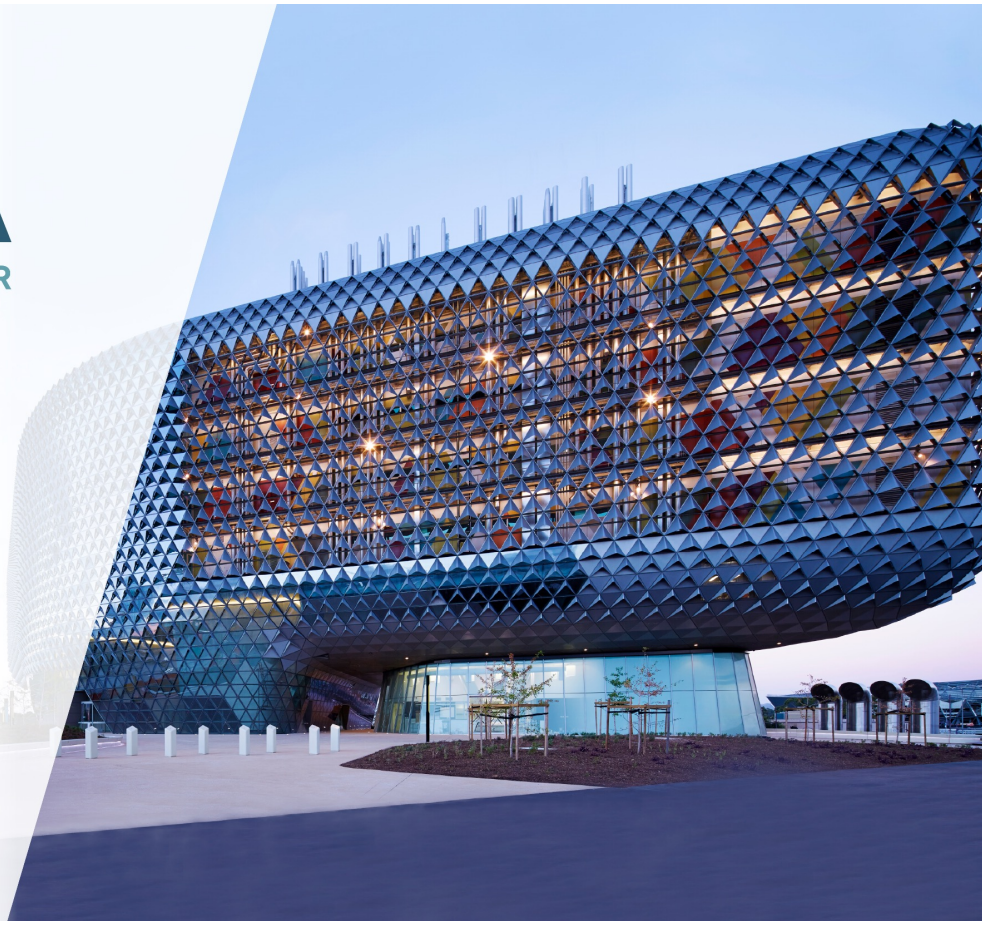
ROSA
REGISTRY OF SENIOR AUSTRALIANS



Oral Health and Dental-Related Health Service and Medication Utilisation in Residents of Aged Care Facilities

Gillian E. Caughey, Tracy Air and Maria C. Inacio for the South Australian Oral Health Plan Older Person's Working Group.

South Australian Oral Health Plan Older Person's Working Group: Angelo Papageorgiou, Jenny Richter, Jasmine Bulman, Tim Budden, Janet Weeks, Lynda van Adrighem, Christine Morris, Bernard Morrison, Peter Rodda, Lauren Civetta, Trudy Ying Hua Lin.

Registry of Senior Australians (ROSA), South Australian Health and Medical Research Institute (SAHMRI)

August 4th, 2023

SAHMRI South Australian Health & Medical Research Institute

Suggested Citation

Caughey GE, Air T and Inacio MC for the South Australian Oral Health Plan Older Person's Working Group. Oral Health-Related Health Service and Medication Utilisation in Residents of Aged Care Facilities. Registry of Senior Australians, South Australian Health and Medical Research Institute. 2023

Acknowledgements

This work was supported by The Hospital Research Foundation (2023-S-RETRO-012-83100).

We would like to acknowledge the Registry of Senior Australians' (ROSA) Steering Committee, Consumer and Community Advisory Committee, Aboriginal and Torres Strait Islander Advisory Committee and the ROSA South Australian Health and Medical Research Institute (SAHMRI) Research Team for ensuring the success of the ROSA which allowed for the successful completion of this report. We also acknowledge the South Australian Government Department for Innovation and Skills (2017-2021) who provided us with support to establish ROSA, the Australian Government Medical Research Future Fund (2021-2024, PHRDI000009), and ROSA collaborating partners (SAHMRI, ECH Inc, Silver Chain, Life Care) for its ongoing support, and the Australian Institute of Health and Welfare (AIHW) for the linkage and construction of input data, SA Health, NSW Ministry of Health and VIC Department of Health for the provision of the state-based admitted and emergency department data used in the ROSA with linkage via the AIHW, SA NT DataLink, Centre for Health Record Linkage and the Centre for Victorian Data Linkage.

Executive Summary

- **Objective:** This report includes the examination of the burden of oral health and dental-related complications on health service utilisation and medication use by residents of residential aged care facilities (RACFs) in Australia.

- **The known:**
    - Australia subsidises aged care services for 1.5 million older Australians yearly. Of these individuals, 246,732 receive care in RACFs yearly.
    - The delivery of high-quality care for older Australians in RACFs, has been a well-documented national challenge.
    - Oral health care is widely acknowledged to be inadequate for residents of RACFs and its effects associated with further health impacts on vulnerable individuals (e.g., cardiovascular disease, cognitive decline and pneumonia).
    - The Royal Commission into Aged Care Quality and Safety Final Report (2021) specifically recommended improved access to an oral health practitioners in residential care (recommendation #38), a national Senior Dental Benefits Scheme to fund services (recommendation #60), and an amendment to the Quality of Care Principles to ensure that dental / oral health care are included (recommendation #69).
    - While several Australian Government Aged Care Reforms are currently underway, no major government actions to improve dental or oral health care for RACF residents have been announced.

- **The new:**
    - In this population-based study of over 360,000 older Australians in 2800 RACFs between 2016/17 and 2019/20 we found that one in five residents were identified as having oral health care needs at the aged care assessment upon entering residential aged care, which includes tooth loss, dental cavities, periodontal disease and gingivitis.
    - Overall there is a very low utilisation of oral / dental-related health services, including dental practitioner MBS subsidised health services

(<0.2% of residents) or medications prescribed by dentists (<2.0% of residents).
    - Over the study period between 0.87-0.93% of residents were hospitalised annually with a dental-related primary or secondary diagnoses (or 8.7-9.3 hospitalisations / 1000 residents), with higher rates in residents with diabetes or those assessed as having oral health care needs.
    - Extrapolation of these rates to the **entire Australian residential aged care population for 2018/19, equates to 1916 residents nationally having a dental-related hospitalisation** (public hospitalisations only).

- **Conclusion:** It is evident that current models of care and service delivery in residential aged care are **inadequate and not meeting resident's oral health care needs**, with as many as **9.3/1000 residents experiencing a dental-related hospitalisation.** Urgent policy and practice changes are required and are imperative if we are to improve the health and wellbeing of Australia's residential aged care population.

Abbreviations

ACAT	Aged Care Assessment Team
ACAP	Aged Care Assessment Program
AIHW	Australian Institute of Health and Welfare
AR-DRG	Australian Refined Diagnosis Related Groups
ASGS	Australian Statistical Geography Standard
ATC	Anatomical Therapeutic Chemical Classification System
CI	Confidence interval
DVA	Department of Veterans' Affairs
ED	Emergency Department
IQR	Interquartile range
ICD-10AM	International Statistical Classification of Disease and Related Health Problems, Tenth Revision, Australian Modification
NDI	National Death Index
MBS	Medicare Benefits Schedule
NSAF	National Screening Assessment Form (from March 2016)
PBS	Pharmaceutical Benefits Scheme
RACF	Residential aged care facility
ROSA	Registry of Senior Australians
SEIFA	Socio-Economic Indexes for Areas

Table of Contents

1. Background

Australia subsidises aged care services for 1.5 million older Australians yearly. Of these individuals, 246,732 (1% of the general Australian population of 25.7 million) receive care in residential aged care facilities (RACFs) yearly. The delivery of high-quality care for older Australians in the aged care sector, especially in RACFs, has been a well-documented national challenge. In the last 20 years, there has been more than 20 investigations into the quality of care provided to older people, ultimately leading to the Royal Commission into Aged Care Quality and Safety (2018-21) and subsequent Aged Care Reforms as response by the Australian Government to overhaul the sector.[1,2]

People living in RACFs need access to quality health care to maintain and manage their complex health profiles. This includes oral health, which is widely acknowledged to be inadequate. Between 20-75% have untreated dental decay, 53% periodontal disease and 19% complete tooth loss.[3,4] Importantly, poor oral health is associated with an increased risk of systemic disease including cardiovascular disease, cognitive decline and pneumonia.[5]

While a moderate increase in the use of general practitioner chronic disease management plans and geriatric medicine services has been observed by older people in RACFs between 2012-13 and 2016-17, the use of these key services was still poorly utilised with only 7 in 20 and 1 out of 20 residents accessing them, respectively.[6] We have previously shown there is a lack of preventive and care planning/management by primary and allied health care providers for residents of RACFs, likely influencing the increasing utilisation of after-hours services in RACFs, which is more common in this setting than in the general population.[6] Lack of access to dental, oral health care and allied health is pervasive in RACF settings. The barriers to dental, oral health care and allied health access (e.g. funding models, limited number of subsidised services, workforce) are well recognised,[7,8] with the impacts highlighted in the Final Report of the Royal Commission.[1]

Recommendations in the Royal Commission's Final Report specifically recommended improved access to an oral health practitioner in residential aged care (recommendation #38), establish a Senior Dental Benefits Scheme to fund dental services (recommendation #60), and amend the Quality of Care Principles to ensure that dental / oral health care are included within the role and responsibilities of aged care providers (recommendation #69).[1] While several Australian Government Aged Care Reforms are currently underway,[9-11] no major government actions to improve dental or oral health care for RACF residents have been announced, an area of recognised neglect in this setting.[1]

To further support the need for improved access to oral health and dental services in residential aged care, this study aims to examine the burden of oral health and dental-related complications on health service utilisation and medication use by residents of residential aged care facilities in Australia.

2. Research Methods

2.1 STUDY DESIGN AND DATA SOURCE

A retrospective repeated cross-sectional study was undertaken using data from the National Historical cohort of the Registry of Senior Australians (ROSA).[12] ROSA is a de-identified linked data platform containing datasets from the Australian Institute of Health and Welfare's National Aged Care Data Clearinghouse, Australian Government Medicare Benefits Schedule (MBS) and Pharmaceutical Benefits Scheme (PBS), and state health authorities' hospitalisation records.[12] It includes linked aged care and healthcare utilisation data for older individuals assessed for and/or accessed government-subsidised aged care services from 2002 onwards. In this study, the following datasets were used: Residential Aged Care Episodes, National Death Index, Aged Care Funding Instrument[13] ([ACFI], entry into residential care assessment) and the Aged Care Assessment Program[14] ([ACAP], aged care eligibility assessment), MBS subsidised health services,[15] PBS subsidised medications,[16] South Australia (SA), New South Wales (NSW), and Victoria (VIC) hospitalisations (i.e., admission / discharge dates and primary and secondary diagnoses coded using International Classification of Diseases, 10th revision, Australian modification[17] [ICD-10AM]).

This study has ethics approval from the University of South Australia (Ref: 200489) and AIHW (Ref: EO2018/1/418) Human Research Ethics Committees.

2.2 STUDY COHORT

All non-Indigenous residents of aged care facilities aged ≥65 between July 1, 2016 and June 30, 2020 in Australia were included. Individuals accessing health care services subsidised by the Australian Government Department of Veterans' Affairs (DVA) were excluded as these individuals receive and utilise MBS subsidised health care services and PBS differently than others.[18] For hospitalisation specific analysis, only individuals who were in SA, NSW, and VIC were included, due to availability of these datasets within the ROSA Historical Cohort. For dental service (MBS) and medication (PBS) utilisation analyses national data were used.

2.3 HEALTH SERVICE AND MEDICATION UTILISATION

2.3.1 Oral / dental-related hospitalisations

Seven oral / dental-related hospitalisations outcomes were examined. Potential preventable hospitalisations (examining primary diagnosis only, and primary or secondary diagnoses) and potentially preventable emergency department (ED) presentations are defined as hospitalisations for dental conditions that may not be preventable, but theoretically would not result in hospitalisation if adequate and timely (non-hospital) care was provided.[19] Other hospitalisations examined included hospitalisations for dental procedures requiring anesthesia (dental care under general anaesthesia due to severity of disease or other medical, physical or behavioural complications carries additional risk and is resource intensive),[19] for dental extractions and restorations,[20] for oral and dental disorders,[20] for pneumonia with an associated dental diagnosis, and for sepsis with an associated dental diagnosis. We also calculated any dental-related hospitalisation, defined as a hospitalisation that included a primary or secondary dental-related diagnoses (using codes included in the hospitalisations described above). Shown in **Supplement 1 Tables S1-S7** are the definitions, codes and data sources used. Hospitalisation outcomes include public hospital encounters in SA, NSW, and VIC, as SA data lacks private hospitalisation data.

2.3.2 Dental health service (MBS) utilisation

MBS subsidised dental practitioner health services examined included provision of dental services in a residential aged care facility (MBS Group O1, items 51700 and 51703, for coding details see **Supplement 2 Table S8**).

2.3.3 Medication (PBS) utilisation

Within Australia's PBS there are specific medications that can be prescribed by a dental practitioner with unique PBS item codes. We examined the dispensing of these dental practitioner specific medications and dispensing of the same medications (i.e., same formulation, strength and pack size) when prescribed by other medical practitioners, including nurse practitioner (**Supplement 3 Tables S9-**

S15). Medications that were specifically indicated for palliative care were excluded. Examples of classes of medicines included stomatological preparations (Anatomical Therapeutic Chemical [ATC] Classification System code A01*), antibacterials for systemic use (ATC code J01*), anti-inflammatory and antirheumatic products (ATC code M01*), analgesics (ATC code N02*), and psycholeptics (ATC code N05*). We also examined additional medicines that may be dispensed for oral conditions that may be related to poor dental/oral care (miconazole [D01AC], nyastatin [A01AB], fluconazole [J02AC]).

2.4 COVARIATES

Covariates included age (major age-groups <80, 80-89, ≥90 years old), sex, state, rurality (major city, inner regional, outer regional, remote and very remote), socio-economic index for areas (SEIFA) of Relative Socio-Economic Disadvantage (IRSD)[17], number of health conditions (from Rx-Risk pharmaceutical based comorbidity index[21]), and specific conditions that may associated with poor dental / oral health outcomes.[22] These include dementia, diabetes, chronic respiratory disease, cardiovascular disease, obesity, malnutrition/weight loss, chronic kidney disease and aspiration pneumonia, that were identified from Rx-Risk,[21] entry into aged care[13] or aged care eligibility assessments[14] health conditions, hospitalisation (inpatient) ICD-10AM codes or Elixhauser comorbidity index (based on ICD-10AM hospitalisation data).[23] Shown in **Supplement 4 Table S16** is a detailed summary of the covariates included, their definitions, codes, data sources and time frames used in the analyses.

Specific care needs that may impact on dental / oral health were identified from the assessment at entry to residential aged care.[13] These include: ACFI Q1 nutrition / eating (category D, requiring physical assistance with readiness to eat and eating), Q2 mobility (category D, mechanical lifting for transfers or requiring physical assistance for transfers and locomotion), Q6 cognitive skills (category D, severe cognitive impairment) and Q12 complex health care needs (R6, special feeding or R17, management ongoing tube feeding). Additionally, presence of a feeding tube

was also identified from MBS procedure codes (30481, 30482, 30483, 31456, 31458, 31460).

