The burden of psychotropic and anticholinergic medicines use in care homes

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The burden of psychotropic and anticholinergic medicines use in care homes: population-based analysis in 147 care homes

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Keypoints:	Two-thirds of care home residents were prescribed at least one psychotropic drug, and one-quarter prescribed two or more; half, Prescribing of all drugs was lowest in those aged 85 years and over. In people with dementia antipsychotic use was higher but, There were no significant associations between prescribing and quality grading by the independent care home regulator., Antipsychotic prescribing and anticholinergic burden remain high despite guidance to avoid in this population., Research to examine adverse effects of complex combinations of drugs affecting cognition in this population is required.

The burden of psychotropic and anticholinergic medicines use in care-homes: population-based analysis in 147 care-homes

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Abstract

Background: Older people living in care-homes are particularly vulnerable to adverse effects of psychotropic and anticholinergic drugs.

Methods: Anonymised dispensed prescription data from all 4478 residents aged ≥60 years in 147 care-homes in two Scottish health boards were analysed. Psychotropic medicines examined were antipsychotics, antidepressants, hypnotic/anxiolytics, opioids and gabapentinoids. Anticholinergic burden was measured using the modified Anticholinergic Risk Scale (mARS). Variation between care-homes and associations with individual and care-home characteristics were examined using multilevel logistic regression.

Results: 63.5% of residents were prescribed at least one psychotropic drug, and 27.0% two or more, most commonly antidepressants (41.6%), opioids (20.3%), hypnotic/anxiolytics (16.9%) and antipsychotics (16.7%). 48.1% were prescribed an anticholinergic drug, and 12.1% had high anticholinergic burden (mARS≥3). Variation between care-homes was high for antipsychotics (intra-cluster correlation coefficient [ICC] 8.2%) and hypnotics/anxiolytics (ICC=7.3%), and moderate for antidepressants (ICC=4.7%) and anticholinergics (ICC=2.8%). Prescribing of all drugs was lower in the oldest old. People with dementia were more likely to be prescribed antipsychotics (adjusted OR=1.45, 95%CI 1.23-1.71) but less likely to be prescribed anticholinergics (aOR=0.61, 95%CI 0.51-0.74). Prescribing of antipsychotics was higher in Tayside (aOR=1.52, 95%CI 1.20-1.92), whereas prescribing of antidepressants (particularly tricyclic-related) was lower (aOR=0.66, 95%CI 0.56-0.79). There was no association with care-home regulator quality scores.

Conclusion: Care-home residents have high psychotropic and anticholinergic burden, with considerable variation between care-homes which is not related to existing measures of quality of care. Research to better understand variation between care-homes and the interaction with local prescribing cultures is needed.

Key words: psychotropic prescribing, anticholinergic drugs, dementia, care-homes, prescribing safety

Key points

- Two-thirds of care-home residents were prescribed at least one psychotropic drug, and one-quarter prescribed two or more; half were prescribed an anticholinergic drug, and one in eight had high anticholinergic burden.
- Prescribing of all drugs was lowest in those aged 85 years and over. In people with dementia antipsychotic use was higher but anticholinergic use lower.
- There were no significant associations between prescribing and quality grading by the independent care-home regulator.
- Antipsychotic prescribing and anticholinergic burden remain high despite guidance to avoid in this population.
- Research to examine adverse effects of complex combinations of drugs affecting cognition in this population is required.

Introduction

Many medicines have adverse effects on cognition or cause sedation. Psychotropic medicines have intended effects on the brain and include hypnotics, anxiolytics, antidepressants, antipsychotics, opioids, and gabapentinoids, but many medicines also have unintended anticholinergic or other effects on cognition or sedation. Older people living in care-homes are a particularly vulnerable population, because the majority have cognitive impairment or dementia [1]. Additionally, most are physically frail, and therefore more at risk of both drug adverse effects and of serious harm if an adverse effect happens (for example, falls and injurious harm).

Antipsychotic drugs are frequently prescribed to manage the behavioural and psychological symptoms of dementia (BPSD). There is good evidence that antipsychotics have small benefits in terms of improved BPSD, but they are known to significantly increase the risk of death and stroke [2-6]. Antipsychotic drugs in older people with dementia have therefore been the subject of multiple regulatory risk communications and policy interventions [7]. There is mixed evidence of reduced prescribing in the UK as a result [3,6], although little evidence of change in prescribing patterns within English care-homes [4]. However, the broader burden of psychotropic and anticholinergic medicines in older people is considerable, particularly in people with dementia [2,8].

