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Original Study

## Rates of PRN Medication Administration in Australian Residential Aged Care

Leonie Picton M ClinEpid<sup>a</sup>, Jenni Ilomäki PhD<sup>a</sup>, Claire S. Keen MPH<sup>a</sup>,  
 Samanta Lalic PhD<sup>a,b</sup>, Beverly Adams RN<sup>c</sup>, Lisa M. Clinnick DN<sup>c,d</sup>,  
 Carl M. Kirkpatrick PhD<sup>a</sup>, Taliesin Ryan-Atwood MPH<sup>a</sup>, Justin P. Turner PhD<sup>a,e</sup>,  
 J. Simon Bell PhD<sup>a,\*</sup>

<sup>a</sup> Centre for Medicine Use and Safety, Faculty of Pharmacy and Pharmaceutical Sciences, Monash University, Melbourne, Australia

<sup>b</sup> Pharmacy Department, Monash Health, Melbourne, Australia

<sup>c</sup> Ballarat Health Services, Ballarat, Australia

<sup>d</sup> School of Nursing, Midwifery and Paramedicine, Australian Catholic University, Ballarat, Australia

<sup>e</sup> Centre de recherche, Institut universitaire de gériatrie de Montréal, University of Montreal, Montreal, Canada

### A B S T R A C T

#### Keywords:

Aged care  
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**Objective:** To investigate administration of pro re nata (PRN) medications and nurse-initiated medications (NIMs) in Australian aged care services over a 12-month period.

**Design:** Twelve-month longitudinal audit of medication administrations.

**Setting and participants:** Three hundred ninety-two residents of 10 aged care services in regional Victoria, Australia.

**Methods:** Records of PRN and NIM administration were extracted from electronic and hard copy medication charts. Descriptive statistics were used to calculate medication administration per person-month. Poisson regression was used to estimate predictors of PRN administration.

**Results:** Over a median follow-up of 12 months (interquartile range 10–12 months), 93% of residents were administered a PRN medication and 41% of residents an NIM on 21,147 and 552 occasions, respectively. The mean number of any PRN administration was 5.85 per person-month. The most frequently administered PRN medications per person-month were opioids 1.54, laxatives 0.96, benzodiazepines 0.72, antipsychotics 0.48, paracetamol 0.46, and topical preparations 0.42. Three-quarters of residents prescribed a PRN opioid or PRN benzodiazepine and two-thirds of residents prescribed a PRN antipsychotic had the medication administered on 1 or more occasions over the follow-up.

**Conclusions and Implications:** Most residents were administered PRN medications. Administration was in line with Australian regulations and institutional protocols. However, the high frequency of PRN analgesic, laxative, and psychotropic medication administration highlights the need for regular clinical review to ensure ongoing safe and appropriate use.

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Medication management is an increasingly complex and important component of quality care in residential aged care services (RACS).<sup>1</sup> Australian RACS are synonymous with long-term care facilities and nursing homes in other countries and provide permanent and respite accommodation for people who require access to 24-hour care that

can no longer be provided in their own homes.<sup>1</sup> A review of the international literature suggests that up to 74% of residents take 9 or more regular medications,<sup>2</sup> with most residents dependent on staff for medication administration. Up to 94% of residents are prescribed pro re nata (PRN) or “as-needed” medications.<sup>3</sup> PRN medications are prescribed by the resident’s physician and administered by nurses, or in some situations by care workers, on an as-needed basis.<sup>4</sup> Previous Australian and German research suggests residents are prescribed up to 4 PRN medications,<sup>5–7</sup> with analgesics and laxatives most frequently administered.<sup>3</sup>

In addition to administering PRN medications, Australian guidelines permit registered nurses to initiate specific over-the-counter

BA and LMC are employed by health services overseen by the Department of Health and Human Services.

\* Address correspondence to J. Simon Bell, PhD, Centre for Medicine Use and Safety, Faculty of Pharmacy and Pharmaceutical Sciences, Monash University, Melbourne, Australia.

E-mail address: [Simon.Bell2@monash.edu](mailto:Simon.Bell2@monash.edu) (J.S. Bell).

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medications not prescribed on a resident's chart.<sup>4</sup> These nurse-initiated medications (NIMs) can be administered for short-term treatment of minor ailments according to institutional protocols and medication lists that outline the formulation and maximum permitted dose.<sup>4</sup> These lists typically include analgesics, such as paracetamol (acetaminophen), laxatives, antacids, artificial tears, urinary alkalizers, and cough mixtures. For example, if a registered nurse assesses that a resident requires a laxative, and the resident does not have a PRN order for a laxative, the nurse may administer a laxative from the RACS-approved NIM list and record the administration in the NIM section of the resident's medication chart. PRN and NIMs that are not administered before the expiry date are disposed of in accordance with institutional protocols.