From 2017/18 onwards a new aged care eligibility assessment tool was introduced in Australian (National Screening and Assessment Form [NSAF]). This new assessment form collected information on a health category 'physical domain-personal health-oral health concerns' that includes: any oral health concerns such as problems with teeth, mouth or dentures, including tooth loss, dental cavities, periodontal disease and gingivitis, which were examined in this report as well.

2.5 ANALYSIS

Analyses were conducted for RACF residents nationally and RACF residents from NSW, VIC, and SA (~70% of RACF residents nationally) when examining hospitalisation / ED presentations due to data availability. Unlike NSW and VIC, SA does not have private hospital data available for analyses, therefore the main analyses were conducted using public hospital data only. A sensitivity analysis using public and private hospitalisation information from NSW and VIC was also conducted (see details below).

Descriptive statistics (frequencies, proportions, medians and interquartile ranges [IQR]) described the study cohort. Overall (2016/17-2019/20) and financial year, crude and age and sex direct standardised (reference year 2017/18 financial year) cumulative incidence and 95% confidence intervals (CI) of oral / dental hospitalisations, dental practitioner health service (MBS) usage, and medications dispensing (PBS) were estimated. Results were also calculated as age and sex standardised rate per 1000 residents.

Median length of stay (days) and IQRs were calculated for hospitalisations with an overnight admission, from date of admission to date of discharge.

Analyses were stratified by major age groups, sex, presence of dementia, state and rurality (major city vs regional/remote). Additional stratification of analyses for

selected outcomes included presence of diabetes and oral health concerns, identified from the NSAF from 2017/18 onwards.

Sensitivity Analysis

A sensitivity analysis was conducted using data from public and private hospitalisations using NSW and VIC data for hospitalisation outcomes compared to public hospitalisations only from NSW and VIC.

3. Results

3.1 CHARACTERISTICS OF THE STUDY COHORT

A total of 360,305 individuals received permanent residential care from 2830 RACFs throughout the country (including all states) between July 1 2016 and June 30 2020 (**Table 1**). There was a small increase in the number of individuals in residential aged care over the study period from 198,734 in 2016/17 to 210,590 in 2019/20. The median age was 85 years old (IQR 80-90) and 62.9% (N=226,490) were female. Median follow-up time for individuals in this cohort was 499 days (IQR 188-1002) and 54.5% (N=196,406) died by the end of the study period.

The median number of health conditions individuals had at cohort entry was 5 (IQR 3-7). Cardiovascular disease was the most common condition (75.4%, N=271718) and over half 53.4% (N=192310) were living with dementia. The prevalence of other conditions that maybe associated with poor oral health outcomes included diabetes (20.5%, N=73971) and chronic respiratory disease (N=22.1%, N=79494) (**Table 1**).

Examination of care needs that could potentially impact oral health care, included 16.3% (N=58977) having the highest level of care needs for nutrition, which requires physical assistance for all aspect of eating, and 58.2% (N=210049) requiring physical assistance with transfers and locomotion. Almost 1% (N=2873) of residents needed special feeding daily by a registered nurse on a one-to-one basis, or by a feeding tube. In a subgroup of the cohort from 2017/18 onwards (N=137713), nearly 20% (19.6%, N=26842) were assessed as having oral health concerns (e.g., pain when eating, gum disease, loose fitting dentures) when their aged care eligibility assessment was conducted (**Table 1**).

The majority (63%) of residential aged care facilities were in a major city (N=1784) and 34.8% (N=986) in a regional area and 1.7% (N=27) in a remote/very remote area. Non-profit ownership was the most common (57.4%, N=1623), followed by for-profit (34.1%, N=965) and government-run facilities (8.6% N=242) (**Table 1**).

Table 1. Characteristics of residents and residential aged care facilities in Australia, 2016/17 to 2019/20.

Resident Characteristics	**N (%)** N=360,305
Age (median, IQR)	85 (80-90)
Female, N (%)	226490 (62.9)
Residents per study year, N	
2016-2017	198734
2017-2018	202879
2018-2019	206001
2019-2020	210590
SEIFA IRSD[a]	
1 – Most disadvantage	65169 (18.1)
2	68347 (19.0)
3	69815 (19.4)
4	64848 (18.0)
5 – Least disadvantage	82891 (23.0)
Follow up time, days (median, IQR) (from cohort entry)	499 (188-1002)
Deceased by 30 June 2020	196406 (54.5)
Number of health conditions, Rx-Risk (median, IQR)[b]	5 (3-7)
Specific health conditions	
Cardiovascular disease	271718 (75.4)
Dementia	192310 (53.4)
Chronic respiratory disease	79494 (22.1)
Diabetes	73971 (20.5)
Chronic kidney disease	18011 (13.0)
Weight loss/malnutrition	27483 (7.6)
Obesity[+]	5744 (4.1)
Aspiration pneumonia[+]	1097 (0.8)
Care Needs[c]	
Nutrition / eating (highest care needs)	58977 (16.3)
Mobility limitations (highest mobility limitation)	210049 (58.2)
Cognitive impairment (severe impairment)	90135 (25.0)
Complex care – special feeding/tube feeding	2873 (0.8)
Oral health concerns (NSAF 2017/18-2019/20)[‡]	26842 (19.6)
Facility Characteristics	N=2830
State	
NSW	920 (32.5)
VIC	797(28.2)
QLD	488 (17.2)
SA	256 (9.1)
WA	255 (9.0)
TAS	76 (2.7)
ACT	27 (1.0)
NT	11 (0.4)
Rurality[d]	
Major City	1784 (63.0)
Inner Regional	662 (23.4)
Outer Regional	324 (11.4)
Remote / Very remote	48 (1.7)
Ownership	
For profit	965 (34.1)
Non-profit	1623 (57.4)
Government	242 (8.6)

Missing data: [a] N=9235 (2.6%); [b] N=5326 (1.48%); [c] N=2568 (0.7%); [d] N=12 (0.4%). [+]Derived from NSW, SA, VIC hospitalisation data N=138787; [‡]Derived from NSAF N=137113. Abbreviations: IQR, interquartile range; SEIFA IRSD, Socio-Economic Indexes for Areas Index of Relative Socio-economic Disadvantage; NSAF, National Screening and Assessment Form; SA, South Australia; NSW, New South Wales; VIC, Victoria; QLD, Queensland; TAS, Tasmania; WA, Western Australia; NT, Northern Territory; ACT, Australian Capital Territory.

3.2 HEALTH SERVICE AND MEDICATION UTILISATION

3.2.1 Oral / dental-related hospitalisations

Shown in **Table 2** is the age and sex adjusted cumulative incidence of oral / dental related public hospitalisations for the overall study cohort and by study year. Crude cumulative incidence is shown in **Supplement 5, Table S17**. Over the study period 0.15% (95% CI 0.14-0.17) of residents had a potentially preventable dental-related hospitalisation as the primary diagnosis, with a median length of stay of 2 days (IQR 1-5) and 0.47% (95% CI 0.44-0.50) had a potentially preventable dental-related hospitalisation as either the primary or secondary diagnosis, with a median length of stay of 6 days (IQR 3-13). The incidence and length of stay for these hospitalisations over the study period was consistent (**Table 2**). Incidence of other oral / dental related hospitalisations examined were also low (<0.5%) with little variation over time (**Table 2**). Incidence of any dental-related hospitalisation (primary or secondary diagnosis) was 1.99% (95% CI 1.94-2.05). Hospitalisation rates per 1000 residents are shown in **Supplement 6 Table S20**.

Males had a higher incidence of all hospitalisations examined, except for potentially preventable ED presentations and hospitalisation for oral and dental disorders, where the incidences were similar (**Table 3**). For example, the incidence of potentially preventable hospitalisations (using primary and secondary diagnoses) was 0.52% (95%CI 0.48-0.57) in males and 0.44% (95% CI 0.41-0.47) in females. For all hospitalisation outcomes, incidence decreased with increasing age. For example, potentially preventable hospitalisations (primary and secondary diagnoses) was more than double in residents aged <80 years old (0.67%, 95% CI 0.6-0.74) compared to residents aged ≥90 (0.3%, 95% CI 0.26-0.35).

For residents living with dementia the incidence of hospitalisation varied compared to those without dementia depending on the type of hospitalisation. Potentially preventable (primary and secondary diagnoses) hospitalisations and ED presentations, pneumonia and sepsis hospitalisations associated with secondary

dental diagnoses and any dental-related hospitalisation were less likely to occur in residents living with dementia (**Table 3**).

Little differences between states were observed apart from NSW having a higher incidence of potentially preventable hospitalisations (primary and secondary diagnoses) (e.g., NSW 0.51%, 95% CI 0.47-0.55 compared to SA 0.43%, 95% CI 0.36-0.50) and ED presentations (e.g., NSW 0.21%, 95% CI 0.19-0.24 compared to SA 0.14%, 95% CI 0.10-0.18) compared to the other states (**Table 4**). Hospitalisations for pneumonia with secondary dental diagnosis was higher in SA compared to the other states (e.g., SA 2.26%, 95% CI 2.10-2.43 compared to NSW 0.29%, 95%CI 0.26-0.32), as was any dental-related hospitalisation (e.g., SA 0.39%, 95% CI 0.33-0.46 compared to VIC 1.89%, 95%CI 1.81-1.98). Examination of hospitalisation incidence by remoteness of the facility (i.e., major city compared to regional/remote) was varied depending on the type of hospitalisation (**Table 4**). Hospitalisation rates per 1000 residents for these stratifications are shown in **Supplement 6 Tables S21-22**.

A sensitivity analysis was conducted using hospitalisation data from NSW and VIC that includes both public and private hospitalisation. Comparison of the incidence of public hospitalisations only with public and private hospitalisations showed a 2-4 fold increase in incidence of oral / dental hospitalisations when private hospitalisations were included. For example, the cumulative incidence of potentially preventable dental related hospitalisations (primary and secondary diagnoses) in the year 2018/19 increased from 0.22% (95% CI 0.20-0.25) to 0.38% (95% CI 0.34-0.41) (**Supplement 7 Table S27 and S28**). Little difference in length of stay was observed using public hospitalisation data only compared to both public and private hospitalisation data. Little change in incidence of all hospitalisations examined over the study period using the publicly available data were observed. However, when examining the public and private hospitalisation data the incidence of all hospitalisations apart from potentially preventable ED presentations, pneumonia and sepsis hospitalisations with secondary dental diagnoses was lower in 2019/20 by comparison to the previous study years.

Table 2. Age and sex standardised cumulative incidence and median length of stay for oral / dental-related hospitalisations, overall and by study year.

	Cumulative Incidence (95% CI), N				
	Overall 2016-20 N=248684	**2016-17** N=138694	**2017-18** N=141144	**2018-19** N=142591	**2019-20** N=144695
Potential preventable dental hospitalisation (primary diagnosis)	0.15 (0.14-0.17) N=380	0.07 (0.06-0.09) N=101	0.06 (0.05-0.08) N=88	0.08 (0.07-0.10) N=116	0.06 (0.04-0.07) N=82
Median length of stay (days, IQR)	2 (1-5)	2 (1-5)	2 (1-5)	2 (1-5)	2 (1-4)
Potential preventable dental hospitalisation (primary and secondary diagnosis)	0.47 (0.44-0.50) N=1167	0.22 (0.19-0.24) N=304	0.20 (0.18-0.23) N=287	0.22 (0.20-0.25) N=313	0.20 (0.17-0.22) N=282
Median length of stay (days, IQR)	6 (3-13)	7 (3-14)	6 (3-11)	6 (3-14)	6 (3-13)
Potential preventable ED presentations	0.14 (0.13-0.16) N=353	0.05 (0.04-0.06) N=72	0.06 (0.05-0.08) N=88	0.07 (0.06-0.09) N=105	0.06 (0.05-0.08) N=90
Hospitalisations for dental requiring anaesthesia	0.09 (0.08-0.10) N=215	0.04 (0.03-0.05) N=54	0.04 (0.03-0.05) N=52	0.04 (0.03-0.05) N=62	0.03 (0.03-0.04) N=50
Median length of stay (days, IQR)	2 (1-6)	1.5 (1-4)	1 (1-5)	2.5 (1-7.5)	2 (1-6)
Dental extractions and restoration	0.08 (0.07-0.09) N=191	0.03 (0.03-0.04) N=47	0.03 (0.02-0.04) N=47	0.04 (0.03-0.05) N=57	0.03 (0.02-0.04) N=43
Median length of stay (days, IQR)	1 (1-4)	1 (1-2)	1 (1-3)	2 (1-4)	2 (1-3)
Oral and dental disorders	0.32 (0.30-0.34) N=795	0.15 (0.13-0.17) N=202	0.13 (0.12-0.15) N=189	0.16 (0.11-0.19) N=235	0.13 (0.11-0.15) N=186
Median length of stay (days, IQR)	2 (1-4)	2 (1-4)	2 (1-4)	2 (1-5)	2 (1-4)
Hospitalisations for pneumonia with an associated secondary dental diagnosis	0.28 (0.26-0.31) N=705	0.12 (0.10-0.14) N=166	0.13 (0.11-0.15) N=188	0.14 (0.12-0.16) N=196	0.11 (0.09-0.13) N=162
Median length of stay (days, IQR)	6 (3-10)	6 (3-10)	7 (4-12)	7 (4-10)	7 (4-11)
Hospitalisations for sepsis with an associated secondary dental diagnosis	0.15 (0.13-0.16) N=369	0.06 (0.05-0.08) N=88	0.07 (0.05-0.08) N=96	0.06 (0.05-0.07) N=86	0.07 (0.06-.08) N=103
Median length of stay (days, IQR)	8 (5-12.5)	8 (5-13)	8 (5-12)	7 (5-10)	9 (6-14)
Any dental-related hospitalisation (primary and secondary diagnosis)	1.99 (1.94-2.05) 4954	0.90 (0.85-0.95) N=1289	0.91 (0.86-0.96) N=1294	0.93 (0.88-0.98) N=1328	0.87 (0.82-0.92) N=1261
Median length of stay (days, IQR)	7 (3-12)	6 (3-12)	7 (3-12)	6 (3-12)	7 (4-12)

Abbreviations: ED, emergency department; IQR, interquartile range; CI, confidence intervals.

Table 3. Cumulative incidence of oral / dental-related hospitalisations by gender, age and presence of dementia.

	Cumulative Incidence (95% CI), N						
	Male N=91863	**Female** N=156821	**Age<80 yr** N=59517	**Age 80-89 yr** N=124125	**Age ≥90 yr** N=65042	**No dementia** N=116989	**Dementia** N=131695
Potential preventable dental hospitalisation (primary diagnosis only)	0.18 (0.15-0.21) N=163	0.14 (0.12-0.16) N=217	0.27 (0.23-0.31) N=159	0.14 (0.12-0.16) N=170	0.08 (0.06-0.10) N=51	0.14 (0.12-0.17) N=169	0.16 (0.14-0.18) N=211
Potential preventable dental hospitalisation (primary and secondary diganoses)	0.52 (0.48-0.57) N=481	0.44 (0.41-0.47) N=686	0.67 (0.60-0.74) N=397	0.46 (0.42-0.50) N=572	0.30 (0.26-0.35) N=198	0.55 (0.51-0.60) N=648	0.39 (0.36-0.43) N=519
Potential preventable ED presentations	0.15 (0.13-0.18) N=140	0.14 (0.12-0.16) N=213	0.19 (0.16-0.23) N=114	0.12 (0.11-0.15) N=154	0.13 (0.11-0.16) N=85	0.16 (0.14-0.19) N=190	0.12 (0.11-0.14) N=163
Hospitalisations for dental requiring anaesthetic	0.12 (0.10-0.15) N=114	0.06 (0.05-0.08) N=101	0.20 (0.17-0.24) N=118	0.07 (0.06-0.08) N=85	0.02 (0.01-0.03) N=12	0.07 (0.06-0.09) N=87	0.10 (0.08-0.12) N=128
Dental extractions and restoration	0.11 (0.09-0.13) N=101	0.06 (0.05-0.07) N=90	0.18 (0.15-0.21) N=105	0.06 (0.05-0.08) N=76	0.02 (0.01-0.03) N=10	0.06 (0.05-0.08) N=72	0.09 (0.08-0.11) N=119
Oral and dental disorders	0.32 (0.29-0.36) N=298	0.32 (0.29-0.35) N=497	0.47 (0.41-0.52) N=277	0.31 (0.28-0.35) N=388	0.20 (0.17-0.24) N=130	0.29 (0.26-0.32) N=338	0.35 (0.32-0.38) N=457
Hospitalisations for pneumonia with an associated secondary dental diagnosis	0.38 (0.34-0.42) N=349	0.23 (0.20-0.25) N=356	0.34 (0.30-0.39) N=203	0.28 (0.25-0.31) N=351	0.23 (0.20-0.27) N=152	0.32 (0.29-0.36) N=378	0.25 (0.22-0.28) N=327
Hospitalisations for sepsis with an associated secondary dental diagnosis	0.19 (0.16-0.22) N=170	0.13 (0.11-0.15) N=199	0.20 (0.17-0.24) N=119	0.15 (0.13-0.17) N=182	0.10 (0.08-0.13) N=68	0.17 (0.15-0.19) N=198	0.13 (0.11-0.15) N=171
Any dental-related hospitalisation (primary and secondary diagnosis)	2.18 (2.09-2.28) N=2002	1.88 (1.82-1.95) N=2952	2.58 (2.45-2.71) N=1535	1.99 (1.91-2.07) N=2467	1.46 (1.37-1.56) N=952	2.23 (2.15-2.32) N=2614	1.78 (1.71-1.85) N=2340

Abbreviations: ED, emergency department, CI, confidence intervals.

