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Clinician training level impacts prescribing practices for the conservative management of acute renal colic: a contemporary update

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Abstract

Purpose Given the current and increasing awareness of the opioid crisis, this study aimed to characterise the types of analgesic prescription for conservatively managed renal colic.

Methods This was a retrospective cohort study of consecutive patients presenting to the Emergency Department (ED) in 2014–2019. Patients were included if they had radiographically confirmed obstructing calculus, managed conservatively without intervention, and were given a prescription for analgesia on discharge. Patient demographics were recorded and analysed. Opioid, non-opioid, and alpha-blocker medications were compared according to patient and disease parameters, and clinician training. Oral morphine equivalents (OMEs) were used to compare prescribed quantities. Subgroup analyses of stone size and location were performed.

Results Our analysis included 1761 patients with confirmed renal colic: median age of 50 years (16–96). Altogether, 88% of included patients were prescribed opioids on discharge, while only 68% were prescribed non-opioids ($p < 0.001$). Oxycodone immediate release was the most frequently prescribed analgesic. Logistic regression modelling controlling for patient and disease characteristics significantly predicted more non-opioid ($p < 0.001$) and alpha-blocker ($p = 0.037$) prescription with clinician training < 3 years. Linear regression modelling demonstrated that clinicians training < 3 years predicted lower OMEs per prescription compared to clinicians with ≥ 3 years of training ($p = 0.001$). Subgroup analyses supported similar predictions with training.

Conclusions Prescribing patterns are associated with different clinician experience levels. However, a substantial amount of opioids are still given overall on patient discharge regardless of the clinician experience. Educational interventions aimed at reducing the opioid prescription rate and quantities may be considered for clinicians of all training levels.

Keywords Renal colic · Ureteric calculus · Opioid · Analgesia · Clinician training · Emergency medicine

Liang G. Qu and Garson Chan contributed equally to the work.

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Abbreviations

AKI	Acute kidney injury
CI	Confidence interval
ED	Emergency department
IR	Immediate release
KDIGO	Kidney Disease Improving Global Outcomes
NSAID	Non-steroidal anti-inflammatory drug
OME	Oral morphine equivalent
OR	Odds ratio
PUJ	Pelviureteric junction
SR	Sustained release
VUJ	Vesicoureteric junction

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Introduction

Acute renal colic contributes to a substantial amount of emergency department (ED) presentations. Adequate analgesia is the initial step in the management of these patients. Greater reduction in pain and requirement for rescue analgesia is possible when using non-steroidal anti-inflammatory drugs (NSAIDs) [1]. In addition, NSAID use minimises nausea and vomiting associated with opioids [1]. These recommendations are reflected in guidelines, supporting the use of opioid-sparing pain relief as first-line management in acute renal colic [2, 3]. Many other medications have been studied for their use as medical expulsion therapy [4]. Among them include alpha-blockers which may aid stone clearance and reduce the need for analgesic drugs [5, 6].

This is especially relevant due to the increasing awareness of harm associated with opioid use [7, 8]. Opioid use has increased in up to 15-fold over the course of 20 years in some countries, with an associated increase in opioid-related harms and hospitalisations [9]. Over 11 million cases of opioid misuse were recorded in 2016 in the USA [7, 8]. Furthermore, of surgical patients discharged with opioids, almost 90% may discharge without an opioid management plan [10]. Opioid-naïve surgical patients after discharge may experience up to 71% increase in the rate of misuse with each additional opioid prescription refill, while 6% of patients may have persistent opioid use more than 3 months later [11, 12]. This is an important area for further investigation, given the high pain burden patients with renal colic endure.

However, there has been limited assessment of the prescribing patterns for analgesia across clinician training levels. Hence, we aimed to investigate the effect of clinician training level on prescribing patterns for acute renal colic.

Materials and methods

This study was a retrospective cohort analysis of consecutive renal colic presentations to an ED in a single tertiary institution. This study spanned a 5-year interval from 01/01/2014 to 01/01/2019. Data extraction collected all consecutive patient episodes with a coded diagnosis in ED for 'acute renal colic' within the study time interval, producing 4320 events (Fig. 1).