There are potential safety and quality issues associated with administration of PRN and NIMs.<sup>1</sup> Judicious use of PRN and NIMs can improve a resident's condition by providing timely access to evidence-based treatment. However, there has been a clinical and policy focus on appropriate use of antipsychotics, benzodiazepines, and opioids, and these medications are often prescribed on a PRN basis.<sup>8–10</sup> There is potential for undertreatment with PRN medications because residents with reduced capacity to communicate their symptoms may be less likely to be administered PRN or NIMs (eg, analgesics).<sup>3,11</sup> In addition, these residents may be less likely to convey symptoms of adverse drug events linked to PRN or NIMs.<sup>3,12</sup> Conversely, repeated administration of PRN and NIMs may mask signs and symptoms that require medical investigation or may lead to interactions with scheduled medications.<sup>13</sup> PRN and NIMs also contribute to polypharmacy and complex medication regimens.<sup>13,14</sup> Medical practitioners may prescribe specific medications such as sedative-hypnotics, antipsychotics, and analgesics on a PRN basis in an attempt to avoid the harms associated with scheduled administration.<sup>15</sup> For residents prescribed the same medication, both scheduled and PRN, there is the possibility of exceeding the recommended maximum daily dose.

Data on the benefits and harms of PRN and NIMs in residential aged care are limited. A recent Cochrane review compared the effects of PRN vs scheduled medication use for the in-hospital treatment of psychotic and behavioral symptoms secondary to psychotic illness.<sup>15</sup> The review found no evidence from randomized trials to support the use of PRN medication regimens and concluded that current practice is based on health professionals' experience rather than high-quality evidence.<sup>15</sup> A recent qualitative study examined nurses' attitudes toward PRN use of psychotropic medications in mental health settings.<sup>16</sup> The authors concluded that both the reasons for using PRN medications and the rates of PRN administration should be continuously monitored to avoid potentially inappropriate use such as the administration of high doses of antipsychotics.<sup>16</sup>

In Australia, Victorian public-sector RACS conduct audit and feedback of medication use with 4 quarterly indicators (polypharmacy defined as 9 or more scheduled medications, scheduled proton pump inhibitor use, scheduled antipsychotic use, and more than 4 daily scheduled administration times). However, as these indicators are based on scheduled medication use, they do not assess PRN or NIM use. Therefore, further information is required on how PRN medications and NIMs are currently used. The objective of this study was to investigate administration of PRN medications and NIMs in Australian aged care services over a 12-month period.

## Methods

### *Design and Setting*

This was a 12-month longitudinal audit of medication administration for all residents of 10 public-sector RACS in the western region of the state of Victoria, Australia. The western region of Victoria has a

population of approximately 240,000 people. The state of Victoria has approximately 180 public-sector RACS. Our cohort included all 392 residents in 10 participating RACS within the same regional city on the index date of July 1, 2016. Australian RACS are staffed by registered nurses, enrolled nurses (equivalent to licensed practical nurses), and personal care assistants (similar to certified nurse assistants). Personal care assistants with suitable training may administer medications from prepared dose administration aids under the supervision of a registered nurse. Unlike in most private and private not-for-profit RACS where medication is mostly administered by enrolled nurses or personal care assistants, medication administration in Victorian public-sector RACS is predominately undertaken by registered nurses. In Australia, most medications administered to residents of RACS are prescribed by visiting general medical practitioners and dispensed by community pharmacists not directly employed by the health service.<sup>1</sup>

### *Data Collection*

All data were collected retrospectively. All data available in RACS electronic records were extracted (authors BA, TRA, LP) then entered (LP) onto a data collection form using EpiData software version 4.4.2.1 (Odense, Denmark).<sup>17</sup> Data not available electronically such as records of NIM and PRN orders not active on the index date were extracted on site from hard copy medication charts at each participating RACS (LP), or at the health service archives for deceased residents (BA, LP).

### *Measures*

#### *Resident characteristics*

Each resident's year of birth, sex, length of stay (in months) at the index date, and month of death or discharge (if occurred during follow-up) were extracted from electronic records. Data on each resident's medical diagnoses documented before the index date were extracted from the electronic medical record. Diagnoses were collated into 17 comorbidity categories including 11 body systems (eg, cardiovascular, musculoskeletal, respiratory, neurological) and specific conditions common in aged care likely to influence PRN administration (eg, dementia, angina, diabetes, constipation, prior falls, dysphagia). Comorbidity categories were binary and diagnoses were not allotted to more than one category.

#### *Medications Prescribed and Administered*

Data on all medications prescribed for scheduled or PRN administration on July 1, 2016 were extracted from each resident's electronic medical record or hardcopy medication chart and recorded on the data collection form. Electronic medication administration data were included in the electronic medical record. Data on all administrations of PRN and NIMs for each resident for the follow-up period July 1, 2016 to June 30, 2017, or until the resident's date of death or leaving the RACS were extracted. The medication name, strength, and number of administrations each month were collected.

#### *RACS Characteristics*

Data on RACS size (in total number of beds), number of prescribers, and RACS service type (staffed by registered and enrolled nurses and professional care assistants, staffed by registered and enrolled nurses only, only residents with dementia, only residents with mental disorders) were provided by the RACS. These RACS factors were selected because they have been associated with rate of PRN medication use in previous studies.<sup>14</sup>

## Outcome Measures

The primary outcomes were the incidence of PRN and NIM administration over 12 months. Residents were censored at death, leaving the RACS or on June 30, 2017, whichever occurred first.

