
Comorbidities (per cent)			
Gastrooesophageal reflux disease	24 (11.4)	28 (13.9)	0.46
Gastrointestinal bleeding	3 (1.4)	2 (1.0)	1
Diabetes mellitus	44 (20.9)	62 (30.8)	0.02
Surgical duration (minutes)	86 (67–103)	78 (66–94)	0.009
Hip replacement	87 (67–106)	81 (69–96)	0.31
Knee replacement	85 (68–103)	76 (61–92)	0.02
General anaesthesia used (per cent)	41 (19.4)	46 (22.9)	0.4
Hip replacement	14 (16.1)	19 (27.1)	0.12
Knee replacement	27 (21.8)	27 (20.6)	0.88

Continued

Table 1 Continued

	2016	2019	P value
Spinal anaesthesia used (per cent)	153 (72.5)	186 (92.5)	<0.001
Hip replacement	60 (69.0)	60 (85.7)	0.02
Knee replacement	93 (75.0)	126 (96.2)	<0.001
Spinal or epidural anaesthesia (per cent)	155 (73.5)	186 (92.5)	<0.001
Hip replacement	62 (71.3)	60 (85.7)	0.04
Knee replacement	93 (75.0)	126 (96.2)	<0.001
Peripheral nerve block (per cent)	10 (4.7)	98 (48.8)	<0.001
Hip replacement	1 (1.1)	1 (1.4)	1
Knee replacement	9 (7.3)	97 (74.0)	<0.001
Surgical local infiltration (per cent)	112 (53.1)	109 (62.6)	0.06
Hip replacement	32 (36.8)	40 (64.5)	0.001
Knee replacement	80 (64.5)	69 (61.6)	0.69
Hospital length of stay (days)	4.1 (3.2–5.2)	3.8 (3.0–4.9)	<0.001
Hip replacement	4.1 (3.2–5.2)	3.1 (2.2–4.2)	0.001
Knee replacement	4.1 (3.2–5.2)	4.0 (3.0–5.0)	0.04
Readmission rate (per cent)	43 (20.4)	20 (10.0)	0.004
Hip replacement	18 (20.7)	2 (2.9)	0.001
Knee replacement	25 (20.2)	18 (13.7)	0.18
Reason for readmission (per cent)			
Pain/analgesia	6 (2.8)	5 (2.5)	1
Constipation	9 (4.3)	0 (0.0)	0.004
Pain/analgesia OR constipation	15 (7.1)	5 (2.5)	0.04
Rule out DVT/PE	5 (2.4)	9 (4.5)	0.28
Other or unrelated reasons	28 (13.3)	15 (7.5)	0.08

ACEi, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; ASA, American Society of Anesthesiologists; CKD, chronic kidney disease; DVT, deep vein thrombosis; eGFR, estimated glomerular filtration rate; PE, pulmonary embolism.

between the two time periods (p=0.001) while anticoagulant use decreased (p<0.001). Those undergoing surgery in 2016 had a higher creatinine and lower estimated glomerular filtration rate (eGFR) (p=0.02 for both), the clinical relevance of this finding is unclear.

Between 2016 and 2019, there were several differences in the perioperative care provided. There was a significant increase in the utilisation of spinal anaesthesia and neuraxial anaesthesia overall (p<0.001 and p<0.001, respectively). Local infiltration analgesia (LIA) was used more frequently in 2019 in those who underwent THA (p=0.01) while peripheral nerve blockade was used more frequently in those who underwent TKA (p<0.001) when compared with 2016.

There was a significant reduction in the hospital readmission rate between the two time periods (2016: 20.4% vs 2019: 10.0%, p=0.004). Broken down by THA and TKA, there was a significant reduction in the readmission rate for THA (20.7% vs 2.9%, p=0.001) while no difference was seen for TKA (20.2% vs 13.7%, p=0.18). The readmission rate for pain or constipation, factors which were targeted by the intervention decreased between 2016 and 2019 (p=0.04).

The information surrounding discharge prescribing for the two periods is summarised in table 2 . There was a significant reduction in the number of patients who received a strong opioid medication at the time of discharge between the two periods (71.6% vs 46.8%, p<0.001). When considering THA or TKA alone, these differences remained statistically significant (p=0.008 and p<0.001, respectively). The number of patients who received sustained released opioid preparations decreased between 2016 and 2019 (31.3% vs 4.0%, p<0.001) with similar reductions seen for both THA and TKA (p=0.002 and p<0.001, respectively). The use of oxycodone as opposed to morphine-based preparations at discharge remained constant between the two time periods (61.6% vs 56.4%, p=0.43) with no difference seen in those undergoing either THA or TKA (p=0.27 and p=1.00, respectively).