Patients with multiple recurrent presentations were included, with each separate episode analysed as a different patient entry. Patients were only included if they had a symptomatic obstructing ureteric colic, with stone identified on radiographic imaging (including either low-dose computerised tomography, ultrasound, or X-ray), performed within 30 days of their presentation, and were subsequently managed conservatively during their admission without surgical intervention (includes ureteric stenting for subsequent ureteropyeloscopy). Patient exclusion criteria included: misdiagnosis, no obstructing stone on radiographic imaging (patients with passed stones were also excluded), no imaging performed within 30 days, insufficient data, or no prescription given on patient discharge.

Data collection was performed by a single author (LGQ), utilising institutional electronic medical records. A securely stored spreadsheet was utilised. Data accuracy and abstraction performance was assessed by interval sampling at the completion of initial data collection. Data were collected on patient demographics, stone characteristics, and laboratory results. The definition of acute kidney injury (AKI) for this study utilised the criteria outlined by the Kidney Disease Improving Global Outcomes (KDIGO) guidelines from 2012 [13]. A fever was defined as ≥ 38.0 °C.

The records of all discharge prescriptions were processed and documented electronically ensuring accurate capture of

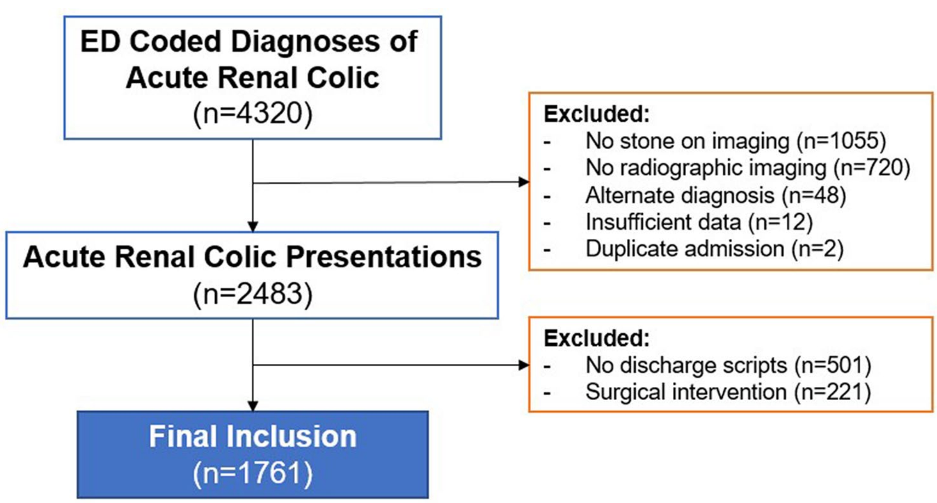

Fig. 1 Study participant selection flowchart. Patients were extracted from an ED database of all patients with a coded discharge diagnosis of acute renal colic. In total, there were 1761 patients included for analysis in this study. *ED* emergency department

all medications. These were broadly categorised into alpha-blockers, opioids and non-opioid medications, including simple analgesics (paracetamol) and non-steroidal anti-inflammatory drugs (NSAIDs). Opioids were separated into the immediate release (IR) and sustained release (SR). Opioid dosages were converted to standardised oral morphine equivalent (OME) doses, according to the conversions by the Faculty of Pain Medicine of the Australian and New Zealand College of Anaesthetists [14].

Training level of the prescribing clinician was de-identified separate to initial data collection and recorded as a number of years worked after graduation, according to the Australian Health Practitioner Regulation Agency register of practitioners. Initial data abstraction from ED documentation was, therefore, blinded to clinician training. Prescribing clinicians were analysed in dichotomous groups, as either < 3 years training, or ≥ 3 years training, in accordance with previously reported literature [15].

This study was approved by the Austin Health Human Research Ethics Committee (Audit/19/Austin/85).