## Statistical Analysis

Data collected at the index date were analyzed using descriptive statistics including frequencies with proportions, means with standard deviations (SD), and medians with interquartile range (IQR). Descriptive statistics were used to compare residents who were and were not administered specific PRN medications prescribed at the index date. The results of the overall administration rates for all PRNs, and for each medication classes separately, were presented as the number of administrations per resident-month. This was calculated as the number of residents administered the medication class during the overall follow-up divided by the number of follow-up months available for each resident. We also plotted the monthly rates of the 5 most administered PRN medication classes. This was done by dividing the number of residents administered the PRN medication by the number of people alive during that month. We further stratified these plots for selected medication classes (opioids, benzodiazepines, antiemetics, laxatives, antipsychotics, and paracetamol) by death status over the 12-month period to investigate the possible association between specific PRN medications and end-of-life care. Poisson regression models were used to determine predictors of PRN administration rates. The resident and RACS-level predictors included sex, age (<75 years, 75–84 years, and ≥85 years), duration of stay at RACS, dementia diagnosis, number of scheduled medications, number of medication dose times, RACS care type, and number of prescribers. Residents who died during the follow-up were censored at the end of the month of their death. This was a conservative approach because it resulted in longer follow-up time and, therefore, was less likely to overestimate the true rate of PRN administration. The outcome variable was categorized as quartiles of PRN administration. Chi-squared goodness-of-fit tests were used for multivariate models. Based on these tests, the Poisson model fit the data well. Predictors of NIM administration were not investigated due to the low incidence of NIM administration. All analyses were undertaken using SAS 9.4 (SAS Inc., Cary, NC).

## Ethics Statement

This study was approved by the Ballarat Health Services and St John of God Ballarat Hospital Human Research Ethics Committee and Monash University Human Research Ethics Committee.

## Results

### Cohort Description

The 392 residents had a total of 3935 months of follow-up with a median follow-up time per resident of 12 months (IQR 10–12) (Table 1). The median resident age was 84 years (IQR 76–90) and 69% were women. The median duration of stay in the RACS at the index date was 2 years and 5 months. Two residents were discharged and 111 residents died during the follow-up period. Residents had a median of 5 (IQR 4–6) comorbidities and 1 in 3 residents had a documented diagnosis of dementia at the index date.

### RACS Characteristics

Each participating RACS had a capacity of 20 to 60 beds and the number of eligible residents at each RACS ranged from 19 to 55

**Table 1**  
Resident and RACS Characteristics

Resident Characteristics	n (%) or Median (IQR)
Eligible residents	392
Age, y	84 (76–90)
Female	269 (68.6)
Dementia	132 (33.7)
Angina	10 (2.6)
Cardiovascular disease	301 (76.8)
Diabetes	103 (26.3)
Other endocrine condition	53 (13.5)
Cancer and other neoplasms	37 (9.4)
History of falls	140 (35.7)
Respiratory disorder	108 (27.6)
Mental health disorder	214 (54.6)
Neurological disorder	99 (25.3)
Musculoskeletal disorder	235 (60)
Gastrointestinal disorder	126 (32.1)
Genitourinary disorder	227 (57.9)
Eye or ear disorder	133 (33.9)
Skin condition	52 (13.3)
Constipation	21 (5.4)
Swallowing difficulties	27 (6.9)
Number of comorbidity categories	5 (4–6)
Number of scheduled medications*	9 (6–11)
Number of scheduled administration times*	4 (3–5)
PRN medications†	4 (3–6)
Follow-up, mo	
Total	3935
Median	12 (10–12)
Resident status at end of follow-up	
Discharged	2 (0.5)
Deceased	111 (28.3)
Still a resident	279 (71.2)
RACS characteristics	n
N	10
Number of beds	20–60
Eligible residents included	19–55
Staffing	
RN and EN only	6
RN, EN, and PCA	4
Service type	
Dementia only	1
Geriatric mental health only	1
General aged care	8
Number of visiting prescribers	7–25

EN, enrolled nurse; PCA, personal care assistant; RN, registered nurse

\*At the index date July 1, 2016.

†Active prescriptions at the index date.

(Table 1). Four RACS were predominately staffed by registered and enrolled nurses and personal care assistants. The other RACS employed only registered and enrolled nurses. One RACS was only for residents with mental disorders and another RACS was only for residents with dementia. The number of prescribers at each RACS ranged from 7 to 25.

### Prescribing of PRN Medications at the Index Date

The median number of scheduled medications per resident at the index date was 9 (IQR 6–11) and the median number of prescribed PRN medications was 4 (IQR 3–6) (Table 1). Laxatives were the most frequently prescribed PRN medications (59% of residents) and 23% of residents were prescribed ≥2 PRN laxatives at the index date. Prescribing of both scheduled and PRN medications from the same therapeutic class was most frequent for laxatives (32% of residents), paracetamol (19%), and antipsychotics (17%).