Table 4. Cumulative incidence of oral / dental-related hospitalisations by state and remoteness.

	Cumulative Incidence (95% CI), N				
	State			Remoteness	
	SA N=32808	NSW N=119617	VIC N=96259	Major city N=176984	Regional / remote N=70899
Potential preventable dental hospitalisation (primary diagnosis only)	0.17 (0.13-0.22) N=56	0.16 (0.14-0.18) N=188	0.14 (0.12-0.17) N=136	0.14 (0.13-0.16) N=251	0.18 (0.15-0.22) N=129
Potential preventable dental hospitalisation (primary and secondary diganoses)	0.43 (0.36-0.50) N=140	0.51 (0.47-0.55) N=606	0.44 (0.40-0.48) N=421	0.49 (0.45-0.52) N=860	0.43 (0.39-0.48) N=306
Potential preventable ED presentations	0.14 (0.10-0.18) N=45	0.21 (0.19-0.24) N=254	0.06 (0.04-0.07) N=54	0.15 (0.13-0.17) N=264	0.12 (0.10-0.15) N=88
Hospitalisations for dental requiring anaesthetic	0.09 (0.06-0.13) N=29	0.09 (0.08-0.11) N=99	0.08 (0.06-0.10) N=75	0.07 (0.06-0.09) N=132	0.12 (0.09-0.15) N=83
Dental extractions and restoration	0.09 (0.06-0.12) N=28	0.08 (0.07-0.10) N=96	0.07 (0.05-0.09) N=67	0.06 (0.05-0.08) N=111	0.11 (0.09-0.14) N=80
Oral and dental disorders	0.37 (0.31-0.44) N=121	0.34 (0.30-0.37) N=402	0.28 (0.25-0.32) N=272	0.33 (0.30-0.36) N=580	0.30 (0.26-0.34) N=213
Hospitalisations for pneumonia with an associated secondary dental diagnosis	0.39 (0.33-0.46) N=127	0.29 (0.26-0.32) N=348	0.27 (0.24-0.30) N=257	0.33 (0.30-0.36) 580	0.21 (0.18-0.25) N=149
Hospitalisations for sepsis with an associated secondary dental diagnosis	0.10 (0.07-0.14) N=33	0.17 (0.15-0.19) N=202	0.14 (0.12-0.16) N=134	0.17 (0.15-0.19) N=295	0.10 (0.08-0.13) N=74
Any dental-related hospitalisation (primary and secondary diagnosis)	2.26 (2.10-2.43) N=741	2.00 (1.92-2.08) N=2394	1.89 (1.81-1.98) N=1819	2.15 (2.08-2.22) N=3804	1.60 (1.51-1.69) N=1134

Abbreviations: ED, emergency department; CI, confidence intervals; SA, South Australia; NSW, New South Wales; VIC, Victoria

3.2.2 Dental practitioner health service (MBS) utilisation

Utilisation of MBS subsidised dental practitioner attendances by residents was very low, with less than 0.1% of residents using this service. A small decrease in incidence of use in 2019/20 was observed by comparison to previous years (**Table 5**). The incidence of dental practitioner attendance was greater in females, younger residents and residents without dementia (e.g., 0.24%, 95% CI 0.22-0.27 for residents without dementia and 0.14%, 95% CI 0.12-0.15 for those living with dementia) (**Table 6**). The incidence of dental practitioner attendances was higher in VIC compared to other states (e.g., VIC 0.26%, 95%CI 0.23-0.30 compared to SA 0.20%, 95% CI 0.16-0.26) (**Table 7**). Little difference in utilisation was observed by remoteness of the facility (**Table 7**). Rates of dental practitioner MBS service utilisation, overall, by study year and stratifications are shown in **Supplement 6 Tables S23-25**.

Table 5. Age and sex standardised cumulative incidence of dental practitioner health services (MBS) utilisation, overall and by study year.

	Cumulative Incidence (95% CI), N				
	Overall N=360305	**2016-17** N=198734	**2017-18** N=202878	**2018-19** N=206001	**2019-20** N=210590
Dental practitioner health service	0.18 (0.17-0.20) N=665	0.09 (0.08-0.11) N=182	0.09 (0.08-0.10) N=182	0.09 (0.08-0.11) N=192	0.07 (0.06-0.08) N=142

Abbreviations: CI, confidence intervals.

Table 6. Cumulative incidence of dental practitioner health services (MBS) utilisation by sex age and dementia status.

	Cumulative Incidence (95% CI), N						
	Male N=133816	**Female** N=226489	**Age <80 yr** N=88976	**Age 80-89 yr** N=179291	**Age ≥90 yr** N=92038	**No Dementia** N=167995	**Dementia** N=192310
Dental practitioner health service	0.14 (0.12-0.17) N=192	0.21 (0.19-0.23) N=473	0.21 (0.18-0.24) N=186	0.19 (0.17-0.21) N=341	0.15 (0.13-0.18) N=138	0.24 (0.22-0.27) N=404	0.14 (0.12-0.15) N=261

Abbreviations: CI, confidence intervals.

Table 7. Cumulative incidence of dental practitioner health services (MBS) utilisation by state and remoteness.

	Cumulative Incidence (95% CI), N									
	SA N=32808	**NSW** N=119617	**VIC** N=96259	**QLD** N=66352	**TAS** N=9254	**WA** N=30819	**NT** N=603	**ACT** N=4593	**Major City** N=250957	**Regional / Remote** N=108397
Dental practitioner health service	0.20 (0.16-0.26) N=66	0.17 (0.15-0.20) N=204	0.26 (0.23-0.30) N=254	0.12 (0.09-0.15) N=78	0.15 (0.09-0.25) N=14	0.16 (0.12-0.21) N=48	<6[#]	<6[#]	0.18 (0.16-0.20) N=452	0.20 (0.17-0.22) N=212

[#]Unable report due to small numbers.
Abbreviations: CI, confidence intervals; SA, South Australia; NSW, New South Wales; VIC, Victoria; QLD, Queensland; TAS, Tasmania; WA, Western Australia; NT, Northern Territory; ACT, Australian Capital Territory
s

3.2.3 Medication utilisation

Of the medications on the PBS that can be prescribed by dental practitioners, a total of 8955 medications were dispensed over the study period to residents in residential aged care (**Table 8**). Little change in the number of dental medications dispensed was observed over the first three years of the study with a small decrease observed in 2019/20 (**Figure 1**). The top five most commonly dispensed dental practitioner medications accounted for 85.5% of all dental medications dispensed during the study period, and the top two medications amoxicillin (N=5510) and clindamycin (N=1005) accounted for 72.8% of all dispensings (**Table 8**).

Table 8. Total number and type of dental practitioner medications dispensed, overall and by study year.

	Residential aged care cohort				
	Overall N=360305	**2016-17** N=198734	**2017-18** N=202879	**2018-19** N=206001	**2019-20** N=210590
Total number of dental practitioner medications dispensed, N	**8955**	**2326**	**2317**	**2379**	**1933**
Am.oxicillin, N	5510	1443	1391	1462	1214
Clindamycin, N	1005	253	281	272	199
Paracetamol and Codeine, N	612	145	164	158	145
Amoxicillan and Clavulanic acid, N	531	134	134	145	108
Metronidazole, N	512	123	145	147	116
Cefalexin, N	313	91	84	86	52
Amphotercin, N	120	42	30	25	23
Phenoxymethylpenicillin, N	101	26	25	19	31

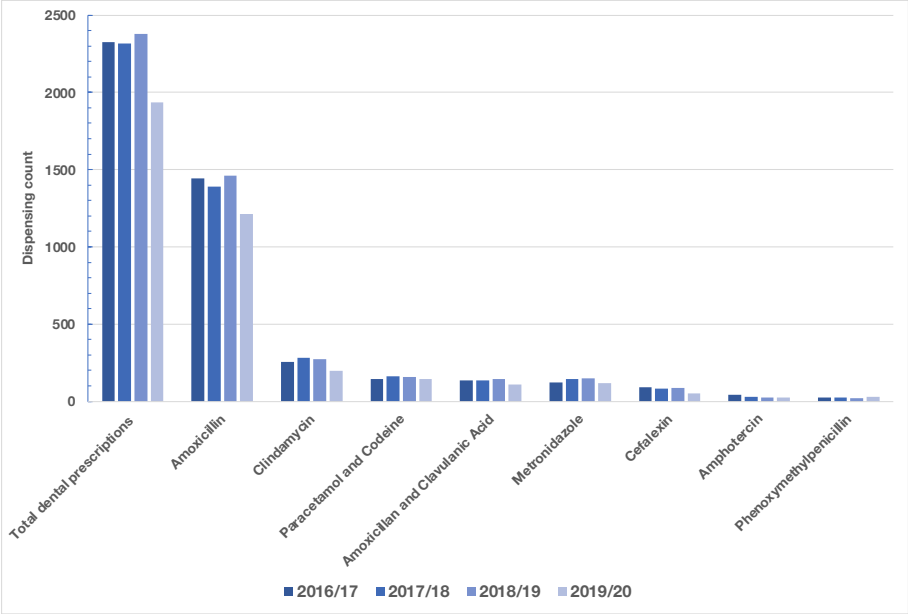


Figure 1. Total counts and most common dental practitioner medicines dispensed over study period.

Shown in **Table 9** are the age and sex adjusted incidence of medication classes dispensed that were prescribed by dental practitioners compared to the same medications prescribed overall (i.e., by dental and medical [including nurse] practitioners). Over the study period, systemic antibacterial medications were the most commonly dispensed dental medications to residents (1.66%, 95% CI 1.62-1.70), followed by analgesics (0.16%, 95% CI 0.15-0.17). Examination of overall medication utilisation showed 74.1% (95% CI 74.0-74.3) of residents were dispensed a systemic antibacterial, followed by an analgesic (56.1%,95% CI 55.8-56.2%) and 38.1% (95% CI 37.9-38.2) a psycholeptic medication, **Table 9**. Compared to overall dispensing of these medications to residents, prescribing by dental practitioners accounted for between 0.04% (psycholeptics N=49/137205) to 2.2% (systemic antibacterial medications) of overall utilisation. Medication dispensing rates per 1000 residents are shown in **Supplement 6 Table S26**.

Table 9. Age and sex standardised cumulative incidence of medication utilisation by dental practitioner prescriber and dental/medical prescribing, overall and by study year.

	Cumulative Incidence (95% CI), N				
	Overall N=360305	**2016-17 N=198734**	**2017-18 N=202879**	**2018-19 N=206001**	**2019-20 N=210590**
Stomatological medications					
Dental practitioners	0.02 (0.02-0.03) N=87	0.01 (0.01-0.02) N=28	0.01 (0.01-0.02) N=25	0.01 (0.01-0.01) N=21	0.01 (0.00-0.01) N=16
Dental and medical practitioners	1.58 (1.54-1.62) N=5706	0.86 (0.82-0.90) N=1705	0.81 (0.77-0.85) N=1638	0.80 (0.76-0.83) N=1634	0.76 (0.72-0.79) N=1584
Antibacterial medications for systemic use					
Dental practitioners	1.66 (1.62-1.70) N=5988	0.85 (0.81-0.89) N=1691	0.83 (0.79-0.87) N=1686	0.84 (0.81-0.88) N=1739	0.68 (0.64-0.71) N=1428
Dental and medical practitioners	74.1 (74.0-74.3) N=267031	61.3 (61.9-61.6) N=121677	60.3 (60.0-60.7) N=122396	60.3 (60.0-60.6) N=124209	57.3 (57.0-57.6) N=120782
Anti-inflammatory and anti-rheumatic medications					
Dental practitioners	0.01 (0.00-0.01) N=43	0.01 (0.0-0.01) N=13	0.01 (0.00-0.01) N=13	0.002 (0.00-0.01) N=9	0.004 (0.00-0.01) N=9
Dental and medical practitioners	2.44 (2.39-2.49) N=8776	1.41 (1.36-1.46) N=2,807	1.28 (1.23-1.33) N=2605	1.29 (1.24-1.34) N=2645	1.27 (1.23-1.32) N=2672
Analgesic medications					
Dental practitioners	0.16 (0.15-0.17) N=574	0.07 (0.06-0.08) N=143	0.08 (0.07-0.09) N=160	0.07 (0.06-0.08) N=151	0.07 (0.06-0.08) N=137

	Cumulative Incidence (95% CI), N				
	Overall N=360305	2016-17 N=198734	2017-18 N=202879	2018-19 N=206001	2019-20 N=210590
Dental and medical practitioners	56.05 (55.8-56.2) N=201941	36.4 (36.1-36.7) N=72277	36.7 (36.4-36.9) N=74391	36.1 (35.8-36.4) N=74424	35.6 (35.3-35.8) N=74941
Psycholeptic medications					
Dental practitioners	0.01 (0.01-0.02) N=49	0.004 (0.00-0.01) N=8	0.01 (0.00-0.01) N=21	0.008 (0.00-0.01) N=16	0.003 (0.00-0.01) N=7
Dental and medical practitioners	38.1 (37.9-38.2) N=137205	32.6 (32.4-32.9) 64873	31.9 (31.7-32.2) 64717	30.4 (30.1-30.6) 62461	26.6 (26.3-26.8) 55780
Topical/oral liquid antifungals (medical practitioner prescriptions)	0.05 (0.05-0.06) N=197	0.01 (0.01-0.02) N=29	0.03 (0.02-0.03) N=53	0.03 (0.02-0.04) N=58	0.04 (0.03-0.05) N=78

Abbreviations: CI, confidence intervals.

Due to the low incidence of dental practitioner prescribing in residential aged care, stratification analyses were conducted for the two most commonly prescribed dental medication classes, systemic anti-bacterial and analgesic medications (**Tables 10-11**). Males were more likely to be dispensed an antibacterial or analgesic medication, incidence of dental prescribing of these medications was higher in younger residents (e.g., antibacterial medications in <80 year old residents 2.00%, 95% CI 1.91-2.10 compared to 1.20%, 95% CI 1.13-1.27 in ≥90 year old residents), and residents with dementia had a lower incidence of dispensing of these dental medications (**Table 10**). Variations in dental prescribing was observed between states with ACT and WA having the highest incidence of these medications dispensed to residents (e.g., ACT antibacterial medications 3.16%, 95% CI 2.69-3.70 compared to TAS 1.11%, 95% CI 0.82-1.35). Residents living in regional / remote areas had a lower incidence of dental medication dispensing than those living in a major city (**Table 11**).

Table 10. Cumulative incidence of medication utilisation by dental practitioner prescribers, by sex, age and presence of dementia.