Statistical analysis

Chi-square and Kruskal–Wallis statistics were calculated for patient demographics. Chi-square statistics were calculated to compare the proportions of each group of analgesics between training levels. NSAIDs were additionally analysed separately to non-opioids. Logistic regression modelling investigated significant predictors of any baseline variable, for the prescription of opioids, non-opioids, NSAIDs, or alpha-blockers. Linear regression analysis was performed for prescribed OME quantities. Patients with missing field data were excluded from regression analyses.

Additional subgroup analyses were performed to further explore relationships with prescriptions and training level. Regression models were fit for the subgroups of stone size > 5 mm versus ≤ 5 mm, as well as proximal (including mid-ureteric) versus distal stones.

Throughout this study, statistical significance was defined as *p* value of < 0.05. All statistical calculations were performed using StataIC version 15.1 (Stata Statistical Software: Release 15. College Station, TX, USA: StataCorp LLC).

Results

In total, 1761 patients were included. Common reasons for exclusion were: subsequent surgical intervention, alternate diagnosis, no radiographic imaging, no stone on imaging, duplicate admission, and insufficient data (Fig. 1). There were 501 patients excluded due to no prescription given on discharge.

The median age was 50 years (16–96) (Table 1). Up to 33% of patients had a past history of urinary tract calculi. There were 28 patients (2%) with pre-existing regular opioid analgesia. The median stone diameter measured on admission imaging was 5 mm (1–63 mm), with the most common stone location being mid-ureteric (54%), followed by vesicoureteric junction (VUJ) (39%). There were 281 patients with AKI and 4 patients with a fever.

Prescription characteristics

Altogether, 88.0% received opioids, while there were 68.0% who received non-opioids and 30.6% alpha-blockers. Clinicians were significantly more likely to prescribe opioids compared to non-opioids ($p < 0.001$). The most frequently prescribed opioid analgesic in patients for expectant management was oxycodone IR ($n = 1322$, 75.1%). Other opioids prescribed include codeine, oxycodone SR, and tramadol. The most frequently prescribed non-opioid medication was paracetamol ($n = 734$, 41.7%), followed by indomethacin ($n = 594$, 33.7%). Other non-opioids that were prescribed include ibuprofen, diclofenac, naproxen, and celecoxib. Of the 30.6% who received prescriptions for alpha-blockers, 377 (21.4%) were tamsulosin, while 163 (9.3%) were prescribed prazosin.

Table 1 Baseline patient and disease characteristics

	No intervention $n = 1761$
Age, years (median, range)	50 (16–96)
Male (*n*, %)	1385 (79)
Past history (*n*, %)	
Previous stones	584 (33)
Significant history	24 (1)
Regular opioids	28 (2)
Other analgesics	38 (2)
Stone diameter (mm) (median, range)	5 (1–63)
Stone location (*n*, %)	
Kidney pelvis	14 (1)
PUJ	122 (7)
Mid-ureter	947 (54)
VUJ	678 (39)
Other additional stones (*n*, %)	871 (49)
Presentation (*n*, %)	
AKI	281 (16)
Fevers	4 (1)
Readmission (*n*, %)	221 (13)

Baseline patient and disease characteristics have been summarised for the 1761 included patients

AKI acute kidney injury, *PUJ* pelviureteric junction, *VUJ* vesicoureteric junction

Univariate analyses for prescriptions by training level

The prescriptions were analysed according to clinician training (Fig. 2). Junior staff with < 3 years of training were responsible for the majority of scripts (1056/1761, 60%). Chi-square testing between clinician training demonstrated statistically significant differences in non-opioid ($p < 0.001$) and NSAID analgesics prescribed ($p < 0.001$), but not for opioids or alpha-blockers. Upon analysis of OME quantities prescribed, median prescribed quantities were 75 mg (20–720 mg) and 78 mg (20–570 mg) for clinicians with < 3 years and ≥ 3 years training respectively ($p < 0.001$).