Antidepressants are among the most commonly prescribed psychoactive drugs in care-homes and are associated with an increased falls risk [9]. Older residents are more commonly prescribed benzodiazepines and z-drugs than those living in their own homes [10,11]. There are additional concerns about anticholinergic (antimuscarinic) medicines, which are associated with a range of adverse drug reactions in older people including falls, delirium, and longer-term decline in cognitive function [8,12,13].

However, whereas previous studies have examined the use of individual medicine classes in care-homes, there is less data about total psychotropic and anticholinergic burden, about variation in prescribing between care-homes, and whether prescribing is associated with care-home characteristics or independent quality evaluations by regulators [2,4,8]. The aims of this study were to measure psychotropic and anticholinergic burden in all older people

living in care-homes in two Scottish health boards with a population of ~750,000, and to examine variation in prescribing between care-homes.

Methods

This is a cross-sectional analysis of linked routine data for all care-home residents aged ≥60 years in the Tayside and Fife regions of Scotland, UK on 31/3/17.

Care-home residents were identified using a validated algorithm matching individual's addresses recorded in the Scottish Master Community Health Index (CHI) with care-home addresses recorded by the Care Inspectorate [14] with additional manual validation of all flagged addresses. Data for individuals were extracted from Master CHI (demographics) and linked to community-dispensed prescribing and hospital admission data. For each care-home, publicly available data was accessed to identify care-home characteristics and quality reports from the national regulator of care-home services, the Care Inspectorate [15]. Datasets were linked at the individual level using the CHI number (the NHS Scotland unique identifier). Medicines were defined as 'currently prescribed' if they were dispensed in the 56 days before 31/3/17.

Outcomes. Psychotropic drugs were defined as oral antipsychotics (drugs in British National Formulary [16] (BNF) chapter 4.2.1), hypnotics (BNF 4.1.1), anxiolytics (BNF 4.1.2), antidepressants (BNF 4.3 subcategorised into tricylic, tricyclic-related, selective serotonin reuptake inhibitor, and other antidepressants), opioids (BNF 4.7.2 and opioid-containing combinations in BNF 4.7.1) subcategorised into weak and strong opioids (Supplementary Table S1) and gabapentinoids (gabapentin/pregabalin). Total anticholinergic burden was calculated for each resident using a modification (mARS) of the Anticholinergic Risk Scale to account for UK-licenced medicines (Supplementary Table S2) [8]. Medicines are scored in terms of anticholinergic potential (1=moderate; 2=strong; 3=very strong). The total mARS score is the sum of scores for currently prescribed anticholinergic medicines. mARS score ≥3 was defined as high anticholinergic burden consistent with the original scale derivation showing that >89% of such patients experience at least one anticholinergic side-effect [17].

Other variables. Patient data included sex, age, and diagnosis of dementia defined as a prescription ever of a dementia drug (memantine, galantamine, donepezil, or rivastigmine), or dementia being coded as a hospital discharge diagnosis (International Classification of Diseases 10 codes 'F00', 'F01', 'F02', 'F03', 'F051', 'G30', and 'G311'). Care-home data included number of beds, ownership (private, not-for-profit or voluntary), whether providing residential or nursing care, the number of general practices providing medical care derived from data on resident's registered general practitioner, the number of complaints about the care-home upheld by the Care Inspectorate in the last three years (dichotomised into <3 or ≥3 complaints), and most recent Care Inspectorate grading [18] of quality of (i) staffing, (ii) management and leadership, (iii) care and support, and (iv) environment (originally a six point scale, categorised as 1-3=inadequate, 4=good, 5-6=excellent).

Statistical Analysis

Counts/percentages of psychotropic prescribing and mARS scores were calculated using R (v3.2.5) and multilevel logistic regression modelling carried out in Stata (v14). Two-level hierarchical logistic regression was used to investigate how prescribing of antipsychotics, antidepressants, hypnotics and anxiolytics and high anticholinergic burden (total mARS score ≥3) varied between care-homes, and associations with resident and care-home characteristics. Univariate odds ratios (OR) were calculated for resident and care-home variables, and adjusted ORs from multivariate models which included variables with statistically significant univariate associations. The level of statistical significance used was 5%, and all OR are therefore reported with 95% confidence intervals. Variation between care-homes was examined by calculating the intracluster correlation coefficient and estimating the median odds ratio [19].