Between the preintervention and postintervention periods, the volume of strong opioid medications patients received, expressed in OME reduced significantly (210.0 (150.0–300.0) vs 146.3 (90.0–160.0) mg, p<0.001). Similar reductions were seen for both THA and TKA (p=0.001 and p<0.001 respectively).

The use of tramadol increased between 2016 and 2019 (39.3% vs 61.7%, p<0.001) as did the number of patients who received NSAIDs (17.5% vs 40.3%, p<0.001). Regular prescribing of NSAID agents increased for patients undergoing TKA (p<0.001), while no difference was seen for those undergoing THA (p=0.21). After excluding patients with contraindications to NSAIDs there remained a significant increase in NSAID use, both overall (p<0.001) and for THA or TKA (p=0.009 and p=0.001 respectively) (see table 3). Between the two time periods there was a significant increase in the proportion of patients who received celecoxib as opposed to other NSAID drugs (p<0.001). The use of gastric protection (omeprazole) also increased (3.3% vs 42.8%, p<0.001). There was no change in the number of patients who received paracetamol (p=0.25) or who received this drug regularly on discharge (p=0.55).

Gabapentinoid usage increased between 2016 and 2019 (2.8% vs 17.4%, p<0.001) with similar differences seen for both THA and TKA (p<0.001 and p=0.004 respectively). There was no difference in the proportion of patients who received prescriptions for both antiemetics (p=0.27) and laxatives (p=0.45).

DISCUSSION

As part of a successful quality improvement programme designed to reduce the number of patients re-presenting to hospital following discharge after either THA or TKA we have addressed many of the deficiencies in analgesia prescribing which existed at discharge at our institution. There was a significant reduction in both the number of patients who received strong opioids and the total amount of opioid dispensed. The use of sustained release

Table 2 Discharge prescribing practices before and after intervention

	2016	2019	P value
Oral morphine equivalents (mg)	210.0 (150.0–300.0)	146.3 (90.0–160.0)	<0.001
Hip replacement	200.0 (150.0–280.0)	150.0 (75.0–200.0)	0.01
Knee replacement	210.0 (150.0–300.0)	120.0 (100.0–150.0)	<0.001
Dispensed strong opioid (per cent)	151 (71.6)	94 (46.8)	<0.001
Hip replacement	59 (67.8)	31 (44.3)	0.008
Knee replacement	92 (74.2)	63 (48.1)	<0.001
Dispensed morphine (per cent)	58 (38.4)	41 (43.6)	0.43
Hip replacement	21 (36.5)	15 (48.4)	0.27
Knee replacement	37 (40.2)	26 (41.3)	1
Dispensed sustained release drug (per cent)	66 (43.7)	7 (7.4)	<0.001
Hip replacement	19 (32.2)	2 (6.5)	0.002
Knee replacement	47 (51.1)	5 (7.9)	<0.001
Paracetamol (percent)	210 (99.5)	197 (98.0)	0.21
Hip replacement	86 (98.9)	69 (98.6)	1
Knee replacement	124 (100.0)	128 (97.7)	0.25
Paracetamol regularly (per cent)	118 (56.2)	117 (59.4)	0.55
Hip replacement	47 (54.7)	42 (60.9)	0.51
Knee replacement	71 (57.3)	75 (58.6)	0.9
NSAID (per cent)	37 (17.5)	81 (40.3)	<0.001
Hip replacement	19 (21.8)	28 (40.0)	0.02
Knee replacement	18 (14.5)	53 (40.5)	<0.001
NSAID regularly (per cent)	12 (32.4)	47 (75.8)	<0.001
Hip replacement	10 (52.6)	16 (72.7)	0.21
Knee replacement	2 (11.1)	31 (77.5)	<0.001
NSAIDs (per cent)			<0.001
Celecoxib	4 (10.8)	57 (87.7)	
Diclofenac	11 (29.7)	2 (3.1)	
Etoricoxib	0 (0.0)	1 (1.5)	
Ibuprofen	19 (51.4)	5 (7.7)	
Naproxen	3 (8.1)	0 (0.0)	
Tramadol (per cent)	83 (39.3)	124 (61.7)	<0.001
Hip replacement	35 (40.2)	42 (60.0)	0.02
Knee replacement	48 (38.7)	82 (62.6)	<0.001
Gabapentinoids (per cent)	6 (2.8)	35 (17.4)	<0.001
Hip replacement	0 (0.0)	14 (20.0)	<0.001
Knee replacement	6 (4.8)	21 (16.0)	0.004
Proton pump inhibitor (per cent)	7 (3.3)	86 (42.8)	<0.001
Antiemetics (per cent)	85 (40.3)	70 (34.8)	0.27
Laxatives (per cent)	169 (80.1)	167 (83.1)	0.45