Multivariate analyses for prescriptions

Regression models were fit for opioids, non-opioids, NSAIDs, and alpha-blockers (Table 2). Opioids were less likely to be prescribed on discharge for patients who presented as a readmission (odds ratio [OR] 0.60, 95% confidence interval [CI] 0.40–0.88, $p = 0.010$). Non-opioids were more likely to be prescribed for larger stone size (OR 1.83, 95% CI 1.37–2.44, $p = 0.005$), and by clinicians with < 3 years training (OR 0.31, 95% CI 0.25–0.39, $p < 0.001$). Sub-analysis of NSAID prescriptions yielded the same set of significant predictors: with stone size ($p = 0.005$), and training ($p < 0.001$). Analysis of alpha-blocker prescriptions were predicted by increasing stone size (OR 2.76, 95% CI 2.03–3.75, $p < 0.001$), and with training (OR 0.80, 95% CI 0.64–0.99, $p = 0.037$).

Linear regression modelling for OME quantities demonstrated that increase in stone size (+ 10.6 mg, 95% CI 3.1–18.0, $p = 0.005$) and previous regular opioid use (+ 34.8 mg, 95% CI 10.0–59.6, $p = 0.006$) both significantly predicted greater OME quantities. Clinicians with ≥ 3 years of training were likely to prescribe more opioids (+ 12.1 mg, 95% CI 6.5–17.6, $p = 0.001$).

Subgroup analysis by stone size

The baseline variables were modelled for prescribed analgesia for subgroups: stone sizes > 5 mm and ≤ 5 mm (Supplementary Table 1). For patients with stones > 5 mm, models were unable to be fit for opioid prescriptions, alpha-blocker prescriptions, and analysis of OME quantities. Fewer non-opioid (OR 0.29, $p < 0.001$) and NSAID (OR 0.37, $p < 0.001$) prescriptions were predicted by training level ≥ 3 years.

For patients with stones ≤ 5 mm, fewer opioid prescriptions were predicted by patients with a past history of stones (OR 0.65, $p = 0.022$), and with prior regular non-opioid use (OR 0.31, $p = 0.029$). Training level ≥ 3 years predicted less non-opioid prescriptions (OR 0.33, $p < 0.001$), less NSAID prescriptions (OR 0.46, $p < 0.001$), and more OMEs prescribed ($b = 0.13$, $p < 0.001$).

Subgroup analysis by stone location

Regression models were fit for subgroups: distal stones and proximal stones (Supplementary Table 1). For patients with distal stones, training level ≥ 3 years predicted less non-opioid prescriptions (OR 0.22, $p < 0.001$), less NSAID prescriptions (OR 0.34, $p < 0.001$), and more OMEs prescribed ($b = 0.16$, $p < 0.001$).

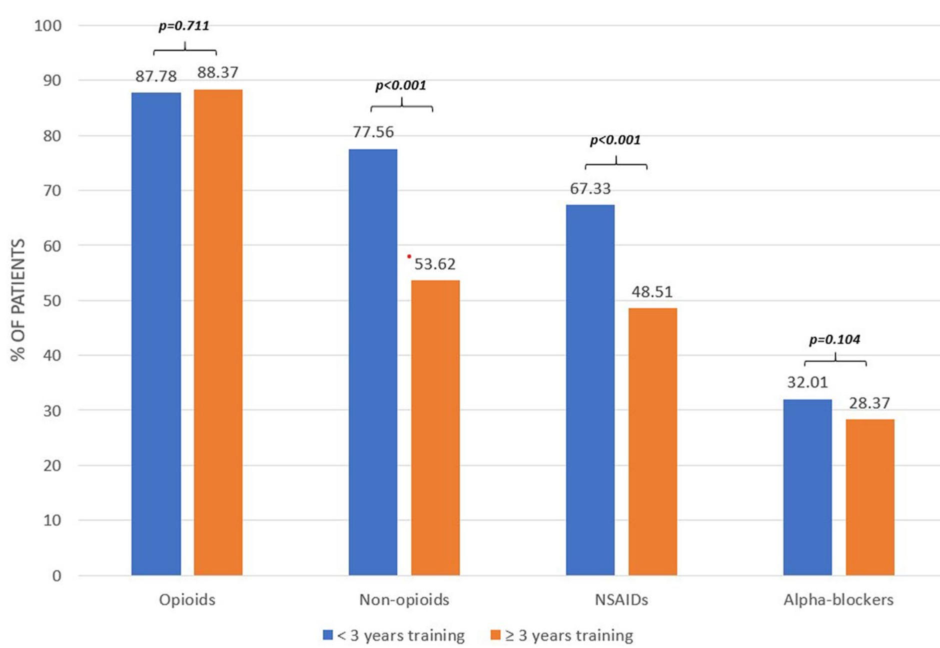

Fig. 2 Prescribed analgesia according to clinician training. The proportion of prescribed analgesia forms are compared according to clinician training. *NSAID* non-steroidal anti-inflammatory drug