	Cumulative Incidence (95% CI), N						
	Male N=133816	**Female** N=226489	**<80 yrs** N=88976	**80-89 yrs** N=179291	**≥90 yrs** N=92038	**No dementia** N=167995	**Dementia** N=192310
Dental practitioner: Antibacterial medications for systemic use	1.77 (1.70-1.84) N=2369	1.60 (1.55-1.65) N=3619	2.00 (1.91-2.10) N=1781	1.73 (1.67-1.79) N=3105	1.20 (1.13-1.27) N=1102	2.08 (2.02-2.15) N=3502	1.29 (1.24-1.34) N=2486
Dental practitioner: Analgesic medications	0.21 0.19-0.24) N=285	0.13 (0.11-0.14) N=289	0.25 (0.22-0.28) N=222	0.15 (0.13-0.16) N=260	0.10 (0.08-0.12) N=92	0.18 0.16-0.20) N=301	0.14 (0.13-0.16) N=273

Abbreviations: CI, confidence intervals.

Table 11. Cumulative incidence of medication utilisation by dental practitioner prescribers, by state and remoteness.

	Cumulative Incidence (95% CI), N									
	SA N=32808	**NSW** N=119617	**VIC** N=96259	**QLD** N=66352	**TAS** N=9254	**WA** N=30819	**NT** N=603	**ACT** N=4593	**Major City** N=250957	**Regional / Remote** N=108397
Dental practitioner: Antibacterial medications for systemic use	1.22 (1.11-1.34) N=400	1.86 (1.79-1.94) N=2230	1.63 (1.56-1.72) N=1573	1.47 (1.38-1.56) N=974	1.11 (0.82-1.35) N=103	1.82 (1.67-1.97) N=560	<6[#]	3.16 (2.69-3.70) N=145	1.61 (1.56-1.66) N=4030	1.79 (1.72-1.87) N=1943
Dental practitioner: Analgesic medications	0.08 (0.05-0.12) N=26	0.19 (0.17-0.22) N=227	0.15 (0.13-0.18) N=145	0.16 (0.13-0.20) N=108	0.06 (0.02-0.14) N=6	0.17 (0.14-0.19) N=52	<6[#]	0.22 (0.12-0.40) N=10	0.15 (0.14-0.17) N=377	0.18 (0.16-0.21) N=195

[#]Unable to be reported due to small numbers.
Abbreviations: CI, confidence intervals; SA, South Australia; NSW, New South Wales; VIC, Victoria; QLD, Queensland; TAS, Tasmania; WA, Western Australia; NT, Northern Territory; ACT, Australian Capital Territory

3.3. ADDITIONAL STRATIFICATIONS: DIABETES AND ORAL HEALTH CONCERNS

Selected study outcomes stratified by the presence of diabetes and residents who were identified as having oral health concerns at entry to residential aged care (from 2017/18 onwards) are shown in **Tables 12 and 13**, respectively. The incidence of potentially preventable dental hospitalisations (primary and secondary diagnosis) and any dental-related hospitalisation were higher in residents with diabetes (0.55%, 95% CI 0.49-0.62 and 2.66%, 95% CI 2.53-2.79, respectively) compared to those without (0.45%, 95% CI 0.42-0.48 and 1.80, 95% CI 1.74-1.86, respectively). Dispensing of antibacterial medications were higher in residents with diabetes (**Table 12**).

Table 12. Cumulative incidence of select study outcomes over the study period by presence of diabetes.

	Cumulative Incidence (95% CI), N	
	Presence of Diabetes	
Hospitalisation cohort (NSW, VIC, SA only)	**No N=192776 (77.5%)**	**Yes N=55908 (22.5%)**
Potentially preventable dental hospitalisation (primary diagnosis),	0.15 (0.14-0.17) N=297	0.15 (0.12-0.18) N=83
Potentially preventable dental hospitalisation (primary + secondary diagnosis)	0.45 (0.42-0.48) N=858	0.55 (0.49-0.62) N=309
Any dental-related hospitalisation (primary + secondary diagnosis)	1.80 (1.74-1.86) N=3469	2.66 (2.53-2.79) N=1485
Total cohort (Australia)	**N=286334 (79.5%)**	**N=73971 (20.5%)**
Dental practitioner MBS health service	0.19 (0.17-0.21) N=541	0.17 (0.14-0.20) N=124
Stomatological medications	0.03 (0.02-0.03) N=72	0.02 (0.01-0.03) N=15
Antibacterial medications for systemic use	1.63 (1.59-1.68) N=4675	1.78 (1.68-1.87) N=1313
Analgesic medications	0.15 (0.14-0.17) N=433	0.19 (0.16-0.22) N=141
Psycholeptic medications	0.01 (0.01-0.02) N=39	0.01 (0.01-0.02) N=10
Anti-inflammatory and anti-rheumatic	0.01 (0.01-0.02) N=33	0.01 (0.01-0.02) N=10

Abbreviations: CI, confidence intervals; SA, South Australia; NSW, New South Wales; VIC, Victoria.

Residents who were identified as having oral health concerns upon entry to residential aged care had a higher incidence of potentially preventable dental hospitalisations (primary and secondary diagnosis) and any dental-related hospitalisation (0.47%, 95% CI 0.38-0.58 and 1.88%, 95% CI 1.70-2.09, respectively) compared to those without (0.35%, 95% CI 0.31-0.39 and 1.62%, 95% CI 1.54-1.71, respectively). Little differences were observed for utilisation of dental practitioner MBS health service use or medications by residents with and without oral health concerns (**Table 13**).

Table 13. Cumulative incidence of select study outcomes by presence of oral health concerns 2017/18 to 2019/20, N=137113.

	Cumulative Incidence (95% CI), N Oral Health Concerns	
Hospitalisation cohort (NSW, VIC, SA only)	**No** **N=77679 (80.5%)**	**Yes** **N=18862 (19.5%)**
Potentially preventable dental hospitalisation (primary diagnosis),	0.10 (0.08-0.12) N=77	0.13 (0.09-0.19) N=24
Potentially preventable dental hospitalisation (primary + secondary diagnosis	0.35 (0.31-0.39) N=270	0.47 (0.38-0.58) N=89
Any dental-related hospitalisation (primary + secondary diagnosis)	1.62 (1.54-1.71) N=1261	1.88 (1.70-2.09) N=355
Total cohort (Australia)	**N=1110271 (80.4%)**	**N=26842 (19.6%)**
Dental practitioner MBS health service	0.14 (0.12-0.16) N=151	0.13 (0.10-0.19) N=36
Stomatological medications	0.01 (0.01-0.02) N=15	NA N<6
Antibacterial medications for systemic use	1.40 (1.33-1.47) N=1543	1.49 (1.35-1.64) N=399
Analgesic medications	0.14 (0.12-0.17) N=159	0.16 (0.12-0.21) N=42
Psycholeptic medications	0.01 (0.01-0.02) N=11	NA N<6
Anti-inflammatory and anti-rheumatic	0.01 (0.0-0.01) N=6	NA N<6

Abbreviations: CI, confidence intervals; SA, South Australia; NSW, New South Wales; VIC, Victoria.

4. Discussion

This large population-based study of over 360,000 older Australians in residential aged care between 2016/17 and 2019/20 showed very low utilisation of oral / dental-related health services, including dental practitioner MBS subsidised health services (<0.2% of residents) or medications prescribed by dentists (<2.0% of residents).This is despite the high prevalence of oral / dental care needs of older people in residential aged care, that is further complicated by increased multimorbidity (including conditions that are associated with poor oral health), polypharmacy, frailty, and functional and cognitive impairments.[24] Further, one in five residents were identified as having oral health care needs at the aged care assessment upon entering residential aged care, which includes tooth loss, dental cavities, periodontal disease and gingivitis. Over the study period, between 0.87-0.93% of residents were hospitalised annually with a dental-related primary or secondary diagnoses. Extrapolation of these rates to the entire Australian residential aged care population for 2018/19, equates to 1916 residents nationally having a dental-related hospitalisation (public hospitalisations only). Dental-related hospitalisations were higher in residents with diabetes or those assessed as having oral health care needs.

A recent report of oral health and dental care in Australia conducted by the AIHW in 2023, reported the rate of potentially preventable dental-related hospitalisations (primary diagnosis) for older Australians aged ≥65 years old to be approximately four times higher than what was observed in the current study for RACF residents.[19] For example, in 2016/17 for the older Australian population the rate was 3.97 per 1000 individuals,[19] whereas in our study the rate was 0.73 per 1000 residents. Access to MBS subsidised dental practitioner health services by residents was very limited, with residents likely accessing dental care via the RACF or privately. In March 2023, 57.6% of older Australians (≥65 years old) had private health insurance,[25] which potentially could have supported access to dental services. Together with the high burden of oral health problems in residents, these findings provide further evidence that oral health care in RACFs is inadequate, with residents

less likely to receive appropriate oral / dental health care required to meet their needs.

Prescribing of medications on the dental schedule by dental practitioners to residents of residential aged care facilities was low. The most dispensed dental medications were systemic antibacterial medications, with only 1.6% of residents receiving this medication over the study period, by comparison to overall prescribing of this medicine class to 74.1% of residents. Dental prescribing accounted for between 0.04% (psycholeptics) to 2.2% (systemic antibacterial medications) of overall medication utilisation in residential aged care over the study period. In the general population prescribing by dental practitioners accounts for 1.4% of all prescribed medicines in Australia (2018).[26] A recent Australian study examined dispensing patterns of dental prescriptions in Australian concession card holders between 2006 and 2018.[27] Of the 56 medicines included on the dental schedule over this period, similar to our findings (85.5%), the top five medicines dispensed accounted for 88.5% of the total count (N=4,591,322/5,189,456). The most common dental medication class dispensed in both our study and the 2021 Australian study was systemic antibacterials, with amoxicillin the most common medication prescribed by dentists. Amoxycillin is recommended as first line therapy for endocarditis prophylaxis in high risk patients having dental procedures[28] and endodontic infections.[29] Clindamycin, the second most commonly dispensed antibiotic in our study has similar indications but for individuals with penicillin allergy.[28,29]

Despite a number of Government supported initiatives over the past year to improve oral health for older Australians, for example Australia's National Oral Health Plan 2015-2024[24] and Better Oral Health in Residential Care[30] (that promoted a multidisciplinary approach to promoting oral health), oral health care for residents in RACFs remains poor. It is reported that less than half of residents have an oral health assessment upon entry to residential aged care and almost three quarters do not have regular dental access.[31] While in the last 10 years the number of general and specialist dentists in Australia has increased by 34% from 19123 in 2013 to

25677 in 2023,[32] it is clear that a multidisciplinary team is required to deliver optimal oral health to residents of RACFs. A number of system, service and practitioner barriers to improving oral health in residential aged care have been identified including high staff turnover and lack of education, difficulties accessing dental services and referral pathways, lack of communication and integration between health and care providers.[31,33]

It is evident that current models of care and service delivery in residential aged care is inadequate and not meeting resident's oral health care needs. Urgent policy and practice changes are required and is imperative if we are to improve the health and wellbeing of Australia's residential care population.

5. References

1. Royal Commission into Aged Care Quality and Safety. Final report: Care, Dignity and Respect. (https://agedcare.royalcommission.gov.au/sites/default/files/2021-03/final-report-volume-1_0.pdf).
2. Australian Government, Department of Health. Stakeholder resources kit – Aged care reforms. (https://www.health.gov.au/resources/collections/stakeholder-resources-kit-aged-care-reforms).
3. Chrisopoulos S, Harford J, Ellershaw A. Oral health and dental care in Australia: Key facts and figures 2015. Canberra, ACT: Australian Institute of Health and Welfare. 2016.
4. Karki AJ, Monaghan N, Morgan M. Oral health status of older people living in care homes in Wales. British Dental Journal 2015;219:331-334.
5. Deutsch A, Jay E. Optimising oral health in frail older people. Aust Prescr 2021;44:153-160.
6. Inacio M, Collier L, Air T, et al. Primary, allied health, geriatric, pain and palliative healthcare service utilisation by aged care residents, 2012–2017. Australas J Ageing 2023;00:1-13. DOI: 10.1111/ajag.13199.
7. Philip K. Allied health: untapped potential in the Australian health system. Aust Health Rev 2015;39(3):244-7. DOI: 10.1071/ah14194.
8. Barr ML, Welberry H, Comino EJ, et al. Understanding the use and impact of allied health services for people with chronic health conditions in Central and Eastern Sydney, Australia: a five-year longitudinal analysis. Prim Health Care Res Dev 2019;20:e141. DOI: 10.1017/S146342361900077X.
9. Australian Government Department of Health. How allied health care is supported under AN-ACC. (https://www.health.gov.au/sites/default/files/documents/2022/04/how-allied-health-care-is-supported-under-an-acc-what-impact-will-an-acc-have-on-allied-health-services.pdf).
10. Australian Government. Department of Health. COVID-19 Temporary MBS Allied Health Services for Residents of Aged Care Facilities (http://www.mbsonline.gov.au/internet/mbsonline/publishing.nsf/Content/Factsheet-RACK-AH).
11. Caughey GE, Collier L, Cations M, Wesselingh S, Inacio MC. Evaluation of Uptake of COVID-19 Temporary Allied Health Services for Residential Aged Care in Australia. J Am Med Dir Assoc Mar 3:S1525-8610(23)00138-X doi: 101016/jjamda202302019 2023.
12. Inacio MC, Lang C, Bray SCE, et al. Health status and healthcare trends of individuals accessing Australian aged care programmes over a decade: the Registry of Senior Australians historical cohort. Intern Med J 2021;51(5):712-724. DOI: 10.1111/imj.14871.
13. Australian Government. Department of Health. Aged Care Funding Instrument (ACFI): User Guide. https://www.health.gov.au/resources/publications/aged-care-funding-instrument-acfi-user-guide (accessed 30 March 2022). 2016.
14. Australian Government Department of Health and Aged Care. Aged Care Assessment Program. https://www.health.gov.au/our-work/aged-care-assessment-programs. 2022.
15. Australian Government Department of Health and Aged Care. Medicare Benefits Schedule (MBS) online. http://www.mbsonline.gov.au/internet/mbsonline/publishing.nsf/Content/Home. 2023.
16. Australian Government Department of Health and Aged Care. Pharmaceutical Benefits Scheme (PBS). https://www.pbs.gov.au/pbs/home. 2023.
17. Australian Government. Department of Health. Aged Care Workforce Action Plan: 2022-2025. (https://www.health.gov.au/sites/default/files/documents/2022/03/aged-care-workforce-action-plan-2022-2025.pdf).
18. Department of Veteran's Affairs. Overview of DVA benefits and services. Department of Veteran's Affairs. (https://www.dva.gov.au/about-us/overview/overview-dva-benefits-and-services).
19. Australian Institute of Health and Welfare. Oral health and dental care in Australia. (https://www.aihw.gov.au/reports/dental-oral-health/oral-health-and-dental-care-in-australia/contents/hospitalisations).
20. Australian Institute of Health and Welfare. Australia's National Oral Health Plan 2015–2024: performance monitoring report in brief. Cat. no. DEN 234. Canberra: AIHW. 2020.