Ethical and other approvals

Analysis of anonymised data in the University of Dundee Health Informatics Centre (HIC) accredited safe haven environment followed HIC Standard Operating Procedures which have been approved by East of Scotland Research Ethics Committee (REC) and Tayside and Fife Caldicott Guardians.

Results

There were 4478 people age ≥60 years resident in one of 147 care-homes on 31/3/17. The majority (71.4%) of residents were women, with a mean age of 86.6 (SD 7.6) years compared to mean age in men of 82.2 (SD 8.8) years, and 2160 (48.2%) residents were known to have dementia. The median number of beds was 37 (range=3-100), 71 (48.3%) care-homes provided nursing care with the remainder classed as residential, and 117 (79.6%) were privately owned. Primary medical care for residents was provided by a single general practice in 26 care-homes (17.7%), with the remainder served by two or more practices. Thirty-two (21.8%) care-homes had ≥3 complaints upheld by the Care Inspectorate over the last three years. Quality of care and support was rated inadequate in 26 (17.7%), good in 55 (37.4%) and excellent in 66 (44.9%) care-homes, compared to 25 inadequate (17.0%), 49 good (33.3%) and 73 excellent (49.7%) for quality of staffing, 28 inadequate (19.0%), 49 good (33.3%) and 70 excellent (47.6%) for quality of management and leadership, and 20 inadequate (13.6%), 57 good (38.8%) and 70 excellent (47.6%) for quality of environment.

The prevalence of psychotropic and anticholinergic prescribing is shown in Table 1. Of the drug-classes analysed in this study, antidepressants were the most frequently currently prescribed drug-class (1865 [41.6%] of residents currently prescribed), compared to opioids (907, 20.3%), hypnotics and anxiolytics (759, 16.9%), antipsychotics (746, 16.7%), and gabapentinoids (174, 3.9%). Half of residents were not prescribed any anticholinergic drugs, with moderate anticholinergic burden (mARS 1-2) in 1616 (36.1%) and high burden (mARS ≥3) in 540 (12.1%) (Table 1 and Supplementary Table S3). There were large (in absolute terms) differences in prescribing of antidepressants and antipsychotics in the two Health Boards, with NHS Tayside using more antipsychotics (18.5% vs 13.8% in NHS Fife) and NHS Fife using more antidepressants (47.7% vs 37.6% in NHS Tayside, predominately because of higher use of trazodone).

Almost two-thirds of residents were prescribed at least one psychotropic drug (Table 2). Combination treatment was common, with 36.5% of residents currently prescribed a psychotropic drug, 19.5% two, and 7.5% three or more. There was little difference between

the two health boards in rates of combination treatment use, although there was underlying variation in the choice of drugs prescribed.

Table 3 summarises significant adjusted associations with current prescribing of antipsychotics, anti-depressants, hypnotic-anxiolytics, and high anticholinergic burden (full models are shown in Supplementary Tables S4-S7). For antipsychotic prescribing, being resident in a care-home in NHS Tayside (OR 1.52, 95%CI 1.20-1.92) and having dementia (OR 1.45, 95%CI 1.23-1.71) were associated with increased antipsychotic use, whereas increasing age was associated with decreased use (age 85+ years vs age 60-71, OR 0.36, 95%CI 0.28-0.45). Similar patterns of decreasing psychotropic use and anticholinergic burden with increasing age were seen for all other outcomes. Antidepressant use was lower in NHS Tayside than NHS Fife (OR 0.66, 95%CI 0.56-0.79), and high anticholinergic burden was lower in people with dementia (OR 0.61, 95%CI 0.51-0.74) although 9.3% of residents with dementia had mARS≥3. Hypnotic/anxiolytic use was lower in residential homes compared to nursing homes (OR 0.80, 95%CI 0.63 to 1.01) although the observed adjusted difference is marginally non-significant. No other variables were significantly associated with any outcome, including care-home ownership, size, Care Inspectorate quality ratings, and upheld complaints.

There was evidence of significant variation between care-homes in all four prescribing outcomes. The empty model intracluster correlation coefficients (the proportion of variation in prescribing attributable to differences between care-homes) was 8.2% for antipsychotics, 4.7% for antidepressants, 7.3% for hypnotic/anxiolytics, and 2.8% for high anticholinergic burden. After adjustment for care-home and patient characteristics, median odds ratios (MOR) were 1.54 for current antipsychotic use (95% CI 1.36-1.73), 1.41 for current antidepressant use (95% CI 1.29-1.53), 1.58 for current hypnotic/anxiolytic use (95% CI 1.41-1.78) and 1.30 for current mARS score ≥ 3 (95% CI 1.11-1.52) (the MOR is the median odds ratio for two patients randomly selected from different care homes, and is a measure of unexplained variation between care homes on the same scale as resident or care home characteristics).