Table 2 Regression analysis of predictors of analgesic use

Response variable	Predictors	*b*	SE of *b*	*p* value	Odds ratio	95% CI
(a)						
Opioid prescriptions	Not re-admission	− 0.514	0.199	0.010	0.598	0.405–0.883
Non-opioid prescriptions	Age	− 0.010	0.004	0.012	0.990	0.983–0.998
	Stone size[a]	0.602	0.147	< 0.001	1.826	1.369–2.436
	Training ≥ 3 years	− 1.155	0.108	< 0.001	0.315	0.255–0.389
NSAID prescriptions	Age	− 0.021	0.004	< 0.001	0.979	0.972–0.986
	Stone size[a]	0.391	0.138	0.005	1.479	1.128–1.938
	Training ≥ 3 years	− 0.839	0.103	< 0.001	0.432	0.353–0.529
	Not re-admission	− 0.301	0.153	0.048	0.740	0.549–0.998
Alpha-blocker prescriptions	Age	− 0.009	0.004	0.022	0.991	0.984–0.999
	Stone size[a]	1.015	0.156	< 0.001	2.756	2.033–3.745
	Training ≥ 3 years	− 0.228	0.109	0.037	0.796	0.643–0.987

Response variable	Predictors	*b*	SE of *b*	*p* value	95% CI
(b)					
Quantity of OMEs (mg)	Stone size[a]	0.080	0.032	0.012	0.018–0.143
	Previous regular opioids	0.301	0.106	0.005	0.093–0.509
	Training ≥ 3 years	0.115	0.024	< 0.001	0.068–0.161

Logistic regression analysis was used to fit models that predicted associations with the different forms of analgesia. Significant predictors are shown in [a]. Oral morphine equivalents (OMEs) were analysed for association with clinician training along with other patient and disease characteristics using linear regression. Significant predictors are shown in [b]

CI confidence interval, *NSAID* non-steroidal anti-inflammatory drug, *OME* oral morphine equivalent, *SE* standard error

[a]Stone size variable analysed using logarithm transformation to normalise residuals

For patients with proximal stones, a model was unable to be fit for opioid prescriptions. Training level ≥ 3 years predicted less non-opioid prescriptions (OR 0.40, $p < 0.001$), less NSAID prescriptions (OR 0.51, $p < 0.001$), and more OMEs prescribed ($b = 0.09$, $p = 0.005$).

Discussion

Our study investigated the prescribing practices of analgesics for acute renal colic. Importantly, this study demonstrated varying prescribing patterns of analgesia according to the level of clinician experience. Of note, more non-opioid and NSAID analgesics were prescribed with clinician experience < 3 years. Greater quantities of OMEs were prescribed by clinician training ≥ 3 years. Alpha-blocker prescription rates were predicted by clinician training on multivariable analysis. These findings were supported by subgroup analyses that demonstrated similar findings. Additionally, oxycodone IR was the most commonly prescribed analgesia. This remains despite the known risks of over-prescription of opioid medication and the reported superior efficacy of non-opioid analgesia for controlling pain associated with acute renal colic [1].

This observed difference in prescribing pattern between training levels may reflect differing adherence to current analgesia recommendations according to published evidence [1]. The concept of the World Health Organization 'analgesia ladder' may be applied to the current setting of acute renal colic, where evidence for NSAID efficacy is widespread and its use should be preferred where possible [1, 16–18]. Possible explanations for our results may include: senior clinicians may seem to be more established in their prescribing behaviours; seniors may be more experienced and comfortable with increasing opioid doses. Furthermore, junior clinicians may have increased supervision and scrutiny from seniors or pharmacists when administering prescriptions. The influence of supervision was unable to be examined for this study.