21. Pratt N, Kerr M, Barratt J, et al. The validity of the Rx-Risk Comorbidity Index using medicines mapped to the Anatomical Therapeutic Chemical (ATC) Classification System. BMJ Open 2018;8(e021122). DOI: 10.1136/bmjopen-2017-021122.
22. Herrera D, Sanz M, Shapira L, et al. Association between periodontal diseases and cardiovascular diseases, diabetes and respiratory diseases: Consensus report of the Joint Workshop by the European Federation of Periodontology (EFP) and the European arm of the World Organization of Family Doctors (WONCA Europe). J Clin Periodontol 2023;doi: 10.1111/jcpe.13807.
23. Inacio MCS, Pratt NL, Roughead EE, Graves SE. Evaluation of three co-morbidity measures to predict mortality in patients undergoing total joint arthroplasty. Osteoarthr Cartil 2016;24:1718-1726.
24. Oral Health Monitoring Group CHC. Healthy Mouths, Healthy Lives: Australia's National Oral Health Plan 2015–2024. https://www.health.gov.au/resources/publications/healthy-mouths-healthy-lives-australias-national-oral-health-plan-2015-2024?language=en. 2015.
25. Australian Prudential Regulation Authority (APRA). Quarterly private health insurance statistics. https://www.apra.gov.au/quarterly-private-health-insurance-statistics. 2023.
26. Australian Government Department of Health and Aged Care. The Pharmaceutical Benefits Scheme. PBS Expenditure and Prescription Report July 2018. https://www.pbs.gov.au/info/statistics/expenditure-prescriptions/pbs-expenditure-and-prescriptions-report. 2019.
27. Park JS, Page AT, Kruger E, Tennant M. Dispensing patterns of medicines prescribed by Australian dentists from 2006 to 2018 - a pharmacoepidemiological study. Int Dent J. 2020 Aug 27;71(2):106–12 Int Dent J 2021;71:106-12.
28. Australian Medicines Handbook. Australian Medicines Handbook (AMH). https://amhonline.amh.net.au2023.
29. American Association of Endodontists (AEE). AAE Guidance on the Use of Systemic Antibiotics in Endodontics. https://www.aae.org/specialty/wp-content/uploads/sites/2/2017/06/aae_systemic-antibiotics.pdf. 2017.
30. Lewis A, Wallace J, Deutsch A, King P. Improving the oral health of frail and functionally dependent elderly. Australian Dental Journal 2015;60:95-105.
31. Webb BC, Whittle T, Schwarz E. Oral health and dental care in aged care facilities in New South Wales, Australia. Part 3 concordance between residents' perceptions and a professional dental examination. Gerodontology 2016;33:3:363–372.
32. Australian Health Practitioner Regulation Agency (AHPRA). AHPRA, Dental board. Statistics. https://www.dentalboard.gov.au/about-the-board/statistics.aspx. 2023.
33. Patterson Norrie T, Villarosa AR, Kong AC, et al. Oral health in residential aged care: Perceptions of nurses and management staff. Nurs Open 2019;7:2:536-546.
34. Caughey GE, Jorissen RN, Lang C, Wesselingh SL, Inacio MC. Hospitalisation for lower respiratory viral infections in older people in residential aged care facilities. Australas J Ageing 2022;41(1):e58-e66.
35. Australian Commission on Safety and Quality in Health Care. Sepsis codes. https://www.safetyandquality.gov.au/standards/clinical-care-standards/sepsis-clinical-care-standard/sepsis-codes. 2023.

6. Supplement

SUPPLEMENT 1: DEFINITIONS FOR HOSPITALISATION OUTCOMES

Table S1. Potentially preventable hospitalisations related to dental (primary diagnosis only, OR primary or secondary diagnosis)

Definition	Numerator	Denominator	Data source
Proportion of all people in residential aged care who have been admitted to hospital with a potentially preventable dental diagnosis (principal diagnosis only, OR principal or secondary diagnosis)	Number of people who have had at least one potentially preventable dental hospital admission during the financial year	Number of people in residential aged care (SA, NSW, VIC)	SA, NSW, VIC hospitalisation data

Abbreviations: SA, South Australia; NSW, New South Wales; VIC, Victoria.

Potentially preventable dental hospitalisation, ICD-10AM codes and description

Description	ICD-10AM
Dental caries	K02*
Other diseases of hard tissues of teeth	K03*
Diseases of pulp and periapical tissues	K04*
Gingivitis and periodontal diseases	K05*
Other disorders of gingiva and edentulous alveolar ridge	K06 *
Other disorders of teeth and supporting structures	K08*
Other cysts of oral region, not elsewhere classified	K09.8
Cyst of oral region, unspecified	K09.9
Stomatitis and related lesions	K12*
Other diseases of lip and oral mucosa	K13*
Diseases of tongue	K14*

**Included all ICD-10-AM codes available under this code block.*

Table S2. Potentially preventable ED presentations related to dental (primary diagnosis only, OR primary or secondary diagnosis)

Definition	Numerator	Denominator	Data source
Proportion of all people in residential aged care who had an emergency department (ED) presentation with a potentially preventable dental diagnosis (principal diagnosis only)	Number of people who have had at least one potentially preventable dental ED presentation	Number of people in residential aged care (SA, NSW, VIC)	SA, NSW, VIC hospitalisation data

Abbreviations: SA, South Australia; NSW, New South Wales; VIC, Victoria.

Potentially preventable dental ED presentations, ICD-10AM codes and description.

Description	ICD-10AM
Dental caries	K02*
Other diseases of hard tissues of teeth	K03*
Diseases of pulp and periapical tissues	K04*
Gingivitis and periodontal diseases	K05*
Other disorders of gingiva and edentulous alveolar ridge	K06 *
Other disorders of teeth and supporting structures	K08*
Other cysts of oral region, not elsewhere classified	K09.8
Cyst of oral region, unspecified	K09.9
Stomatitis and related lesions	K12*
Other diseases of lip and oral mucosa	K13*
Diseases of tongue	K14*

**Included all ICD-10-AM codes available under this code block.*

Table S3. Hospitalisations for dental procedures requiring anaesthesia.

Definition	Numerator	Denominator	Data source
Proportion of all people in residential aged care who had a hospitalisation for dental procedures requiring anaesthesia	Number of people who have had at least one hospitalisation for a dental procedure that required anaesthesia	Number of people in residential aged care (SA, NSW, VIC)	SA, NSW, VIC hospitalisation data

Dental procedures requiring anaesthesia, Australian Classification of Health Interventions (ACHI) codes and description.

Description	ACHI codes
Nonsurgical removal of tooth	457*
Surgical removal of tooth	458*
Pulp treatment	462*
Periradicular surgery	463*
Metallic restoration	465*
Tooth-coloured restoration	466*
Other restorative dental service	469*
Crown	470*
Bridge	471*
Other dental service on crown and bridge	472*
Tooth root resection, per root	97241-00
Replantation and splinting of tooth	97387-00
Transplantation of tooth or tooth bud	97388-00
Exploration or negotiation of calcified root canal, per canal	97445-00
Obturation of resorption defect or perforation	97457-00
Interim therapeutic root filling	97458-00
Provision of resin splint, indirect	97772-00
Provision of metal splint, indirect	97773-00
Metallic inlay for denture tooth	97778-00

** Included all ACHI codes available under this code block.*

Table S4. Hospitalisations for AR-DRG D40 dental extractions and restorations.

Definition	Numerator	Denominator	Data source
Proportion of all people in residential aged care who had a hospitalisation for AR-DRG 40 dental extractions and procedures (principal diagnosis (AD40PDX1) and intervention procedure (AP40INT1).[20]	Number of people who have had at least one hospitalisation classified as AR-DRG D40	Number of people in residential aged care (SA, NSW, VIC)	SA, NSW, VIC hospitalisation data

Abbreviations: SA, South Australia; NSW, New South Wales; VIC, Victoria.

AR-DRG D40 dental extractions and restorations (principal diagnosis (AD40PDX1), ICD-10AM codes and description.

Description	ICD-10AM
Nonsurgical removal of tooth	B00.2
Surgical removal of tooth	B37.0
Pulp treatment	D10.0
Periradicular surgery	D10.1
Metallic restoration	D10.2
Tooth-coloured restoration	D10.3
Other restorative dental service	D16.5
Crown	E10.63
Bridge	E11.63
Other dental service on crown and bridge	E13.63
Tooth root resection, per root	E14.63
Disorders of tooth development and eruption	K00*
Embedded and impacted teeth	K01*
Dental caries	K02*
Other diseases of hard tissues of teeth	K03*
Diseases of pulp and periapical tissues	K04*
Gingivitis and periodontal diseases	K05*
Gingival recession	K06.0
Gingival enlargement	K06.1
Gingival and edentulous alveolar ridge lesions associated with trauma	K06.2
Other specified disorders of gingiva and edentulous alveolar ridge	K06.8
Disorder of gingiva and edentulous alveolar ridge, unspecified	K06.9
Dentofacial anomalies	K07*
Exfoliation of teeth due to systemic causes	K08.0
Loss of teeth due to accident, extraction or local periodontal disease	K08.1
Atrophy of edentulous alveolar ridge	K08.2
Retained dental root	K08.3
Pathological fracture of tooth	K08.81
Other specified disorders of teeth and supporting structures	K08.88
Disorder of teeth and supporting structures, unspecified	K08.9
Cysts of oral region, not elsewhere classified	K09*
Other diseases of jaw	K10*
Stomatitis and related lesions	K12*
Other diseases of lip and oral mucosa	K13*
Diseases of tongue	K14*
Macrostomia	Q18.4

Microstomia	Q18.5
Macrocheilia	Q18.6
Microcheilia	Q18.7
Cleft hard palate	Q35.1*
Cleft soft palate	Q35.3*
Cleft uvula	Q35.7
Cleft palate, unspecified	Q35.9
Congenital malformations of lips, not elsewhere classified	Q38.0*
Ankyloglossia	Q38.1*
Macroglossia	Q38.2*
Other congenital malformations of tongue	Q38.3*
Congenital malformations of salivary glands and ducts	Q38.4*
Congenital malformations of palate, not elsewhere classified	Q38.5*
Other congenital malformations of mouth	Q38.6*
Open wound of maxillary region	S01.42
Open wound of mandibular region	S01.43
Open wound of mouth, part unspecified	S01.50
Open wound of lip	S01.51
Open wound of buccal mucosa	S01.52
Open wound of gum (alveolar process)	S01.53
Open wound of tongue and floor of mouth	S01.54
Dislocation of tooth	S03.2
Sprain and strain of jaw	S03.4
Foreign body in mouth	T18.0

**Included all codes available under this code block*

AR-DRG D40 dental extractions and restorations intervention procedure (AP40INT1), Australian Classification of Health Interventions (ACHI) codes and description.[20]

Description	ACHI Block or ACHI Code
Tooth root resection, per root	97241-00
Surgical periodontal procedure, not elsewhere classified, per tooth or implant	97245-00
Nonsurgical removal of tooth	457*
Surgical removal of tooth	458*
Replantation and splinting of tooth	97387-00
Metallic restoration	465*
Tooth-coloured restoration	466*
Other restorative dental service	469*
Crown	470*
Bridge	471*
Other dental service on crown and bridge	472*
Fitting of implant abutment, per abutment	97661-00
Full crown attached to osseointegrated implant, non-metallic, indirect	97671-00
Full crown attached to osseointegrated implant, veneer, indirect	97672-00
Full crown attached to osseointegrated implant, metallic, indirect	97673-00
Provision of resin splint, indirect	97772-00
Provision of metal splint, indirect	97773-00
Metallic inlay for denture tooth	97778-00

** Included all ACHI codes available under this code blocks*

Table S5. Hospitalisations for AR-DRG D67 oral and dental disorders.

Definition	Numerator	Denominator	Data source
Proportion of all people in residential aged care who had a hospitalisation for AR-DRG 67 oral and dental disorders (Principal Diagnosis (AD67PDX1), including D67A major complexity and D67B minor complexity.[20]	Number of people who have had at least one hospitalisation classified as AR-DRG 67	Number of people in residential aged care (SA, NSW, VIC)	SA, NSW, VIC hospitalisation data

Abbreviations: SA, South Australia; NSW, New South Wales; VIC, Victoria.

AR-DRG D67 oral and dental disorders (AD67PDX1), ICD-10AM codes and description.

Description	ICD-10AM
Nonsurgical removal of tooth	B00.2
Surgical removal of tooth	B37.0
Pulp treatment	D10.0
Periradicular surgery	D10.1
Metallic restoration	D10.2
Tooth-coloured restoration	D10.3
Other restorative dental service	D16.5
Crown	E10.63
Bridge	E11.63
Other dental service on crown and bridge	E13.63
Tooth root resection, per root	E14.63
Disorders of tooth development and eruption	K00*
Embedded and impacted teeth	K01*
Dental caries	K02*
Other diseases of hard tissues of teeth	K03*
Diseases of pulp and periapical tissues	K04*
Gingivitis and periodontal diseases	K05*
Gingival recession	K06.0
Gingival enlargement	K06.1
Gingival and edentulous alveolar ridge lesions associated with trauma	K06.2
Other specified disorders of gingiva and edentulous alveolar ridge	K06.8
Disorder of gingiva and edentulous alveolar ridge, unspecified	K06.9
Dentofacial anomalies	K07*
Exfoliation of teeth due to systemic causes	K08.0
Loss of teeth due to accident, extraction or local periodontal disease	K08.1
Atrophy of edentulous alveolar ridge	K08.2
Retained dental root	K08.3
Pathological fracture of tooth	K08.81
Other specified disorders of teeth and supporting structures	K08.88
Disorder of teeth and supporting structures, unspecified	K08.9
Cysts of oral region, not elsewhere classified	K09*
Other diseases of jaw	K10*
Stomatitis and related lesions	K12*
Other diseases of lip and oral mucosa	K13*
Diseases of tongue	K14*
Macrostomia	Q18.4
Microstomia	Q18.5
Macrocheilia	Q18.6

Microcheilia	Q18.7
Cleft hard palate	Q35.1*
Cleft soft palate	Q35.3*
Cleft uvula	Q35.7
Cleft palate, unspecified	Q35.9
Cleft lip, bilateral	Q36.0
Cleft lip, median	Q36.1
Cleft lip, unilateral	Q36.9
Congenital malformations of lips, not elsewhere classified	Q38.0*
Ankyloglossia	Q38.1*
Macroglossia	Q38.2*
Other congenital malformations of tongue	Q38.3*
Congenital malformations of salivary glands and ducts	Q38.4*
Congenital malformations of palate, not elsewhere classified	Q38.5*
Other congenital malformations of mouth	Q38.6*
Open wound of maxillary region	S01.42
Open wound of mandibular region	S01.43
Open wound of mouth, part unspecified	S01.50
Open wound of lip	S01.51
Open wound of buccal mucosa	S01.52
Open wound of gum (alveolar process)	S01.53
Open wound of tongue and floor of mouth	S01.54a
Dislocation of tooth	S03.2
Sprain and strain of jaw	S03.4
Foreign body in mouth	T18.0

**Included all ICD-10-AM codes available under this code block*

Table S6. Hospitalisations for pneumonia with an associated oral / dental disorder.

Definition	Numerator	Denominator	Data source
Proportion of all people in residential aged care who had a hospitalisation for pneumonia[34] (principal diagnosis, excluding viral) with an oral / dental (secondary) diagnosis.	Number of people who have had at least one hospitalisation for pneumonia with an oral / dental diagnosis	Number of people in residential aged care (SA, NSW, VIC)	SA, NSW, VIC hospitalisation data

Abbreviations: SA, South Australia; NSW, New South Wales; VIC, Victoria.