### Rates of PRN Medication Administration Over the Follow-Up

Overall, 93% of residents were administered a PRN medication over the follow-up period (Table 2). The mean number of any PRN

**Table 2**  
Number of Residents (n = 392) Prescribed PRN and Scheduled Medications at Index Date and Administrated During the Follow-Up Period, Total Number of Administrations and the Mean Number of Administrations per Person-Month

PRN Class	Number of Residents Prescribed, n (%)	Prescribed $\geq 2$ PRN Medications From the Same Class, n (%)	Prescribed PRN and Scheduled Medications From Same Class, n (%)	Number of Residents Administered, n (%)	Total Number of Administrations, n	Number of Administrations Among Residents Who Were Administered, Median (IQR)	Number of Administrations per Person-month, Mean (SD)
Any PRN	376 (95.9)			364 (92.9)	21,147	32 (13–70.5)	5.85 (8.67)
Paracetamol*	174 (44.4)	10 (2.6)	73 (18.6)	154 (39.3)	1922	7 (2–15)	0.46 (1.11)
Opioid*	118 (30.1)	25 (6.4)	43 (11.0)	166 (42.3)	4720	9 (3–25)	1.54 (4.42)
Morphine injected	34 (8.7)			89 (22.7)	1782	6 (3–15)	0.67 (3.15)
Morphine oral	4 (10.2)			12 (3.1)	324	22.5 (9.5–38)	0.10 (0.71)
Benzodiazepines	81 (20.7)	10 (2.6)	26 (6.6)	130 (33.2)	2446	5.5 (2–16)	0.72 (2.94)
Midazolam	20 (5.1)			66 (16.8)	1119	3 (2–7)	0.38 (2.69)
Antipsychotic	94 (24.0)	6 (1.5)	67 (17.1)	91 (23.2)	1637	9 (4–18)	0.48 (1.57)
Laxative	230 (58.7)	91 (23.2)	126 (32.1)	208 (53.1)	3910	10.5 (3.5–21)	0.96 (1.91)
Beta agonist	82 (20.9)	6 (1.5)	36 (9.2)	65 (16.6)	970	4 (1–12)	0.24 (1.34)
Antacid/PPI	40 (10.2)	1 (0.3)	25 (6.4)	26 (6.6)	317	5 (1–13)	0.07 (0.49)
Antiemetic	135 (34.4)	57 (14.5)	8 (2.0)	104 (26.5)	627	3 (1–7)	0.20 (0.69)
Eye/ear preparation	54 (13.8)	5 (1.3)	21 (5.4)	27 (6.9)	253	7 (2–17)	0.06 (0.29)
Glyceryl trinitrate	47 (12.0)	0	6 (1.5)	14 (3.6)	65	3 (1–3)	0.01 (0.14)
Topical treatment	149 (38.0)	47 (12.0)	26 (6.6)	85 (21.7)	1705	5 (1–22)	0.42 (1.94)
Urinary alkalinizer	8 (2.0)	0	0	5 (1.3)	50	3 (2–7)	0.01 (0.16)
Other	148 (37.8)	41 (10.5)	139 (35.5)	109 (27.8)	1374	5 (2–12)	0.37 (1.21)
Insulin	16 (4.1)	0	16 (4.1)	20 (5.1)	928	18 (3.5–46.5)	0.25 (2.10)
Paracetamol and codeine	20 (5.1)	0	2 (0.5)	16 (4.1)	223	3.5 (2–5)	0.05 (0.68)

PPI, proton pump inhibitor.

\*Includes paracetamol and codeine combination products when assessed baseline prescribing only.

administrations was 5.85 per person-month of follow-up. The most frequently administered medication classes were opioids (mean 1.54 administrations per person-month), laxatives (0.96 per person-month), benzodiazepines (0.72 per person-month), antipsychotics (0.48 per person-month), paracetamol (0.46 per person-month), and topical preparations (0.42 per person-month). Of the total PRN opioid administrations, morphine was injected (mostly subcutaneously) at on average 0.67 occasions per person-month.

Of residents prescribed a PRN opioid or benzodiazepine at the index date, 76% and 77% were administered the medication on 1 or more occasions over the follow-up. Of residents prescribed a PRN antipsychotic at the index date, 68% were administered the medication over the follow-up. The characteristics of residents administered

vs not administered a prescribed PRN opioid, benzodiazepine, or antipsychotic are reported in Table 3.

Monthly administration rates of the most frequently administered medication classes (opioids, laxatives, antipsychotics paracetamol, and benzodiazepines) did not vary over the 12-month period (Figure 1).