Many studies have analysed the prescribing patterns of analgesia. However, the best available literature is based in the USA, where the healthcare system, prescribed analgesia, and training programs all differ. Limited studies have investigated prescribing practices for acute renal colic specifically. In the USA and France, opioids were prescribed for 51% of patients, however, clinician training was not analysed [19]. In another study from the USA investigating prescriptions for musculoskeletal pain, opioids were more readily prescribed by clinicians with more than 3 years' experience [15]. Factors that may influence opioid prescriptions include consultant choice influencing resident decision making, patient satisfaction, and the preconceived fear of opioid abuse [20]. Our study represents the first report of the association between clinician training and prescribing practices, for patients presenting with acute renal colic.

Although overall rates of opioid prescriptions were seemingly high (88%), this is likely artefactual due to exclusion of 501 conservatively managed renal colic patients for not having a discharge prescription. This study also analysed clinician training as a dichotomous variable. The decision to not examine clinician training as a continuous variable was made given the assumption that an increase in years from graduation after becoming a consultant physician would no longer impact or be correlated to prescribing practices. Furthermore, the study of clinician prescribing practices has previously been examined as a dichotomous variable at 3 years [15], allowing for a comparison of our findings with other studies in this field. This study is restricted by its retrospective nature and uncontrollable study population, leading to selection bias. Our findings may not be generalizable for patients with larger or more complicated stone disease. There was a low proportion of proximal or larger stones in this study, likely due to the greater proportion excluded who underwent subsequent surgical intervention, although there is growing evidence for early intervention for distal small calculi [21]. This study similarly did not consider inpatient analgesia use and clinical progress that may influence the choice of prescription on discharge. In addition, this study analysed each patient admission episode as a separate patient, which may influence our cohort by those with multiple recurrent presentations. Although simple analgesics were still represented in our study, this analysis does not capture discharge recommendations for patients to obtain over-the-counter analgesics without needing a prescription. Differing radiographic modalities were utilised for including patients. The known differing sensitivities of detection across modalities likely affect the completeness of inclusion for this analysis [22]. Use of CT may furthermore help characterise other stone characteristics such as composition, to guide subsequent management [23]. In addition, the analysis of the proportion of patients who were discharged with no script at all was not able to be performed. Ideally, it would be useful to analyse training experience for the clinician who decides that a patient does not require any analgesia at all on discharge [24]. Lastly, our study does not account for the likely impact of inter-clinician variability, which has been previously demonstrated to affect the choice of prescription even for the same clinical case [25].

Our study has implications for the design of interventions to improve prescribing practices for renal colic and beyond. Our findings suggest that future opioid-reducing interventions should consider targeting clinicians of all levels. Current intervention research for improving prescribing practices focuses on junior medical staff and medical students with programs limited to didactic, educational sessions [26, 27]. More recent research has focused on interventions that utilise longitudinal curricula that builds upon knowledge over several years, producing longer-lasting durable improvements in practice [28]. In addition, systems-level interventions may also be considered, to ensure widespread adherence to improving practices across healthcare systems [29]. Adjunctive supportive measures that may help prescribing clinicians include technological assistance and online real-time information for prescribing opioids [30].

Conclusion

The most common prescriptions for the conservative management of acute renal colic were opioid analgesics, which are known to be associated with misuse and harm. Lower clinician training level was associated with the prescription of more non-opioid analgesics, alpha-blockers, and less OME quantity per prescription. These previously underappreciated findings will increase awareness of the global opioid crisis, and assist with guiding future opioid-reducing interventions.

Author contributions LGQ, GC and JG: conceived the study; LGQ: performed data collection; LGQ and GC: performed data analysis; LGQ, GC and JG: drafted the manuscript. All authors contributed substantially to its revision. LGQ takes responsibility for the paper as a whole.

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Data availability Data will not be available online but will be shared upon request.

Compliance with ethical standards

Conflict of interest The authors declare no conflicts of interest relevant to this manuscript.

Ethics approval Ethics approval was obtained from our local human research and ethics committee.

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