Discussion

Just under two-thirds of older care-home residents were prescribed at least one psychotropic drug, and one-quarter at least two, most commonly antidepressants (41.6% of residents), opioids (20.3%), hypnotic/anxiolytics (16.9%) and antipsychotics (16.7%). Prescribing was less common in the oldest old, with people with dementia more likely to be prescribed antipsychotics (which are known to have small benefit and major harm in this population) but with lower anticholinergic burden (which is associated with worsened cognition). NHS Tayside residents were more likely to be prescribed antipsychotics but less likely to be prescribed antidepressants (particularly trazodone) than NHS Fife residents. There was significant unexplained variation between care-homes (although less so for anticholinergic burden than psychotropic drugs), but no care-home level variables other than health board were significantly associated with prescribing, and in particular there was no association with external inspection ratings of quality of care.

Strengths of the analysis include use of complete population data with robust ascertainment of care-home residence [14], and the use of community-dispensed prescription data to measure drug exposure. This is in contrast to many previous studies which have been in volunteer or research cohorts [20,21]. Limitations are that care-home residence relied on matching permanent addresses in Master CHI file, meaning that the findings may not apply to short-term or temporary residents. Dispensed medicines may also be used as required rather than regularly, which may mean we over-estimate co-prescribing. Just under half of residents were identified by routine data as having dementia, compared to previous estimates of 62% of Scottish long-stay care-home residents, likely reflecting that dementia in this population is not always coded [22,23], so observed associations with dementia may be biased in either direction. Finally, the study does not examine whether exposure is actually associated with adverse events, meaning we cannot be certain whether the observed prescribing is harmful, although all the drugs examined are known to have a number of significant adverse effects, particularly in frail populations [7,8].

Antipsychotic and hypnotic/anxiolytic prescribing rates were similar to a previous population study of people with dementia in Scotland, but higher antidepressant prescribing rates were observed in this study (41.6% vs 28.7%) [2]. Antipsychotic prescribing rates were

comparable to other studies in the UK [4] and internationally [24, 25], and it is notable that there is little evidence that antipsychotic prescribing in UK care-homes changed after major policy initiatives to reduce antipsychotic use in people with dementia in 2009 [4]. High anticholinergic burden was similar to that reported in previous studies although prevalence in this context will vary with the tool used to measure anticholinergic burden [26,27]. Few studies have examined cumulative burden of psychotropic medicines [2]. Ruths et al examined cumulative burden in Norwegian nursing homes, finding that in 2009, 22.9% were prescribed an antipsychotic, 50.9% an antidepressant, 21.9% an anxiolytic and 19.1% a hypnotic, with 32.7% prescribed two or more of the four drug classes (similar to this study) [28].

Studies examining variation in prescribing are less common, but where done have found evidence of considerable variation between care-homes in the UK, France and Canada [4,26,29]. Facility-level characteristics such as size (number of beds), setting (rural, non-rural), ownership (private, public) and arrangements for medical care have been found to be associated with variation in inappropriate prescribing [4,26,29], but we did not find any statistically significant associations between psychotropic prescribing and care-home characteristics (including size, external ratings of quality, and upheld complaints). We did observe relatively large differences in prescribing practice between the two health boards, similar to large geographical variation in antipsychotic use in a previous English study [4]. Although we cannot exclude residual confounding due to casemix variation, there is therefore evidence that both care-home and wider medical 'culture' may influence patterns of prescribing.

This study quantifies the individual and total burden of multiple drugs with psychotropic effects, finding that just under two-thirds of residents were prescribed at least one such drug, and over one-quarter of residents prescribed two or more. There is good evidence that antipsychotic prescribing in older people with dementia has small to modest benefits in behavioural disturbance, but carries significant risks of major harm [2-6]. More broadly, sedative and anticholinergic drug use in physically and cognitively frail older people is risky [8,12,13]. This study cannot identify whether prescribing is appropriate, but it is clearly risky and this vulnerable population needs regular review to ensure that such treatment is still

indicated and optimised. There was considerable unexplained variation between care-homes, and between the two health boards examined. It is likely that prescribing is driven by care-home characteristics (for example, staff tolerance to and response to BPSD) and by local prescribing cultures (given the observed greater prescribing of antipsychotics in one health board vs the observed greater prescribing of trazodone in the other). Improving prescribing is therefore likely to require interventions targeting both care-home staff and practices, and medical and non-medical prescribers providing care.