#### Predictors of PRN Administration

RACS factors including staffing and number of prescribers did not predict higher administration of PRN medications; however, there was a wide variation in PRN administration rates across the 10 RACS. The mean number of PRN administrations per person-month ranged from

**Table 3**  
Characteristics of Residents Prescribed a PRN Opioid, Benzodiazepine, or Antipsychotic and whether a Medication From that Class Was Administered Over the 12-month Period, median (IQR) or n (%)

Characteristics	Opioid (n = 118)		Benzodiazepine (n = 81)		Antipsychotic (n = 94)	
	Administered	Not Administered	Administered	Not Administered	Administered	Not Administered
n	90	28	62	19	64	30
Age, y						
<75	16 (17.8)	3 (10.7)	17 (27.4)	4 (21.1)	13 (20.3)	6 (20.0)
75–84	32 (35.6)	16 (57.1)	17 (27.4)	5 (26.3)	24 (37.5)	7 (23.3)
$\geq 85$	42 (47.7)	9 (32.1)	28 (45.2)	10 (52.6)	27 (42.2)	17 (56.7)
Sex (female)	68 (75.6)	13 (46.4)	48 (77.4)	11 (57.9)	41 (64.1)	20 (66.7)
Months in care in 6-month increases	20 (10.5–35)	25 (11–56)	14.5 (7–25)	31.5 (15–50)	14 (6–31)	21.5 (14–29)
Dementia	21 (23.3)	12 (42.9)	22 (35.5)	8 (42.1)	37 (57.8)	27 (90.0)
Number of regular medications	9 (7–12)	8.5 (5–10.5)	8 (6–10)	8 (4–9)	8 (5.5–10)	8 (5–9)
Number of dose times	4 (3–5)	3 (3–5)	4 (2–5)	3 (2–5)	4 (3–5)	4 (2–5)
Facility care type						
Staffed by RN, EN and PCA	19 (21.1)	12 (42.3)	14 (22.6)	4 (21.1)	6 (9.4)	4 (13.3)
Staffed by RN and EN only	65 (72.2)	13 (46.4)	43 (69.4)	11 (57.9)	39 (60.9)	16 (53.3)
Only residents with dementia	5 (5.6)	3 (10.7)	4 (6.5)	2 (10.5)	14 (21.9)	6 (20.0)
Only residents with mental health disorders	1 (1.1)	0	1 (1.6)	2 (10.5)	5 (7.8)	4 (13.3)
Number of prescribers per bed	0.42 (0.30–0.42)	0.42 (0.30–0.46)	0.42 (0.30–0.43)	0.35 (0.20–0.42)	0.36 (0.30–0.50)	0.40 (0.30–0.50)
Number of comorbidities	5 (4–6)	5 (5–6)	5 (4–6)	5 (4–7)	5 (4–6.5)	5 (4–6)

EN, enrolled nurse; IQR, interquartile range; PCA, personal care assistant; RN, registered nurse

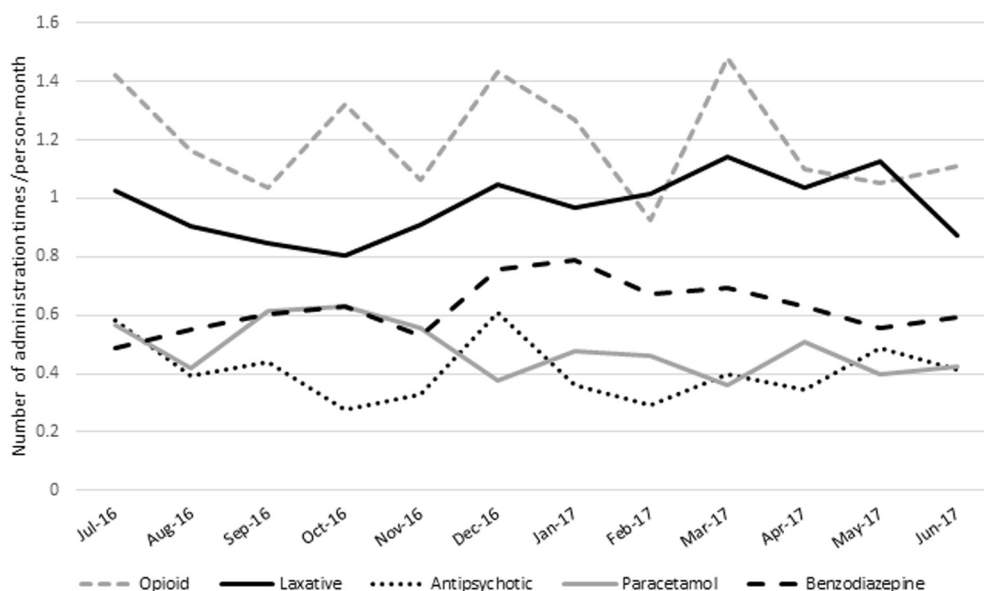


Fig. 1. Monthly rates of PRN administration for the 5 most frequently administered medication classes.

2.8 (SD 4.0) to 10.1 (SD 11.2) (Supplemental Figure 1). Resident sex, age, months in RACS, dementia status, number of scheduled medications, and number of daily doses did not predict administration of PRN medications (Supplemental Table 1). However, the mean total number of PRN administrations per person-month among those residents who died during follow-up was 8.0 (SD 8.8) and among those who survived was 5.0 (SD 8.5). Opioids, benzodiazepines, and antiemetics were more frequently administered among residents who died during the follow-up period (Figure 2).