Pneumonia hospitalisation[34], ICD-10AM codes and description

Description	ICD-10AM Code
Influenza due to identified novel influenza A virus with pneumonia	J09.X1
Influenza due to other identified influenza virus with pneumonia	J10.0*
Influenza due to unidentified influenza virus with pneumonia	J11.0*
Pneumonia due to Streptococcus pneumoniae	J13*
Pneumonia due to Hemophilus influenzae	J14*
Bacterial pneumonia, not elsewhere classified	J15*
Pneumonia due to other infectious organisms, not elsewhere classified	J16*
Pneumonia in diseases classified elsewhere	J17*
Pneumonia, unspecified organism	J18*
Coal worker's pneumoconiosis	J60
Pneumoconiosis due to asbestos and other mineral fibers	J61
Pneumoconiosis due to dust containing silica	J62*
Pneumoconiosis due to other inorganic dusts	J63*
Unspecified pneumoconiosis	J64
Pneumoconiosis associated with tuberculosis	J65
Airway disease due to specific organic dust	J66*
Hypersensitivity pneumonitis due to organic dust	J67*
Respiratory conditions due to inhalation of chemicals, gases, fumes and vapors	J68*
Pneumonitis due to solids and liquids	J69*
Respiratory conditions due to other external agents	J70*

**Included all ICD-10-AM codes available under this code block.*

AR-DRG D67 oral and dental disorders (AD67PDX1), ICD-10AM codes and description.

sDescription	ICD-10AM Code
Nonsurgical removal of tooth	B00.2
Surgical removal of tooth	B37.0
Pulp treatment	D10.0
Periradicular surgery	D10.1
Metallic restoration	D10.2
Tooth-coloured restoration	D10.3
Other restorative dental service	D16.5
Crown	E10.63
Bridge	E11.63
Other dental service on crown and bridge	E13.63
Tooth root resection, per root	E14.63
Disorders of tooth development and eruption	K00*
Embedded and impacted teeth	K01*
Dental caries	K02*
Other diseases of hard tissues of teeth	K03*
Diseases of pulp and periapical tissues	K04*

Gingivitis and periodontal diseases	K05*
Gingival recession	K06.0
Gingival enlargement	K06.1
Gingival and edentulous alveolar ridge lesions associated with trauma	K06.2
Other specified disorders of gingiva and edentulous alveolar ridge	K06.8
Disorder of gingiva and edentulous alveolar ridge, unspecified	K06.9
Dentofacial anomalies	K07*
Exfoliation of teeth due to systemic causes	K08.0
Loss of teeth due to accident, extraction or local periodontal disease	K08.1
Atrophy of edentulous alveolar ridge	K08.2
Retained dental root	K08.3
Pathological fracture of tooth	K08.81
Other specified disorders of teeth and supporting structures	K08.88
Disorder of teeth and supporting structures, unspecified	K08.9
Cysts of oral region, not elsewhere classified	K09*
Other diseases of jaw	K10*
Stomatitis and related lesions	K12*
Other diseases of lip and oral mucosa	K13*
Diseases of tongue	K14*
Macrostomia	Q18.4
Microstomia	Q18.5
Macrocheilia	Q18.6
Microcheilia	Q18.7
Cleft hard palate	Q35.1*
Cleft soft palate	Q35.3*
Cleft uvula	Q35.7
Cleft palate, unspecified	Q35.9
Cleft lip, bilateral	Q36.0
Cleft lip, median	Q36.1
Cleft lip, unilateral	Q36.9
Congenital malformations of lips, not elsewhere classified	Q38.0*
Ankyloglossia	Q38.1*
Macroglossia	Q38.2*
Other congenital malformations of tongue	Q38.3*
Congenital malformations of salivary glands and ducts	Q38.4*
Congenital malformations of palate, not elsewhere classified	Q38.5*
Other congenital malformations of mouth	Q38.6*
Open wound of maxillary region	S01.42
Open wound of mandibular region	S01.43
Open wound of mouth, part unspecified	S01.50
Open wound of lip	S01.51
Open wound of buccal mucosa	S01.52
Open wound of gum (alveolar process)	S01.53
Open wound of tongue and floor of mouth	S01.54a
Dislocation of tooth	S03.2
Sprain and strain of jaw	S03.4
Foreign body in mouth	T18.0

**Included all ICD-10-AM codes available under this code block*

Table S7. Hospitalisations for sepsis with an associated oral / dental disorder.

Definition	Numerator	Denominator	Data source
Proportion of all people in residential aged care who had a hospitalisation for sepsis[35] (principal diagnosis) with an oral / dental (secondary) diagnosis.	Number of people who have had at least one hospitalisation for sepsis with an oral / dental diagnosis	Number of people in residential aged care (SA, NSW, VIC)	SA, NSW, VIC hospitalisation data

Abbreviations: SA, South Australia; NSW, New South Wales; VIC, Victoria.

Sepsis hospitalisation[35], ICD-10AM codes and description

Description	ICD-10AM Code
Sepsis due to Salmonella	A02.1
Sepsis due to Shigella	A03.7
Sepsis due to plague	A20.7
Sepsis due to tularaemia	A21.7
Sepsis due to anthrax	A22.7
Sepsis due to Brucella	A23.7
Sepsis due to glanders and melioidosis	A24.7
Sepsis due to Erysipelothrix [erysipeloid] [rhusiopathiae]	A26.7
Sepsis due to Pasteurella, not elsewhere classified	A28.01
Sepsis due to extraintestinal yersiniosis	A28.21
Sepsis due to Listeria [monocytogenes]	A32.7
Sepsis due to Meningococcus	A39.7
Sepsis due to Streptococcus, group A	A40.0
Sepsis due to Streptococcus, group B	A40.1
Sepsis due to Streptococcus, group D	A40.21
Sepsis due to Enterococcus	A40.22
Sepsis due to Streptococcus pneumoniae	A40.3
Other streptococcal sepsis	A40.8
Streptococcal sepsis, unspecified	A40.9
Sepsis due to Staphylococcus aureus	A41.0

**Included all ICD-10-AM codes available under this code block.*

AR-DRG D67 oral and dental disorders (AD67PDX1), ICD-10AM codes and description.

ssDescription	ICD-10AM Code
Nonsurgical removal of tooth	B00.2
Surgical removal of tooth	B37.0
Pulp treatment	D10.0
Periradicular surgery	D10.1
Metallic restoration	D10.2
Tooth-coloured restoration	D10.3
Other restorative dental service	D16.5
Crown	E10.63
Bridge	E11.63
Other dental service on crown and bridge	E13.63
Tooth root resection, per root	E14.63
Disorders of tooth development and eruption	K00*
Embedded and impacted teeth	K01*
Dental caries	K02*
Other diseases of hard tissues of teeth	K03*
Diseases of pulp and periapical tissues	K04*

Gingivitis and periodontal diseases	K05*
Gingival recession	K06.0
Gingival enlargement	K06.1
Gingival and edentulous alveolar ridge lesions associated with trauma	K06.2
Other specified disorders of gingiva and edentulous alveolar ridge	K06.8
Disorder of gingiva and edentulous alveolar ridge, unspecified	K06.9
Dentofacial anomalies	K07*
Exfoliation of teeth due to systemic causes	K08.0
Loss of teeth due to accident, extraction or local periodontal disease	K08.1
Atrophy of edentulous alveolar ridge	K08.2
Retained dental root	K08.3
Pathological fracture of tooth	K08.81
Other specified disorders of teeth and supporting structures	K08.88
Disorder of teeth and supporting structures, unspecified	K08.9
Cysts of oral region, not elsewhere classified	K09*
Other diseases of jaw	K10*
Stomatitis and related lesions	K12*
Other diseases of lip and oral mucosa	K13*
Diseases of tongue	K14*
Macrostomia	Q18.4
Microstomia	Q18.5
Macrocheilia	Q18.6
Microcheilia	Q18.7
Cleft hard palate	Q35.1*
Cleft soft palate	Q35.3*
Cleft uvula	Q35.7
Cleft palate, unspecified	Q35.9
Cleft lip, bilateral	Q36.0
Cleft lip, median	Q36.1
Cleft lip, unilateral	Q36.9
Congenital malformations of lips, not elsewhere classified	Q38.0*
Ankyloglossia	Q38.1*
Macroglossia	Q38.2*
Other congenital malformations of tongue	Q38.3*
Congenital malformations of salivary glands and ducts	Q38.4*
Congenital malformations of palate, not elsewhere classified	Q38.5*
Other congenital malformations of mouth	Q38.6*
Open wound of maxillary region	S01.42
Open wound of mandibular region	S01.43
Open wound of mouth, part unspecified	S01.50
Open wound of lip	S01.51
Open wound of buccal mucosa	S01.52
Open wound of gum (alveolar process)	S01.53
Open wound of tongue and floor of mouth	S01.54a
Dislocation of tooth	S03.2
Sprain and strain of jaw	S03.4
Foreign body in mouth	T18.0

**Included all ICD-10-AM codes available under this code block*

SUPPLEMENT 2: DEFINITIONS FOR DENTAL PRACTITIONER HEALTH SERVICE (MBS) UTILISATION

Table S8. Dental practitioner MBS health service utilisation.

Definition	Numerator	Denominator	Data source
Proportion of all people in residential aged care who received an MBS service by a dental practitioner.[15]	Number of people who have had at least one MBS dental service	Number of people in residential aged care (Australia)	MBS

MBS dental health service codes.[15]

Description	MBS item Code
Professional attendance (other than a second or subsequent attendance in a single course of treatment) by an approved dental practitioner, at consulting rooms, hospital or residential aged care facility where the patient is referred to him or her	51700
Professional attendance by an approved dental practitioner, each attendance subsequent to the first in a single course of treatment at consulting rooms, hospital or residential aged care facility where the patient is referred to him or her	51793

SUPPLEMENT 3: DEFINITIONS FOR MEDICATION (PBS) USE

Table S9. Dental and medical practitioner medication prescribing: stomatological preparations (ATC code A01)

Definition	Numerator	Denominator	Data source
Proportion of all people in residential aged care who were dispensed a stomatological (A01) preparation	Number of people who have had at least one stomatological medication dispesned	Number of people in residential aged care (Australia)	PBS

PBS stomatological preparations.

Description	PBS item code, dental	PBS item code, medical
Amphotericin B 10 mg lozenge	3306B	2931G
Benzydamine hydrochloride 0.15% mouthwash	5032W	1121B, 5385K

Table S10. Dental and medical practitioner medication prescribing: antibacterials for systemic use (ATC code J01).

Definition	Numerator	Denominator	Data source
Proportion of all people in residential aged care who were dispensed an antibacterial for systemic use (J01).	Number of people who have had at least one antibacterial medication dispensed	Number of people in residential aged care (Australia)	PBS

PBS Antibacterial medications for systemic use.

Description	PBS item code, dental	PBS item code, medical
Amoxicillin	3301R, 3393N, 3300Q, 5225B, 3310F, 3302T, 13184X	11998L, 1184E, 1889K, 11947T, 8750E, 1888J, 9714G,1886G,13182T,1887H
Amoxicillin and clavulanic acid	5011R, 13190F, 5009P, 5008N, 5006L	8319W, 13179P, 13194K, 1892N, 11941L, 1891M, 11933C, 8254K
Benzathine benzylpenicillin	11735P, 5027N	11723B, 2267H, 11755Q
Benzylpenicillin	3399X, 3398W	2647H,3487M, 1775K, 3486L
Cefaclor	5046N, 5047P, 5045M	2460L, 2461M, 1169M
Cefalexin	3317N, 3318P, 3319Q, 13278W, 3320R	11963P, 3119E, 11934D, 3094W, 13285F, 3095X, 2655R, 3058Y, 10778G
Cefotaxime	1768C	1758M
Cefuroxime	11191B, 11228Y, 5052X	11192C, 11227X, 8292K
Clindamycin	5057E	3138E
Dicloxacillin	5096F, 5097G	8121K, 8122L, 10790X
Doxycycline	3321T, 5082L, 3322W	2709N, 9105F,2708M, 10779H, 2714W, 2702F, 10791K, 9107H, 9108J, 10777F, 2703G
Erythromycin	3325B, 3334L, 3337P	1404X, 10780J, 2424N, 2428T
Flucloxacillin	5257Q, 5258R, 5090X, 5091Y, 5095E	9149M, 9150N, 1526H, 1527J, 1525G, 10788T
Lincomycin	11366F, 5144R	11380Y, 2520E
Metronidazole	5157K, 3339R, 5155H, 3341W	1642K, 1636D, 1621H, 1630T
Phenoxymethylpenicillin	3363B, 3364C, 5012T, 5024K, 5029Q, 13291M, 3360W, 3361X	1789E, 2965C, 9143F, 8976K, 13282C, 8977L, 1787C, 3028J
Procaine benzylpenicillin	3371K	1794K
Roxithromycin	5259T, 5250W, 5261X	8129W, 1760P, 12001P, 11993F, 8016X
Trimethoprim + sulfamethoxazole	3391L, 3390K	3103H, 2951H
Vancomycin	5083M, 3323X	2269K, 3130R

Table S11. Dental and medical practitioner medication prescribing: anti-inflammatory and antirheumatic medications (ATC code M01).

Definition	Numerator	Denominator	Data source
Proportion of all people in residential aged care who were dispensed an anti-inflammatory or antirheumatic medication (M01).	Number of people who have had at least one anti-inflammatory or antirheumatic medication dispensed.	Number of people in residential aged care (Australia).	PBS

PBS anti-inflammatory and antirheumatic medications.

Description	PBS item code, dental	PBS item code, medical
Diclofenac	5079H, 5076E, 5077F	1302M, 1299J, 1300K
Ibuprofen	5123P, 5124Q	3190X, 3192B
Indometacin	5126T, 5128X	2454E, 2757D
Ketoprofen	5136H	1590Q
Naproxen	5179N, 5176K, 5178M, 5186Y	1615B, 1674D, 1614Y, 1795L
Piroxicam	5210R, 5204X, 5202T, 5203W	1895R,1898X, 1896T, 1897W

Table S12. Dental and medical practitioner medication prescribing: analgesics (ATC code N02).

Definition	Numerator	Denominator	Data source
Proportion of all people in residential aged care who were dispensed an analgesic medication (N02).	Number of people who have had at least one analgesic medication dispensed.	Number of people in residential aged care (Australia).	PBS

PBS analgesic medications.

Description	PBS item code, dental	PBS item code, medical
Codeine	12054K, 5063L	2065B, 1214X
Hydromorphone	12559B, 12045Y, 5115F, 12032G, 5116G, 12010D, 5117H	12582F, 12047C, 8541M, 12046B,8542N, 12016K, 8543P
Morphine	10863R, 10858L, 12067D, 5163R, 5168B, 5169C, 5170D, 5239R, 5237P, 5238Q	10864T, 10862Q, 10874H, 10868B, 12009C, 1646P, 1644M, 3479D, 1645N, 3480E, 1647Q, 2124T,2122Q, 2123R
Oxycodone	12311Y, 13234M, 5194J, 12074L, 5197M, 5191F, 5190E, 5195K	12314D, 13233L, 2481N, 12031F, 8501K, 8464L, 8644Y, 2622B
Paracetamol + Codeine	12066C, 3316M	12022R, 1215Y
Tramadol	12024W, 5232J, 5231H, 5150C	12008B, 8455B, 3484J, 8582Q, 8843K

Table S13. Dental and medical practitioner medication prescribing: psycholeptics (ATC code N05).

Definition	Numerator	Denominator	Data source
Proportion of all people in residential aged care who were dispensed a psycholeptic medication (N05).	Number of people who have had at least one psycholeptic medication dispensed	Number of people in residential aged care (Australia)	PBS

PBS psycholeptic medication.

Description	PBS item code, dental	PBS item code, medical
Diazepam	5071X, 5072Y	3161J, 3162K
Nitrazepam	5189D	2723H, 2732T
Oxazepam	5192G, 5193H	3132W, 3134Y, 3133X, 3135B
Prochlorperazine	5206B, 5205Y	2369Q, 3477B, 2893G
Temazepam	5221T	2089Y, 2088X

Table S14. Dental and medical practitioner medication prescribing: topical / oral liquid anti-fungal medications

Definition	Numerator	Denominator	Data source
Proportion of all people in residential aged care who were dispensed a topical or oral liquid anti-fungal medication.	Number of people who have had at least one topical or oral liquid anti-fungal medication dispensed.	Number of people in residential aged care (Australia).	PBS

PBS topical or oral liquid anti-fungal medications.

Description	ATC	PBS item Code (not dental specific)
Miconazole	D01AC	9031H
Nyastatin	A01AB	10854G
Fluconazole	J02AC	5446P

Table S15. Dental and medical practitioner medication prescribing: other medications.

Definition	Numerator	Denominator	Data source
Proportion of all people in residential aged care who were dispensed a 'other' dental medication	Number of people who have had at least one dental 'other' medication dispensed.	Number of people in residential aged care (Australia).	PBS

'Other' dental medications.

ATC code	Description	PBS item code, dental	PBS item code, medical
A03	Atropine sulphate Metoclopramide	5022H 5151D, 5153F	1089H, 3453R 1207M, 3476Y, 1206L
A07	Nystatin	3345C, 3342X	1699K, 1696G
C01	Adrenaline	5004J	1016L, 3451P
D07	Hydrocortisone	5113D, 5114E, 5118J, 5119K	1449G, 3467L, 2881P, 2882Q, 1510L, 1511M
H02	Betamethasone Methylprednisolone Triamcinolone	5034Y 5148Y 5233K	2494T 1928L 2990J
H04	Glucagon hydrochloride	5105Q	1449G, 3467L
N03	Carbamazapine	5041H, 5039F, 1724R, 5038E, 5037D	2427R, 2422L, 1706T, 2426Q, 2421Y
N04	Benzatropine	11249C	11255J, 11265X
R06	Promethazine	3374N	1948M, 3488N
A01AB	Chlorhexidine	N/A	4161B, 4204G

SUPPLEMENT 4: DEFINITIONS FOR COVARIATES

Table S16. Covariate descriptions, data sources, codes and time frames for ascertainment.