Conclusion

The burden of psychotropic prescribing in care-home residents is high. Use of antipsychotics remains common, but antidepressant and combination prescribing is strikingly high. Further research is needed to examine the harms of individual and combination psychotropic prescribing in care-homes, and to develop and evaluate interventions to optimise prescribing. Given rapidly changing needs in this frail and vulnerable population, potentially harmful prescribing of psychotropics needs regular careful review to ensure continued appropriateness.

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Conflicts of interest

None declared.

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Table 1. Prescribing of all drug classes

	All residents No. (%) of all residents N=4478	NHS Tayside No. (%) of all residents N=2685	NHS Fife No. (%) of all residents N=1793
Antidepressants	**1865 (41.6)**	**1009 (37.6)**	**856 (47.7)**
Selective serotonin reuptake inhibitor	847 (18.9)	509 (19.0)	338 (18.9)
Other[a]	720 (16.1)	394 (14.7)	326 (18.2)
Tricyclic-related	285 (6.4)	51 (1.9)	234 (13.1)
Tricyclic	173 (3.9)	106 (3.9)	67 (3.7)
Hypnotic/anxiolytic	**759 (16.9)**	**475 (17.7)**	**284 (15.8)**
Anxiolytic	449 (10.0)	295 (11.0)	154 (8.6)
Hypnotic	378 (8.4)	228 (8.5)	150 (8.4)
Antipsychotics	**746 (16.7)**	**498 (18.5)**	**248 (13.8)**
Atypical	573 (12.8)	392 (14.6)	181 (10.1)
Typical	187 (4.2)	117 (4.4)	70 (3.9)
Opioids[b]	**907 (20.3)**	**556 (20.7)**	**351 (19.6)**
Weak opioids	528 (11.8)	327 (12.2)	201 (11.2)
Strong opioids	423 (9.4)	255 (9.5)	168 (9.4)
Gabapentinoids	**174 (3.9)**	**92 (3.4)**	**82 (4.6)**
High anticholinergic burden (mARS score ≥3)[c]	**540 (12.1)**	**338 (12.6)**	**202 (11.3)**

a. Agomelatine, Duloxetine, Mirtazapine, Reboxetine, Venlafaxine were categorised as other antidepressants. 1 resident in each health board was prescribed a monamine oxidase inhibitor antidepressant.

b. Weak and strong opioids are listed in Supplementary table S1.

c. Medicines contributing to the mARS score are listed in Supplementary Table S2. Note that some of the psychotropic medicines in table 1 (eg tricyclic antidepressants, antipsychotics) also contribute to mARS score.

Table 2. Prescribing by Health Board – Psychotropic Combinations

	All residents No. (%) of all residents N=4478	NHS Tayside No. (%) of all residents N=2685	NHS Fife No. (%) of all residents N=1793
Psychotropic combinations*			
None	1634 (36.5)	1010 (37.6)	624 (34.8)
Only one psychotropic	1633 (36.5)	971 (36.2)	662 (36.9)
Any two psychotropic	874 (19.5)	487 (18.1)	387 (21.6)
Any three psychotropics	282 (6.3)	185 (6.9)	97 (5.4)
Any four psychotropics	51 (1.1)	30 (1.1)	21 (1.2)
All five psychotropics	4 (0.1)	2 (0.07)	2 (0.1)
Only one psychotropic			
Antidepressants alone	901 (20.1)	472 (17.6)	429 (23.9)
Opioids alone	291 (6.5)	189 (7.0)	102 (5.7)
Antipsychotics alone	219 (4.9)	155 (5.8)	64 (3.6)
Hypnotic/anxiolytics alone	191 (4.3)	135 (5.0)	56 (3.1)
Gabapentinoid alone	31 (0.7)	20 (0.7)	11 (0.6)
Two psychotropic combinations			
Antidepressant + opioid	254 (5.7)	132 (4.9)	122 (6.8)
Antidepressant + hypnotic/anxiolytic	191 (4.3)	93 (3.5)	98 (5.5)
Antipsychotic + antidepressant	187 (4.2)	107 (4.0)	80 (4.5)
Antipsychotic + hypnotic/anxiolytic	71 (1.6)	53 (2.0)	18 (1.0)
Antipsychotic + opioid	60 (1.3)	41 (1.5)	19 (1.1)
Hypnotic/anxiolytic + opioid	51 (1.1)	35 (1.3)	16 (0.9)
Antidepressant + gabapentinoid	30 (0.7)	12 (0.4)	18 (1.0)
Opioid + gabapentinoid	19 (0.4)	8 (0.3)	11 (0.6)
Hypnotic/anxiolytic + gabapentinoid	8 (0.2)	4 (0.1)	4 (0.2)
Antipsychotic + gabapentinoid	3 (0.06)	2 (0.07)	1 (0.06)