#### Administration of NIMs

Data on NIMs were available for 386 of the 392 residents. In total, 158 (41%) residents were administered a NIM over the follow-up with an average of 0.16 administrations per person-month. The most frequently administered NIMs were laxatives, analgesics, and antacids. Laxatives were administered to 86 (22%), analgesics to 56 (15%), and antacids to 43 (11%) residents. There were 182 laxative, 196 analgesic, and 96 antacid administrations over the follow-up. The mean number of laxative administrations was 0.05 per person-month, analgesic administrations 0.07 per person-month, and antacid administrations 0.02 per person-month. Other medication classes were administered to  $\leq 5$  ( $\leq 1\%$ ) residents over the follow-up.

#### Discussion

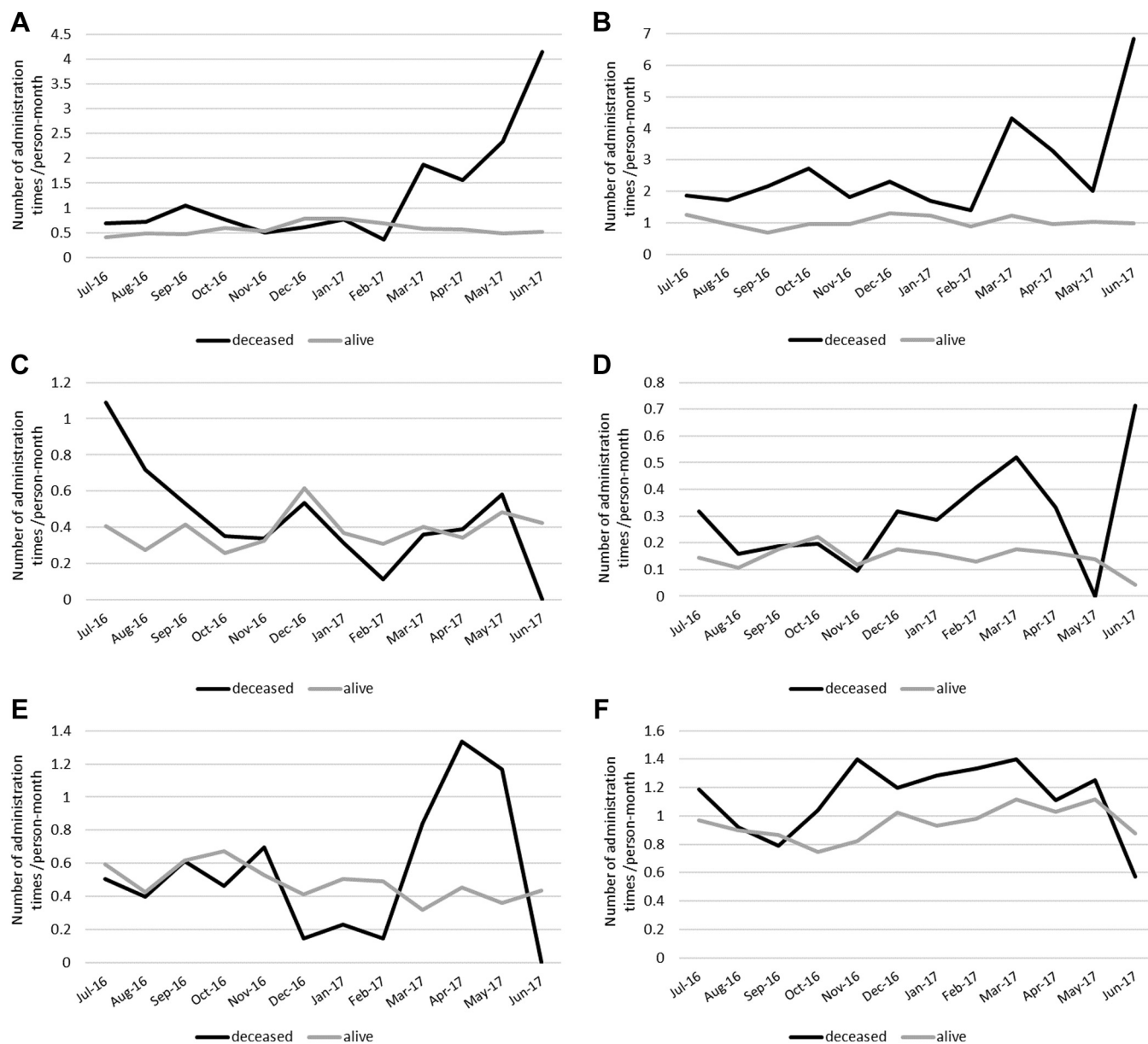
The main finding of this study was that 96% of all residents were prescribed and 93% of all residents were administered a PRN medication over a median follow-up of 12 months. Overall, 41% of all residents were also administered an NIM. The proportion of residents administered PRN medications was considerably higher than in previous Australian and international studies in which the proportion of residents administered PRNs has ranged from 28% to 55%.<sup>14</sup> However, the follow-up time in our study was longer than in most previous studies, in which follow-up times have ranged from 1 week to 7 months.