Table 3 NSAID use in patients without contraindications

	2016	2019	P value
Patients prescribed NSAID (per cent)	21 (26.6)	31 (59.6)	<0.001
THA	12 (32.4)	14 (63.6)	0.03
TKA	9 (19.1)	17 (56.7)	0.003

Contraindications to NSAID use included estimated glomerular filtration rate (eGFR) <60 mL/min, prior adverse reaction, use of medications active on the renin–angiotensin–aldosterone axis, diuretics, anticoagulants and prior history of gastric ulceration. NSAID, non-steroidal anti-inflammatory drug; THA, total hip arthroplasty; TKA, total knee arthroplasty.

strong opioids was almost completely eliminated. Despite these changes, the proportion of patients who received oxycodone as opposed to morphine did not change and the use of gabapentinoids increased.

The reductions in opioid prescription and consumption were accompanied by parallel increases in the utilisation of other components of a multimodal analgesic regimen—namely tramadol and NSAIDs. These changes when combined with the high baseline use of regular paracetamol represent a transition towards a balanced utilisation of multimodal analgesia following THA or TKA. Readmission to hospital at 42 days following discharge decreased overall, with lower numbers of patients being readmitted due to pain or for adverse effects of analgesic therapy such as constipation, NSAID-related side effects or nausea.

The 'opioid crisis' describes the rise in drug related morbidity and mortality especially in the developed world due to misuse of natural and synthetic opioids.[20 21] By reducing opioid prescribing at the time of discharge after surgery medical professionals can stem the flow of these drugs into the community and reduce overall side effects, tolerance, long-term use, abuse and diversion of drugs.[22]

Even when used appropriately, opioids are frequently associated with side effects including slowing of gastrointestinal transit, nausea and vomiting, sedation and an increased risk of falls.[4] When used with sedatives such as benzodiazepines, gabapentinoids or alcohol, opioid induced sedation and ventilatory impairment can lead to premature death secondary to hypoxaemia.[23 24] International guidelines, including those from the ANZCA suggest that sustained release opioids should not be used in the management of acute pain due to the significant risk of adverse effects.[17] Our results conform with these recommendations with reductions in the number of patients receiving either morphine or oxycodone sustained release formulations on hospital discharge. In those where opioids were prescribed, the amount supplied significantly decreased. These prescriptions were frequently paired with laxatives and antiemetics to reduce the risk of opioid induced adverse effects.

Multimodal analgesia represents an attractive strategy to reduce strong opioid use at hospital discharge.[25] Simple analgesics such as paracetamol and NSAIDs should routinely be used where possible following THA and TKA.[5–8] Although we attempted to increase the use of NSAIDs, we were limited by relative and absolute contraindications to their use. This was evidenced through the incidence of chronic renal impairment and by the percentage of patients using either diuretics or medications active on the renin–angiotensin–aldosterone system.[26 27] Recent findings from database analyses and systematic reviews suggest that the postoperative use of either gabapentin or pregabalin may contribute to pulmonary complications with only minimal beneficial effect on pain scores and opioid consumption.[1 9 10] As such, the increase in the use of these drugs across the two time periods may need to be addressed through future interventions.