* Combinations of antipsychotics, antidepressants, hypnotic/anxiolytics, opioids and gabapentinoids.

Table 3. Adjusted associations of patient and care-home characteristics with four types of current prescribing

Variable[a]	Current anti-psychotic use Adjusted OR (95% CI) [b]	Current anti-depressant use Adjusted OR (95% CI) [b]	Current hypnotic/ anxiolytic use Adjusted OR (95% CI) [b]	Current mARS score≥3 Adjusted OR (95% CI) [b]
Care-home level				
Fife (n=57)	1	1	..	..
Tayside (n=90)	1.52 (1.20-1.92)	0.66 (0.56-0.79)		
Nursing home (n=71)	..	..	1	..
Residential home (n=76)			0.80 (0.63-1.01)[d]	
Patient level				
No dementia (n=2,318)	1	..	..	1
Dementia (n=2,160)	1.45 (1.23-1.71)			0.61 (0.51-0.74)
Aged 60-74 (n=492)	1	1	1	1
Aged 75-84 (n=1,309)	0.64 (0.50-0.82)	0.83 (0.67-1.03)	0.73 (0.57-0.95)	0.62 (0.47-0.81)
Aged 85+ (n=2,677)	0.36 (0.28-0.45)	0.55 (0.45-0.67)	0.62 (0.48-0.79)	0.37 (0.28-0.47)
Random effects null model				
Intracluster correlation coefficient	8.2% (5.3-12.5)	4.7% (3.1-7.1)	7.3% (4.7-11.3)	2.8% (1.1-7.1)
Random effects adjusted model				
Intracluster correlation coefficient	5.8% (3.41-9.71)	3.8% (2.3-6.0)	6.5% (4.1-10.3)	2.3% (0.7-6.9)
Median Odds Ratio[c] null model	1.68 (1.49 - 1.89)	1.47 (1.35-1.60)	1.63 (1.45-1.83)	1.34 (1.16-1.55)
Median Odds Ratio[c] adjusted model	1.54 (1.36-1.73)	1.41 (1.29-1.53)	1.58 (1.41-1.78)	1.30 (1.11 – 1.52)

a) All variables which are statistically significantly associated in adjusted analysis are shown in the relevant column (a ".." indicates a variable not statistically significantly associated in that model, but shown in the table as statistically significantly associated in another model). Other variables examined but not significant in any adjusted model were: Patient sex; care-home number of beds; care-home ownership; number of general practices with registered residents at the care-home; number of complaints upheld in the last three years; Care Inspectorate rating of care-home quality (four domains – quality of care and support, quality of environment, quality of staff, quality of management and leadership).

b) Unadjusted associations for all models are shown in appendix tables S4 to S7.

c) Median odds ratio (MOR) is a measure of variation between care-homes on the same scale as the model fixed effects. For repeated pairs of randomly sampled residents in different care-homes, the OR of the outcome is calculated. The MOR is the median value of the distribution of OR.

d) Not significant in adjusted model, but included as significant in univariate and marginal in adjusted

Supplementary Data

Table S1. Medicines categorised as weak and strong opioids.
Table S2. Medicines and their associated Modified Anticholinergic Risk Score.
Table S3. Prescribing by Health Board – Modified Anticholinergic Risk Score.
Table S4. Adjusted and unadjusted associations of patient and care-home characteristics for antipsychotic prescribing.
Table S5. Adjusted and unadjusted associations of patient and care-home characteristics for antidepressant prescribing.
Table S6. Adjusted and unadjusted associations of patient and care-home characteristics for Hypnotic/Anxiolytic prescribing.
Table S7. Adjusted and unadjusted associations of patient and care-home characteristics for mARS ≥3.