Similar to previous studies, laxatives, analgesics, and benzodiazepines were the most frequently administered PRN medications.<sup>14</sup> The frequent PRN administration of laxatives, analgesics, and benzodiazepines suggests the need for ongoing review to ensure clinical appropriateness. The Australian Government-funded Residential

Medication Management Review program, delivered collaboratively by general medical practitioners and pharmacists, provides a mechanism for clinical review of PRN medication prescribing.<sup>18</sup> Although our study did not assess whether residents were under- or over-treated, opioids and benzodiazepines are high-risk medications often implicated in medication errors<sup>19</sup> and adverse events.<sup>20</sup> Unlike previous studies, sex and dementia diagnosis were not associated with PRN administration rates.<sup>14</sup> This is encouraging from a resident care perspective, because anecdotal concerns have been raised that people with dementia who are less able to express their symptoms may be less likely to receive PRN symptom management.<sup>21</sup>

Analgesic use accounted for the largest proportion of all PRN administrations. More than 40% of residents were administered an opioid and almost 40% were administered paracetamol on a PRN basis during follow-up. One in 5 residents had paracetamol prescribed as both a scheduled and a PRN medication at the index date. These charts were often annotated with warnings not to exceed the maximum total daily dose. Injectable morphine accounted for a large proportion of all PRN opioid administrations. More than 50% of people who used PRN opioids were administered injectable morphine at an overall rate of 0.45 occasions per person-month. Although injectable morphine may be required if a resident is receiving palliative care,<sup>22</sup> immediate-release liquid formulations are generally preferred for episodic or breakthrough pain and for residents unable to swallow tablets.<sup>23,24</sup> It is unclear whether injectable forms were administered because other more suitable formulations were not prescribed. In total, 11% of residents had scheduled and PRN opioid orders prescribed at the index date. Breakthrough pain can occur despite regular analgesia and therefore PRN administration of analgesia may be required.<sup>25</sup> Although this is common practice, there is currently limited evidence evaluating the safety for this practice in RACS.<sup>13</sup> Conversely, only 7% of residents were prescribed PRN opioids at the index date but not administered during the follow-up. This may reflect changing requirements for analgesia over time and the importance of regular review of PRN orders. There was evidence of higher rates of PRN opioid, benzodiazepine, and antiemetic administration among residents who died during the follow-up, suggesting that some PRN administration may have been linked to end-of-life care.

We found that 33% of residents were administered PRN benzodiazepines and 23% were administered PRN antipsychotics during the follow-up. These rates may partly reflect the fact that our



**Fig. 2.** Monthly rates of PRN administration for selected medication classes stratified by death status over the 12-month period (A) benzodiazepines, (B) opioids, (C) antipsychotics, (D) antiemetics, (E) paracetamol, (F) laxatives.

sample included 1 RACS that admitted only residents with mental health disorders and another RACS in which only residents with dementia were admitted. However, harms related to PRN benzodiazepines and antipsychotics have been reported,<sup>26,27</sup> and the high rate of administration highlights the need for regular review to ensure ongoing safe and appropriate use. Encouragingly, it was rare for residents to be prescribed both scheduled and PRN benzodiazepines (6%). One (17%) in 6 residents was prescribed both scheduled and PRN antipsychotics. A cross-sectional study by Allers et al.<sup>26</sup> found that residents with dementia were 3.5 times more likely to receive antipsychotics than those without dementia. Although we did not investigate the association of specific medication classes, dementia was not associated with higher overall rates of PRN administration.

RACS-related factors including service care type (staffing mix) and number of prescribers were not associated with PRN administration. However, there was a threefold variation in rate of PRN administration

per resident-month across the 10 RACS. This was consistent with an Australian cross-sectional study by Stokes et al.<sup>7</sup> that suggested that the key determinant of PRN medication orders was the specific RACS in which a resident lived. Interestingly, this variation in PRN administration rate across the 10 RACS did not appear to be explained by differences in key resident characteristics. We found that resident age, sex, dementia diagnosis, and duration of stay did not predict PRN administration rate. This finding is contrary to previous studies<sup>14</sup> that have found that older age was associated with higher use of PRN medications.

Even though 41% of residents were administered an NIM, the frequency of administration was low and mostly limited to laxatives and analgesics. This is consistent with medications typically approved for nurse initiation.<sup>4</sup> With such low use, the need for NIM protocols could be questioned; however, NIM protocols facilitate timely treatment of minor ailments for residents. Appropriate documentation and ongoing review of NIM is required to ensure quality use and

compliance with relevant legislation and regulations.<sup>4</sup> Given that 22% of topical PRN medications prescribed at the index date were not administered, there may be scope to include some of these medications on the NIM list for the purpose of reducing the length of PRN medication charts.

### Strengths and Limitations

We analyzed data on all actual administrations rather than only prescribing of PRN and NIMs over a long follow-up. This is important because previous research has demonstrated infrequent administration of PRN and NIMs, even when listed on the medication chart.<sup>14</sup> In addition, the longitudinal nature of the study accounted for changes in PRN administration over the follow-up time. Another strength was that we analyzed both PRN and NIMs. Our study was one of the first to comprehensively explore the use of NIMs in Australian RACS over time. However, we did not directly assess the clinical appropriateness of PRN and NIMs for specific residents, nor whether the use of these medications resulted in successful resolution of signs and symptoms. For this reason, we could not determine whether residents were under- or overtreated. Our study was conducted in public-sector RACS where medication administration is often undertaken by registered nurses. This may limit the generalizability of the results to private not-for-profit and private for-profit RACS where medication administration is often undertaken by enrolled nurses or care workers. The participating RACS were in a regional area, and though all Australian Government-subsidized RACS must adhere to the same Commonwealth Aged Care Quality Standards, the results may not be generalizable to metropolitan settings.