Between 2016 and 2019, there was a significant increase in the number of patients prescribed tramadol on discharge from hospital. This could in part explain the reduction in strong opioid use in our population. Through its diverse mechanism of action, both on opioid receptors and through the inhibition of norepinephrine and serotonin reuptake, tramadol may allow patients with moderate to severe pain to obtain effective analgesia without resorting to strong opioid therapy. Although this approach is supported by the WHO through its 'analgesic ladder' and guidelines from professional societies, tramadol may be poorly tolerated in some patient groups with side effects including nausea and vomiting, sedation, and the risk of serotonin toxicity.[25 28 29] There is also evidence to suggest that exposure to tramadol containing preparations may increase the risk of opioid overdose due to concurrent use of multiple preparations, this is however contested.[30 31]

Our intervention focused on two principal strategies; improving the discharge prescribing practices of orthopaedic surgical interns and providing patients with adequate printed information to manage their medications in the community. The use of printed guidelines and an education session for the surgical interns are examples of printed educational material (PEM) and educational outreach respectively.[32] Systematic reviews consistently show that while some improvement in prescribing practice is possible with these strategies, the magnitude of this effect is generally small.[32 33] Standardisation, however, is a strategy that has been successfully used to reduce the amount of opioid prescribed on discharge.[34 35]

We enhanced the printed information sheet provided to the patients with clear written instructions, which can improve recall and compliance.[36–38] Colour coding was also used to denote medications which should be administered regularly, those which were to be taken as required and medications which were used for side effects such as nausea or constipation. This is an example of explicit categorisation which can improve patient's retention of information.[36 39] The novel aspect of this intervention was that the information sheet was completed by the prescriber prior to discharge, as such it served as an aide memoire for good prescribing practices. Any modifications to the standard patient instructions needed to be made manually and the form signed. Significantly, no long-acting or sustained release opioids were included on this form.

This study has several strengths. By limiting our intervention to two elective procedures at a single facility, we were able to reduce the heterogeneity between patients meaning the applicability of the changes we implemented was increased. Although many interventions focus simply on prescriber PEM, we reinforced their message through in-person education sessions with the interns and hospital clinical pharmacists. The novel use of a patient information sheet that required completion by the prescribing doctor also acted to prompt and reinforce good prescriber practices.

We have also identified several weaknesses. We have shown that over the intervention period intraoperative practice changed significantly. LIA use increased markedly for THA while peripheral nerve block was increasingly used for TKA. This was not the result of a specific change in policy or guidelines but rather the evolution of clinical practice and represents a potential cause of bias accounting for the improvement in readmission rates.

A further weakness is that both the written guidelines and the colour-coded patient information sheet were developed by a multidisciplinary group including anaesthetists and a clinical pharmacist, however, neither junior doctors nor patients were involved in this process. Quality improvement theory, including Model for improvement and Experience based co-design, emphasize the involvement of patients in intervention design.[40]

Ensuring the ongoing sustainability of our intervention was a further difficulty. We have continued to provide the prescriber education sessions but are planning to transition this to an education session provided by a clinical pharmacist. Although we emphasised the importance of the information package to the orthopaedic surgical interns, there was no way to confirm that the printed information sheet was provided to every patient. Going forward the pharmacist will be allocated time for patient education prior to discharge ensuring the education sheet will be provided to each patient once completed by the prescriber. This will allow us to ensure patients have a sound comprehension of instructions prior to discharge.

Following discharge, the responsibility for medication administration lies with the patient or their caregivers with supervision provided by their general practitioner. We were able to note readmission to the hospital, however, revisions to or repeat prescriptions from General Practitioners were not studied as a part of our intervention. Previous data from our group suggest that at 3 months after TKA, repeat prescriptions for strong opioids are obtained by between 4% and 7% of patients.[41]

When compared with other centres internationally, our baseline readmission rate is high. As noted in the methods section of this paper, the population served

by the Counties Manukau District Health Board have a greater dependence on public hospitals for the provision of primary healthcare due to the greater than average deprivation across multiple domains which exists in our catchment population.

CONCLUSIONS

We have observed significant improvements in discharge medication prescribing and unplanned readmission rates following THA and TKA after the introduction of PEM, individualised patient and prescriber education and standardisation of practice. An increase in the use of LIA for THA and peripheral nerve blocks for TKA were, however, potential confounding factors. Future research will focus on integrating these measures with our hospital's electronic medical record such that limits can be placed on the volume of opioid medications prescribed with tailored patient information including opioid tapering, information about side effects and the disposal of unused drugs. The intervention will be broadened to apply to other homogeneous and commonly performed surgical procedures at our institution.

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Patient consent for publication Not applicable.

Ethics approval Approval was prospectively obtained from the Auckland Regional Health Research Ethics Committee (AHREC, reference AH1311) and the Counties Manukau Health Research Office (reference 1191) prior to study conduct.

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