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The burden of psychotropic and anticholinergic medicines use in care homes: population-based analysis in 147 care homes

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Supplementary Tables

Table S1. Medicines categorised as weak and strong opioids.

Weak Opioid	**Strong Opioid**
Codeine Phosphate	Hydromorphone Hydrochloride
Dihydrocodeine Tartrate	Morphine
Dextropropoxyphene Hydrochloride*	Tramadol Hydrochloride
Co-Codamol (paracetamol + codeine)	Oxycodone
Co-Dydramol (paracetamol + dihydrocodeine)	Fentanyl
Co-Proxamol (paracetamol + dextropropoxyphene)*	Diamorphine Hydrochloride
Co-Codaprin (aspirin + codeine)*	Methadone Hydrochloride
Co-Codamol with Buclizine Hydrochloride*	Buprenorphine
Aspirin with Paracetamol and Codeine*	Morphine with Cocaine
Ibuprofen with Codeine Phosphate*	Morphine with Cocaine with Chlorpromazine
Paracetamol Codeine & Caffeine *	Pentazocine
Opium*	Paracetamol with Tramadol Hydrochloride
	Dipipanone with Cyclizine
	Pethidine Hydrochloride
	Dextromoramide
	Phenazocine Hudrobromide
	Morphine with Cyclizine
	Oxycodone and Naloxone
	Morphine with Atropine
	Pethidine with Promethazine
	Papaverine Hydrochloride
	Meptazinol
	Nalbuphine Hydrochloride
	Papaveretum
	Tapentadol

* Technically prescribable but rarely prescribed, particularly in this population

Table S2. Medicines and their associated score using the Modified Anticholinergic Risk Scale (mARS).

Score 3	**Score 2**	**Score 1**
Amitriptyline	Amantadine Hydrochloride	Co-Careldopa
Atropine Sulfate	Baclofen	Entacapone
Morphine with Atropine	Cetirizine	Haloperidol
Benztropine	Cimetidine	Haloperidol Decanoate
Chlorpromazine Hydrochloride	Cimetidine with alginate	Methocarbamol
Morphine and Cocaine with Chlorpromazine	Clozapine	Metoclopramide Hydrochloride
Cyproheptadine Hydrochloride	Desipramine Hydrochloride	Paracetamol with Metoclopramide
Dicycloverine Hydrochloride	Loperamide Hydrochloride	Lysine Acetylsalicylate & Metoclopramide
Dicycloverine Hydrochloride compound preparations	Loperamide with activated dimeticone	Aspirin with Metoclopramide
Dicycloverine with Codeine	Loratadine	Mirtazapine
Fluphenazine Decanoate	Nortriptyline	Paroxetine
Fluphenazine Hydrochloride	Olanzapine	Pramipexole
Fluphenazine Enanthate	Prochlorperazine	Quetiapine
	Pseudoephedrine Sulfate	
Hydroxyzine Hydrochloride	Pseudoephedrine Hydrochloride	Ranitidine
Hyoscyamine	Acrivastine and Pseudoephedrine Hydrochloride	Ranitidine Bismuth Citrate
Imipramine Hydrochloride	Brompheniramine and Pseudoephedrine	Risperidone
Oxybutinin Hydrochloride	Guaifenesin with Pseudoephedrine	Selegiline
Perphenazine	Ibuprofen with Pseudoephedrine Hydrochloride	Trazodone Hydrochloride
Promethazine Hydrochloride	Paracetamol Pseudoephedrine Hydrochloride and Pholcodine	Lofepramine
Promethazine Theoclate	Pseudoephedrine and Triprolidine Hydrochloride	Reboxetine
Pethidine with Promethazine	Clomipramine Hydrochloride	Tiotropium
Tizanidine Hydrochloride	Darifenacin	Tiotropium and Olodaterol
Trifluoperazine	Dosulepin Hydrochloride	Levodopa
Tranylcypromine with Trifluoperazine	Doxepin	
	Fesoterodine	
Clemastine	Levomepromazine	
Orphenadrine Hydrochloride	Pericyazine	
Orphenadrine Citrate	Propiverine Hydrochloride	
Procyclidine Hydrochloride	Solifenacin	
Thioridazine	Solifenacin and Tamsulosin Hydrochloride	
Chlorphenamine Maleate	Trospium Chloride	
	Tolterodine	
	Flavoxate Hydrochloride	
	Trimipramine	
Combination Score 6	**Combination Score 5**	**Combination Score 2**
Amitriptyline Hydrochloride with Perphenazine	Nortriptyline with Fluphenazine	Co-Careldopa with Entacapone