### Conclusions and Implications

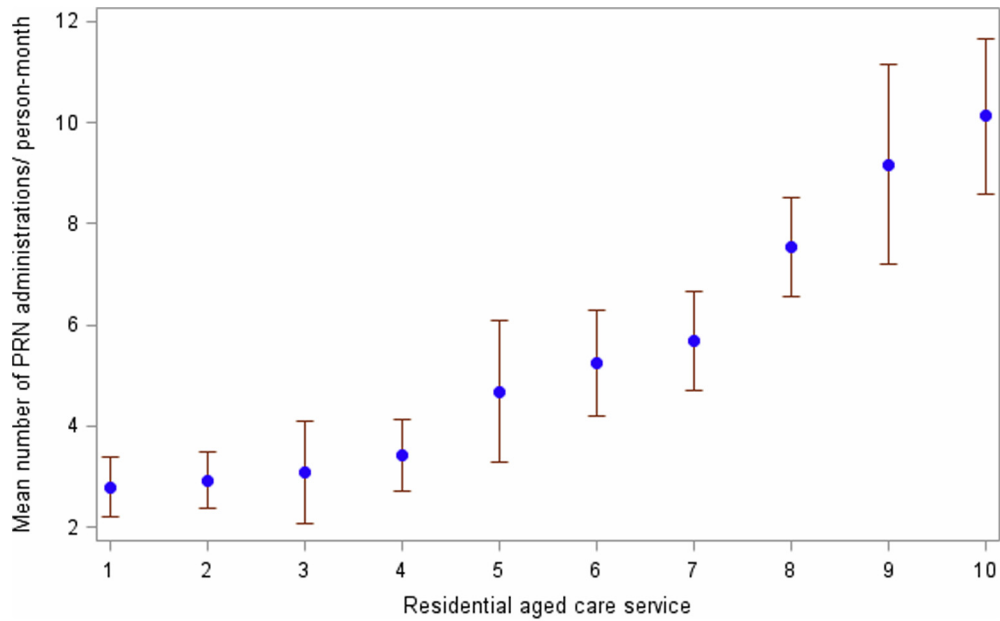
Most residents were administered PRN medications and 41% were administered NIMs. Administration was in line with the Australian regulations and institutional protocols. However, the high frequency of PRN analgesic, laxative, and psychotropic medication administration highlights the need for regular clinical review to ensure ongoing safe and appropriate use.

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**Supplemental Figure 1.** Mean number of PRN administrations per person-month in each of the 10 RACS.

### Supplemental Table 1

Predictors of PRN Use Over the 12-month Follow-up (1<sup>st</sup> Quartile, <9 Administrations, is the Reference Group)

Predictors	2 <sup>nd</sup> Quartile (9–28 Administrations)	3 <sup>rd</sup> Quartile (29–64 Administrations)	4 <sup>th</sup> Quartile (>64 Administrations)
	RR (95% CI)	RR (95% CI)	RR (95% CI)
Male sex	0.86 (0.66–1.13)	0.99 (0.76–1.30)	0.92 (0.69–1.24)
Age, y			
<75	Reference	Reference	Reference
75–84	1.25 (0.88–1.77)	1.14 (0.81–1.60)	1.09 (0.79–1.52)
≥85	1.36 (0.98–1.90)	1.27 (0.91–1.77)	1.21 (0.88–1.68)
Months in care (6-month increases)	1.00 (0.997–1.003)	1.00 (0.997–1.003)	1.00 (0.997–1.003)
Dementia diagnosis	0.80 (0.60–1.06)	0.95 (0.73–1.24)	0.88 (0.66–1.18)
Number of scheduled medications	0.99 (0.95–1.03)	1.00 (0.96–1.04)	1.00 (0.97–1.03)
Number of daily dose times	1.05 (0.95–1.17)	1.00 (0.90–1.11)	1.03 (0.94–1.12)
Facility care type			
Staffed by RN, EN, and PCA	Reference	Reference	Reference
Staffed by RN and EN only	1.39 (0.89–2.16)	1.08 (0.54–2.14)	1.39 (0.98–1.97)
Only residents with dementia	1.82 (0.65–5.08)	1.22 (0.80–1.84)	1.67 (0.77–3.64)
Only residents with mental health disorders	0.84 (0.41–1.75)	0.93 (0.53–1.61)	0.88 (0.45–1.74)
Number of prescribers per bed			
<0.35	Reference	Reference	Reference
0.35–0.49	0.95 (0.60–1.51)	1.22 (0.80–1.84)	1.02 (0.70–1.49)
>0.5	0.94 (0.40–2.23)	0.93 (0.53–1.61)	0.94 (0.62–1.42)

CI, confidence interval; EN, enrolled nurse; PCA, personal care assistant; RN, registered nurse; RR, rate ratio.