Variable	Data sources	Derived from	Time frame (if applicable)
Health Conditions			
Total number of health conditions	PBS	Rx-Risk	6 months prior to cohort entry
Dementia	PBS ACAP health conditions ACFI health conditions	Rx-Risk: RX_11 HC0500-HC0532 HC0500-HC0532	6 months prior to cohort entry Any point prior to cohort entry Any point prior to cohort entry
Diabetes	PBS Hospitalisation (inpatient data)	Rx-Risk: RX_13 Elixhauser: Elixhauser_11, Elixhauser_12	6 months prior to cohort entry 12 months prior to cohort entry
Chronic respiratory disease	PBS Hospitalisation (inpatient data)	Rx Risk: RX_9 Elixhauser: Elixhauser_10	6 months prior to cohort entry 12 months prior to cohort entry
Cardiovascular disease	PBS Hospitalisation (inpatient data)	Rx-Risk: RX_6, RX_10, RX_23, RX_27, RX_28 Elixhauser: Elixhauser_1, Elixhauser_2, Elixhauser_3, Elixhauser_4, Elixhauser_5, Elixhauser_6, Elixhauser_7	6 months prior to cohort entry 12 months prior to cohort entry
Obesity	Hospitalisation (inpatient data)	ICD-10: E660, E661, E662, E668, E669, Z683, Z6830, Z6831, Z6832, Z6833, Z6834, Z6835, Z6836, Z6837, Z6838, Z6839, Z684, Z6841, Z6842, Z6843, Z6844, Z6845	12 months prior to cohort entry
Malnutrition	PBS Hospitalisation (inpatient data)	Rx-Risk: RX_33 ICD-10AM: E43, E440, E441, E46, E639, R634, R636, R64, Z681	6 months prior to cohort entry 12 months prior to cohort entry
Chronic kidney disease	Hospitalisation (inpatient data)	ICD-10 AM: N18, N181, N182, N183, N184, N185, N189 Elixhauser: Elixhauser_14	12 months prior to cohort entry
Aspiration pneumonia	Hospitalisation (inpatient data)	ICD-10AM: J69, J690, J691, J698	12 months prior to cohort entry
Care Needs			
Nutrition / eating	ACFI (Q1)	Q1 – Category D, requiring physical assistance with readiness to eat and eating	Closest ACFI prior to cohort entry (before, and up to 90 days after cohort entry)

Mobility	ACFI (Q2)	Q2 – Category D, mechanical lifting for transfers or requiring physical assistance for transfers and locomotion	Closest ACFI prior to cohort entry (before, and up to 90 days after cohort entry)
Cognitive impairment	ACFI (Q6)	Q6 – Category D, severe cognitive impairment	Closest ACFI prior to cohort entry (before, and up to 90 days after cohort entry)
Special / tube feeding	ACFI (Q12 Complex health care needs) MBS	Q12 R6 Special feeding – Yes or Q12 R17 management ongoing tube feeding – Yes MBS Procedure codes: 30481, 30482, 30483, 31456, 31458, 31460	Closest ACFI prior to cohort entry (before, and up to 90 days after cohort entry) 12 months prior to cohort entry
Oral health concerns	NSAF	Physical Health – Oral Health. Any oral health concerns such as problems with teeth, mouth or dentures, including tooth loss, dental cavities, periodontal disease and gingivitis	Recorded in NSAF 2017/18 onwards.

Abbreviations: PBS, Pharmaceutical Benefits Scheme; ACAP, Aged Care Assessment Program; ACFI, Aged Care Funding Instrument; MBS, Medicare Benefits Schedule; NSAF, National Screening and Assessment Form; Rx-Risk, Rx-Risk pharmaceutical based comorbidity index[21]; Elixhauser, Elixhauser hospitalisation based comorbidity index[23]; ICD-10AM, International Classification of Diseases Australian Modification.

SUPPLEMENT 5: RESULTS CRUDE CUMULATIVE INCIDENCE

Table S17. Crude cumulative incidence of oral / dental-related hospitalisations

	Overall Estimate (95% CI)	2016-17 Estimate (95% CI)	2017-18 Estimate (95% CI)	2018-19 Estimate (95% CI)	2019-20 Estimate (95% CI)
Total N	248684	138694	141144	142591	144695
Potential preventable dental hospitalisation (primary only)	0.15 (014-0.17)	0.07 (0.06-0.09)	0.06 (0.05-0.08)	0.08 (0.07-0.10)	0.06 (0.05-0.07)
N	380	101	88	116	82
Potential preventable dental hospitalisation (primary + secondary)	0.47 (0.44-0.50)	0.22 (0.20-0.25)	0.20 (0.18-0.23)	0.22 (0.20-0.25)	0.19 (0.17-0.22)
N	1167	304	287	313	282
Potential preventable ED presentations	0.14 (0.13-0.16)	0.05 (0.04-0.06)	0.06 (0.05-0.08)	0.07 (0.06-0.09)	0.06 (0.05-0.08)
N	353	72	88	105	90
Hospitalisations for dental requiring anaesthesia	0.09 (0.07-0.10)	0.04 (0.03-0.05)	0.04 (0.03-0.05)	0.04 (0.03-0.06)	0.03 (0.03-0.05)
N	215	54	52	62	50
Dental extractions and restoration	0.08 (0.07-0.09)	0.03 (0.03-0.05)	0.03 (0.03-0.04)	0.04 (0.03-0.05)	0.03 (0.02-0.04)
N	191	47	47	57	43
Oral and dental disorders	0.32 (0.30-0.34)	0.15 (0.13-0.17)	0.13 (0.12-0.15)	0.16 (0.15-0.19)	0.13 (0.11-0.15)
N	795	202	189	235	186
Hospitalisations for pneumonia with an associated secondary dental diagnosis	0.28 (0.26-0.31)	0.12 (0.11-0.14)	0.13 (0.12-0.15)	0.14 (0.12-0.16)	0.11 (0.10-0.13)
N	705	166	188	196	162
Hospitalisations for sepsis with an associated secondary dental diagnosis	0.15 (0.13-0.16)	0.06 (0.05-0.08)	0.07 (0.06-0.08)	0.06 (0.05-0.07)	0.07 (0.06-.09)
N	369	88	96	86	103
Any dental-related hospitalisation (primary and secondary diagnosis)	1.99 (1.94-2.05)	0.90 (0.85-0.95)	0.91 (0.86-0.96)	0.93 (0.88-0.98)	0.87 (0.82-0.92)
N	4954	1251	1289	1328	1261

Abbreviations: CI, confidence intervals.

Table S18. Crude cumulative incidence of dental practitioner health services (MBS) utilisation

	Overall Estimate (95% CI)	2016-17 Estimate (95% CI)	2017-18 Estimate (95% CI)	2018-19 Estimate (95% CI)	2019-20 Estimate (95% CI)
Total N	360305	198734	20879	206001	210590
MBS					
Dental practitioner health services (MBS)	0.18 (0.17-0.20)	0.09 (0.08-0.11)	0.09 (0.08-0.10)	0.09 (0.08-0.11)	0.07 (0.06-0.08)
N	665	182	182	192	142

Abbreviations: CI, confidence intervals.

Table S19. Crude cumulative incidence of medication utilisation

	Overall Estimate (95% CI)	2016-17 Estimate (95% CI)	2017-18 Estimate (95% CI)	2018-19 Estimate (95% CI)	2019-20 Estimate (95% CI)
Total N	360305	198734	202879	206001	210590
Dental and medical practitioner prescriptions: Stomatological preparations-overall	1.58 (1.54-1.62)	0.86 (0.82-0.90)	0.81 (0.77-0.85)	0.79 (0.76-0.83)	0.75 (0.72-0.79)
N	5706	1705	1,638	1,634	1,584
Dental practitioner prescriptions: Stomatological preparations	0.02 (0.02-0.03)	0.01 (0.01-0.02)	0.01 (0.01-0.02)	0.01 (0.01-0.02)	0.01 (0.00-0.01)
N	87	28	25	21	16
Dental and medical practitioner prescriptions: Antibacterial for systemic use	74.1 (74.0-74.3)	61.2 (61.0-61.4)	60.3 (60.1-60.5)	60.3 (60.1-60.5)	57.4 (57.1-57.6)
N	267031	121677	122396	124209	120782
Dental practitioner prescriptions: Antibacterial for systemic use	1.66 (1.62-1.70)	0.85 (0.81-0.89)	0.83 (0.79-0.87)	0.84 (0.81-0.88)	0.68 (0.64-0.71)
N	5988	1691	1686	1739	1428
Dental and medical practitioner prescriptions: Anti-inflammatory and anti-rheumatic	2.44 (2.39-2.49)	1.41 (1.36-1.47)	1.28 (1.24-1.33)	1.28 (1.24-1.33)	1.27 (1.22-1.32)
N	8776	2807	2605	2645	2672
Dental practitioner prescriptions: Anti-inflammatory and anti-rheumatic	0.01 (0.00-0.01)	0.01 (0.0-0.01)	0.01 (0.00-0.01)	0.004 (0.00-0.01)	0.004 (0.00-0.01)
N	43	13	13	9	9
Dental and medical practitioner prescriptions: Analgesics	56.05 (55.8-56.2)	36.4 (36.2-36.6)	36.7 (36.5-36.9)	36.1 (35.9-36.3)	35.6 (35.4-35.8)
N	201941	7277	74391	7424	74941
Dental practitioner prescriptions: Analgesics	0.16 (0.15-0.17)	0.07 (0.06-0.08)	0.08 (0.07-0.09)	0.07 (0.06-0.08)	0.07 (0.06-0.08)
N	574	143	160	151	137
Dental and medical practitioner prescriptions: Psycholeptics	38.1 (37.9-38.2)	32.6 (32.4-32.9)	31.9 (31.7-32.2)	30.3 (30.1-30.6)	26.5 (26.3-26.8)
N	137205	64873	64717	62461	55780
Dental practitioner prescriptions: Psycholeptics	0.01 (0.00-0.02)	0.004 (0.00-0.01)	0.014 (0.01-0.02)	0.008 (0.00-0.012)	0.003 (0.00-0.01)
N	49	8	21	16	7
Topical/oral liquid antifungals (miconazole,nyastin,fluconazole)	0.05 (0.05-0.06)	0.01 (0.01-0.02)	0.03 (0.02-0.03)	0.03 (0.02-0.04)	0.04 (0.03-0.05)
N	197	29	53	58	78

Abbreviations: CI, confidence intervals.

SUPPLEMENT 6: RESULTS RATE PER 1000 RESIDENTS

Table S20. Age and sex standardised rate of oral / dental-related hospitalisations per 1000 residents.

	Overall Estimate (95% CI)	2016-17 Estimate (95% CI)	2017-18 Estimate (95% CI)	2018-19 Estimate (95% CI)	2019-20 Estimate (95% CI)
Total N	248684	138694	141144	142591	144695
Potential preventable dental hospitalisation (primary only) **N**	1.52 (1.38-1.69) 380	0.73 (0.58-0.87) 101	0.62 (0.49-0.75) 88	0.76 (0.67-0.97) 116	0.57 (0.45-0.69) 82
Potential preventable dental hospitalisation (primary + secondary) **N**	4.69 (4.43-4.97) 1167	2.19 (1.94-2.43) 304	2.03 (1.80-2.27) 287	2.20 (1.96-2.45) 313	1.95 (1.73-2.18) 282
Potential preventable ED presentations **N**	1.42 (1.23-1.58) 353	0.52 (0.40-0.64) 72	0.62 (0.49-0.75) 88	0.73 (0.59-0.87) 105	0.62 (0.50-0.75) 90
Hospitalisations for dental requiring anaesthesia **N**	0.86 (0.76-0.99) 215	0.39 (0.28-0.49) 54	0.37 (0.27-0.47) 52	0.44 (0.33-0.55) 62	0.35 (0.25-0.45) 50
Dental extractions and restoration **N**	0.77 (0.67-0.88) 191	0.34 (0.24-0.44) 47	0.33 (0.24-0.43) 47	0.40 (0.30-0.51) 57	0.30 (0.21-0.39) 43
Oral and dental disorders **N**	3.20 (2.98-3.43) 795	1.45 (1.25-1.65) 202	1.34 (1.15-1.53) 188	1.66 (1.44-1.87) 235	1.29 (1.11-1.48) 186
Hospitalisations for pneumonia with an associated secondary dental diagnosis **N**	2.83 (2.63-3.05) 705	1.20 (1.02-1.38) 166	1.34 (1.15-1.53) 189	1.37 (1.18-1.57) 196	1.11 (0.94-1.28) 162
Hospitalisations for sepsis with an associated secondary dental diagnosis **N**	1.48 (1.34-1.64) 369	0.63 (0.50-0.77) 88	0.68 (0.54-0.82) 96	0.60 (0.48-0.73) 86	0.70 (0.57-.85) 103
Any dental-related hospitalisation (primary and secondary diagnosis) **N**	19.9 (19.4-20.5) 4954	9.05 (8.55-9.55) 1257	9.17 (8.67-9.67) 1294	9.32 (8.82-9.83) 1329	8.74 (8.26-9.22) 1263

Abbreviations: CI, confidence intervals.

Table S21. Rates of oral / dental-related hospitalisations per 1000 residents by gender, age and presence of dementia.

	Rate per 1000 residents (95% CI)						
	Male N=91863	**Female** N=156821	**<80 yr** N=59517	**80-89 yr** N=124125	**>=90 yr** N=65042	**No dementia** N= 116989	**Dementia** N=131695
Potential preventable dental hospitalisation (primary only)	1.77 (1.52-2.07)	1.38 (1.21-1.58)	2.67 (2.29-3.12)	1.37 (1.18-1.59)	0.78 (0.60-1.03)	1.44 (1.24-1.68)	1.69 (1.40-1.83)
N	163	217	159	170	51	169	211
Potential preventable dental hospitalisation (primary and secondary)	5.24 (4.79-5.72)	4.37 (4.06-4.71)	6.67 (6.05-7.36)	4.61 (4.25-5.00)	3.04 (2.65-3.50)	5.54 (5.13-5.98)	3.94 (3.62-4.29)
N	481	686	397	572	198	648	519
Potential preventable ED presentations	1.52 (1.29-1.80)	1.36 (1.19-1.55)	1.92 (1.59-2.30)	1.24 (1.06-1.45)	1.31 (1.06-1.62)	1.62 (1.41-1.87)	1.24 (1.06-1.44)
N	140	213	114	154	85	190	163
Hospitalisations for dental requiring anaesthetic	1.24 (1.03-1.49)	0.64 (0.53-0.78)	1.98 (1.66-2.37)	0.68 (0.55-0.85)	0.18 (0.11-0.32)	0.74 (0.60-0.92)	0.97 (0.81-1.16)
N	114	101	118	85	12	87	128
Dental extractions and restoration AR-DRG D40	1.10 (0.91-1.34)	0.57 (0.47-0.71)	1.76 (1.46-2.14)	0.61 (0.49-0.77)	0.15 (0.08-0.28)	0.62 (0.49-0.77)	0.90 (0.76-1.08)
N	101	90	105	76	10	72	119
Oral and dental disorders AR-DRG D67	3.90 (3.51-4.32)	2.38 (1.34-1.72)	3.53 (3.08-4.04)	2.94 (2.65-3.26)	2.41 (2.07-2.82)	3.31 (2.99-3.65)	2.61 (2.36-2.91)
N	358	374	210	365	157	387	345
Hospitalisations for pneumonia with an associated secondary dental diagnosis	3.80 (3.42-4.21)	2.27 (2.05-2.52)	3.41 (2.97-3.91)	2.83 (2.55-3.14)	2.34 (1.99-2.74)	3.23 (2.92-3.57)	2.48 (2.22-2.77)
N	349	356	203	351	152	378	327
Hospitalisations for sepsis with an associated secondary dental diagnosis	1.85 (1.74-2.32)	1.27 (1.10-1.46)	2.00 (1.67-2.39)	1.47 (1.27-1.70)	1.04 (0.82-1.33)	1.69 (1.47-1.94)	1.30 (1.11-1.51)
N	170	199	119	182	68	198	171
Any dental-related hospitalisation (primary and secondary diagnosis)	21.8 (20.9-22.8)	18.8 (18.2-19.5)	25.8 (24.5-27.1)	19.9 (19.1-20.7)	14.6 (13.7-15.6)	22.3 (21.5-23.2)	17.8 (17.1-18.5)
N	2002	2952	1535	2467	952	2614	2340

Abbreviations: CI, confidence intervals.

Table S22. Rates of oral / dental-related hospitalisations per 1000 residents by state and remoteness

	SA Estimate (95% CI)	NSW Estimate (95% CI)	VIC Estimate (95% CI)	Major city Estimate (95% CI)	Regional/remote Estimate (95% CI)
Total N	32808	119617	96259	176984	70899
Potential preventable dental hospitalisation (Primary only)	1.71 (1.31-2.22)	1.57 (1.36-1.81)	1.41 (1.19-1.67)	1.42 (1.25-1.60)	1.82 (1.53-2.16)
N	56	188	136	251	129
Potential preventable dental hospitalisation (Primary and Secondary)	4.27 (3.62-5.03)	5.07 (4.68-5.48)	4.37 (0.40-0.48)	4.86 (4.55-5.19)	4.32 (3.86-4.83)
N	140	606	421	860	306
Potential preventable ED presentations	1.37 (1.03-1.83)	2.12 (1.88-2.40)	0.56 (0.43-0.73)	1.49 (1.32-1.68)	1.24 (1.01-1.53)
N	45	254	54	264	88
Hospitalisations for dental requiring anaesthetic	0.88 (0.62-1.27)	0.83 (0.68-1.01)	0.78 (0.62-0.98)	0.75 (0.63-0.88)	1.17 (0.94-1.45)
	29	99	75	132	83
Dental extractions and restoration AR-DRG D40	0.85 (0.59-1.23)	0.80 (0.66-0.98)	0.70 (0.55-0.88)	0.63 (0.52-0.76)	1.13 (0.91-1.40)
N	28	96	67	111	80
Oral and Dental Disorders AR-DRG D67	3.69 (3.09-4.40)	3.36 (3.05-3.71)	2.83 (2.51-3.18)	3.28 (3.02-3.55)	3.00 (2.63-3.43)
N	121	402	272	580	213
Hospitalisations for pneumonia with an associated secondary dental diagnosis	3.87 (3.31-4.67)	2.91 (2.62-3.23)	2.67 (2.36-3.02)	3.18 (2.93-3.46)	2.10 (1.79-2.47)
N	127	348	257	564	149
Hospitalisations for sepsis with an associated secondary dental diagnosis	1.00 (0.72-1.43)	1.69 (1.47-1.94)	1.39 (1.18-1.65)	1.67 (1.49-1.87)	1.04 (0.83-1.31)
N	33	202	134	295	74
Any dental-related hospitalisation (primary and secondary diagnosis)	22.6 (21.0-24.3)	20.0 (19.2-20.8)	18.9 (18.1-19.8)	21.5 (20.8-22.2)	16.0 (15.1-16.9)
N	741	2394	1819	3804	1134

Abbreviations: CI, confidence intervals. SA, South Australia; NSW, New South Wales; VIC, Victoria.

Table S23. Age and sex standardised rate of dental practitioner health services (MBS) utilisation per 1000 residents

	Overall Estimate (95% CI)	2016-17 Estimate (95% CI)	2017-18 Estimate (95% CI)	2018-19 Estimate (95% CI)	2019-20 Estimate (95% CI)
Total N	360305	198734	202879	206001	210590
MBS					
Dental practitioner health services	1.84 (1.71-1.99)	0.91 (0.78-1.05)	0.90 (0.77-1.03)	0.93 (0.80-1.06)	0.68 (0.57-0.79)
N	665	182	182	192	142

Abbreviations: CI, confidence intervals.

Table S24. Rates of dental practitioner health services (MBS) utilisation per 1000 residents, by sex age and dementia status

	Male Estimate (95% CI)	Female Estimate (95% CI)	<80 yr Estimate (95% CI)	80-89 yr Estimate (95% CI)	>=90 yr Estimate (95% CI)	No dementia Estimate (95% CI)	Dementia Estimate (95% CI)
Total N	133816	226489	8976	179291	92038	167995	192310
MBS							
Dental practitioner health services	1.43 (1.25-1.65)	2.09 (1.91-2.29)	2.09 (1.81-2.41)	1.90 (1.71-2.11)	1.50 (1.27-1.77)	2.40 (2.18-2.65)	1.36 (1.20-1.53)
N	192	473	186	341	138	404	261

Abbreviations: CI, confidence intervals.

Table S25. Rates of dental practitioner health services (MBS) utilisation per 1000 residents, by state and remoteness

	SA Estimate (95% CI)	NSW Estimate (95% CI)	VIC Estimate (95% CI)	QLD estimate (95% CI)	TAS Estimate (95% CI)	WA Estimate (95% CI)	NT Estimate (95% CI)	ACT Estimate (95% CI)	Major city Estimate (95% CI)	Regional/ remote Estimate (95% CI)
Total N	32808	119617	96259	66352	9254	3819	603	4,593	250957	108397
MBS										
Dental practitioner health services	2.01 (1.58-2.56)	1.71 (1.49-1.96)	2.64 (2.33-2.98)	1.18 (0.94-1.47)	1.51 (0.90-2.54)	1.56 (1.18-2.06)	<6[#]	<6[#]	1.80 (1.64-1.97)	1.96 (1.71-2.24)
N	66	204	254	78	14	48			452	212

[#]Unable report due to small numbers.

Abbreviations: CI, confidence intervals. SA, South Australia; NSW, New South Wales; VIC, Victoria; QLD, Queensland; TAS, Tasmania; WA, Western Australia; NT, Northern Territory; ACT, Australian Capital Territory

Table S26. Age and sex standardised rate of medication utilisation by dental practitioner prescriber and dental/medical prescribing per 1000 residents

	Overall Estimate (95% CI)	2016-17 Estimate (95% CI)	2017-18 Estimate (95% CI)	2018-19 Estimate (95% CI)	2019-20 Estimate (95% CI)
Total N	360305	198734	202879	206001	210590
Dental and medical practitioner prescriptions: Stomatological preparations-overall	15.8 (15.4-16.2)	8.57 (8.16-8.98)	8.07 (7.68-8.46)	7.95 (7.56-8.33)	7.56 (7.18-7.93)
N	5706	1705	1638	1634	1584
Dental practitioner prescriptions: Stomatological preparations	0.24 (0.20-0.30)	0.14 (0.09-0.19)	0.12 (0.08-0.17)	0.10 (0.05-0.15)	0.07 (0.04-0.11)
N	87	28	25	21	16
Dental and medical practitioner prescriptions: Antibacterial for systemic use	741.1 (739.7-742.6)	612.6 (609.1-616.0)	603.3 (600.0-606.7)	602.6 (599.2-605.9)	572.8 (569.5-576.0)
N	267031	121677	122396	124209	120782
Dental practitioner prescriptions: Antibacterial for systemic use	16.6 (16.2-17.0)	8.50 (8.09-8.90)	8.31 (7.91-8.71)	8.44 (8.05-8.84)	6.78 (6.43-7.13)
N	988	1,691	1686	1739	1428
Dental and medical practitioner prescriptions: Anti-inflammatory and anti-rheumatic	24.4 (23.9-24.9)	14.1 (13.6-14.6)	12.8 (12.3-13.3)	12.9 (12.4-13.4)	12.7 (12.3-13.2)
N	8776	2807	2605	2645	2672
Dental practitioner prescriptions: Anti-inflammatory and anti-rheumatic, N	0.12 (0.09-0.16)	0.06 (0.03-0.10)	0.06 (0.03-0.10)	0.04 (0.02-0.07)	0.04 (0.01-0.07)
	43	13	13	9	9
Dental and medical practitioner prescriptions: Analgesics	560.5 (558.9-562.1)	363.8 (361.2-366.5)	366.7 (364.0-369.3)	361.0 (358.4-363.6)	355.4 (352.9-358.0)
N	201941	72277	74391	74424	74941
Dental practitioner prescriptions: Analgesics	1.59 (1.47-1.73)	0.72 (0.60-0.84)	0.79 (0.67-0.91)	0.73 (0.62-0.85)	0.65 (0.54-0.76)
N	574	143	160	151	137
Dental and medical practitioner prescriptions: Psycholeptics	380.8 (379.2-382.4)	326.1 (323.6-328.6)	319.0 (316.5-321.5)	303.5 (301.1-305.9)	265.5 (263.3-267.7)
N	137205	64873	64717	62461	55780
Dental prescriptions: Psycholeptics	0.14 (0.10-0.18)	0.04 (0.01-0.07)	0.10 (0.05-0.15)	0.08 (0.04-0.12)	0.03 (0.02-0.07)
N	49	8	21	16	7
Topical/oral liquid antifungals (miconazole, nyastin, fluconazole)	0.55 (0.47-0.63)	0.15 (0.09-0.20)	0.26 (0.19-0.33)	0.28 (0.21-0.35)	0.37 (0.29-0.46)
N	197	29	53	58	78

Abbreviations: CI, confidence intervals.

SUPPLEMENT 7: SENSITIVITY ANALYSES PUBLIC AND PRIVATE HOSPITALISATIONS (NSW AND VIC)

Table S27. Age and sex standardised cumulative incidence of oral health / dental-related public hospitalisations for NSW and VIC

	2016-17 Estimate (95% CI)	2017-18 Estimate (95% CI)	2018-19 Estimate (95% CI)	2019-20 Estimate (95% CI)
Total N	120319	122627	123857	125717
Potential preventable dental hospitalisation (Primary only)	0.08 (0.06-0.09)	0.06 (0.05-0.08)	0.08 (0.06-0.09)	0.06 (0.04-0.07)
N	86	79	96	70
Potential preventable dental hospitalisation Median length of stay	2 (1-5)	2 (1-4)	2 (1-5)	2 (1-4)
Potential preventable dental hospitalisation (Primary + secondary)	0.22 (0.20-0.25)	0.21 (0.18-0.23)	0.22 (0.20-0.25)	0.20 (0.17-0.22)
N	267	256	274	248
Potential preventable dental hospitalisation – Median length of stay	7 (3-14)	6 (3-11)	6 (3-16)	7 (3-14)
Hospitalisations for dental requiring anaesthetic	0.04 (0.03-0.05)	0.04 (0.03-0.05)	0.04 (0.03-0.05)	0.03 (0.02-0.04)
N	48	47	51	43
Hospitalisations for dental requiring anaesthetic - Median length of stay	2 (1-4)	1 (1-4)	2 (1-7)	2.5 (1-8)
Dental extractions and restoration	0.03 (0.02-0.05)	0.04 (0.03-0.05)	0.04 (0.03-0.05)	0.03 (0.02-0.04)
N	41	43	46	36
Dental extractions and restoration – Median length of stay	1 (1-2)	1 (1-3)	1 (1-4)	2(1-3)
Oral and Dental Disorders	0.14 (0.12-0.16)	0.14 (0.12-0.16)	0.16 (0.14-0.18)	0.13 (0.11-0.15)
N	170	166	194	159
Oral and Dental Disorders – Median length of stay	2 (1-4)	2 (1-4)	2 (1-5)	2 (1-4)
Hospitalisations for pneumonia with an associated secondary dental diagnosis	0.12 (0.10-0.14)	0.13 (0.11-0.15)	0.13 (0.11-0.15)	0.11 (0.09-0.13)
N	140	159	157	137
Hospitalisations for pneumonia with an associated secondary dental diagnosis – Median length of stay	6 (4-10)	7 (4-12)	7 (4-11)	7 (4-12)
Hospitalisations for sepsis with an associated secondary dental diagnosis	0.07 (0.05-0.08)	0.07 (0.06-0.09)	0.06 (0.05-0.08)	0.07 (0.06-0.09)
N	83	88	79	90
Hospitalisations for sepsis with an associated secondary dental diagnosis – Median length of stay	8 (5-12)	8 (5-12.5)	7 (5-10)	9 (6-14)
Any dental-related hospitalisation (primary and secondary diagnosis)	0.89 (0.84-0.95)	0.89 (0.84-0.95)	0.90 (0.85-0.96)	0.84 (0.79-0.89)
N	1077	1096	1118	1059
Any dental-related hospitalisation (primary and secondary diagnosis) - Median length of stay (IQR)	6 (3-12)	7 (3-12)	7 (3-13)	7 (4-13)

Abbreviations: CI, confidence intervals; NSW, New South Wales; VIC, Victoria.

Table S28. Age and sex standardised cumulative incidence of oral / dental-related public and private hospitalisations for NSW and VIC

	2016-17 Estimate (95% CI)	2017-18 Estimate (95% CI)	2018-19 Estimate (95% CI)	2019-20 Estimate (95% CI)
Total N	120319	122627	123857	125717
Potential preventable dental hospitalisation (Primary only) **N**	0.18 (0.16-0.21) 221	0.20 (0.17-0.22) 240	0.21 (0.18-0.23) 254	0.15 (0.12-0.17) 182
Potential preventable dental hospitalisation – Median length of stay (IQR)	1 (1-2)	1 (1-2.5)	1 (1-2)	1 (1-3)
Potential preventable dental hospitalisation (Primary + secondary) **N**	0.36 (0.32-0.39) 432	0.36 (0.33-0.40) 443	0.38 (0.34-0.41) 465	0.31 (0.28-0.34) 382
Potential preventable dental hospitalisation – Median length of stay (IQR)	6 (2-14)	5 (2-10)	5 (1-13)	6 (2-12)
Potential preventable ED presentations	0.05 (0.04-0.07)	0.07 (0.05-0.08)	0.07 (0.06-0.09)	0.06 (0.05-0.07)
Hospitalisations for dental requiring anaesthetic **N**	0.16 (0.14-0.18) 162	0.18 (0.15-0.20) 218	0.18 (0.15-0.20) 219	0.13 (0.11-0.15) 164
Hospitalisations for dental requiring anaesthetic - Median length of stay (IQR)	1 (1-2)	1 (1-1)	1 (1-2)	1 (1-3)
Dental extractions and restoration **N**	0.15 (0.13-0.18) 185	0.17 (0.15-0.20) 211	0.17 (0.15-0.20) 212	0.12 (0.10-0.14) 153
Dental extractions and restoration – Median length of stay (IQR)	1 (1-1)	1 (1-1)	1 (1-1)	1 (1-2)
Oral and Dental Disorders **N**	0.27 (0.24-0.30) 322	0.29 (0.26-0.32) 351	0.31 (0.28-0.34) 381	0.23 (0.21-0.26) 292
Oral and Dental Disorders – Median length of stay (IQR)	1 (1-3)	1 (1-3)	1 (1-3)	1 (1-4)
Hospitalisations for pneumonia with an associated secondary dental diagnosis **N**	0.13 (0.11-0.15) 153	0.15 (0.13-0.17) 187	0.14 (0.12-0.16) 176	0.12 (0.10-0.14) 149
Hospitalisations for pneumonia with an associated secondary dental diagnosis – Median length of stay (IQR)	6 (4-11)	8 (4-13)	7 (4-12)	7 (4-12)
Hospitalisations for sepsis with an associated secondary dental diagnosis **N**	0.07 (0.06-0.09) 89	0.08 (0.06-0.09) 97	0.07 (0.05-0.08) 83	0.07 (0.06-0.09) 95
Hospitalisations for sepsis with an associated secondary dental diagnosis – Median length of stay (IQR)	9 (5-14)	8 (6-14)	7.5 (5-11)	9.5 (6-14)
Any dental-related hospitalisation (primary and secondary diagnosis) **N**	1.10 (1.04-1.16) 1330	1.14 (1.08-1.20) 1402	1.16 (1.10-1.22) 1431	1.01 (0.95-1.06) 1267
Any dental-related hospitalisation (primary and secondary diagnosis) - Median length of stay (IQR)	6 (3-13)	7 (3-13)	7 (3-13)	7 (4-13)

Abbreviations: CI, confidence intervals; NSW, New South Wales; VIC, Victoria.