Table S3. Prescribing by Health Board – Modified Anticholinergic Risk Score

	All residents No. (%) of all residents N=4478	NHS Tayside No. (%) of all residents N=2685	NHS Fife No. (%) of all residents N=1793
Modified Anticholinergic Risk Score#			
Zero	2322 (51.9)	1444 (53.8)	878 (49.0)
One	1043 (23.3)	586 (21.8)	457 (25.5)
Two	573 (12.8)	317 (11.8)	256 (14.3)
Three	321 (7.2)	205 (7.6)	116 (6.5)
Four	122 (2.7)	72 (2.7)	50 (2.8)
Five	57 (1.3)	34 (1.3)	23 (1.3)
Six or more	40 (0.9)	27 (1.0)	13 (0.7)

Medicines contributing to mARS scoring are listed in table S2.

Table S4. Adjusted and unadjusted associations of patient and care home characteristics for antipsychotic prescribing.

Variable	% (95% CI) of residents prescribed an antipsychotic	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Care home level			
Fife (n=57)	13.8 (11.7-16.2)	1	1
Tayside (n=90)	18.5 (16.4-20.9)	1.42 (1.11-1.82)	1.52 (1.20-1.92)
Small (<25 beds) (n=41)	18.2 (14.3-22.9)	1	
Medium (25-49 beds) (n=68)	15.9 (13.6-18.6)	0.84 (0.60-1.16)	
Large (50 + beds) (n=37)	17.0 (14.5-19.8)	0.95 (0.67-1.35)	
Local authority or voluntary (n=30)	14.5 (11.6-17.9)	1	
Private (n=117)	17.1 (15.3-19.0)	1.19 (0.86-1.65)	
Nursing home (n=71)	17.8 (15.6–20.3)	1	
Residential home (n=76)	15.0 (12.9–17.4)	0.78 (0.61-1.00)	
Single GP practice (n=26)	15.0 (11.8-18.9)	1	
Multiple GP practices (n=121)	16.9 (15.2-18.9)	1.12 (0.80-1.58)	
0-2 complaints upheld in 3 years (n=115)	16.4 (14.6-18.4)	1	
3+ complaints upheld in 3 years (n=32)	17.4 (14.2-21.1)	1.06 (0.79-1.42)	
Quality of Care and Support			
Excellent (n=66)	14.8 (12.5-17.5)	1	
Good (n=55)	18.6 (15.8-21.8)	1.39 (1.06-1.83)	
Inadequate (n=26)	17.1 (14.3-20.4)	1.23 (0.88-1.72)	
Quality of Environment			
Excellent (n=70)	15.0 (12.8-17.6)	1	
Good (n=57)	18.3 (15.7-21.3)	1.29 (0.99-1.69)	
Inadequate (n=20)	17.8 (14.9-21.0)	1.24 (0.86-1.80)	
Quality of Staff			
Excellent (n=73)	15.1 (12.8-17.8)	1	
Good (n=49)	18.4 (15.6-21.6)	1.36 (1.03-1.79)	
Inadequate (n=25)	17.7 (15.0-20.9)	1.28 (0.91-1.80)	
Quality of Management & Leadership			
Excellent (n=70)	15.8 (13.3-18.6)	1	
Good (n=49)	17.0 (14.5-19.9)	1.14 (0.86-1.51)	
Inadequate (n=28)	18.4 (15.6-21.7)	1.29 (0.93-1.80)	
Patient level			
No dementia (n=2318)	14.6 (12.6-16.9)	1	1
Dementia (n=2160)	18.8 (17.0-20.9)	1.37 (1.16-1.61)	1.45 (1.23-1.71)
Aged 60-74 (n=492)	28.3 (23.9-33.1)	1	1
Aged 75-84(n=1309)	20.1 (18.3-23.3)	0.68 (0.53-0.87)	0.64 (0.50-0.82)
Aged 85+ (n=2677)	12.6 (10.9-14.4)	0.38 (0.30-0.48)	0.36 (0.28-0.45)
Female (n=3198)	15.9 (14.3-17.7)	1	
Male (n=1280)	18.5 (15.9-21.5)	1.13 (0.95-1.35)	
Random effects			
Intracluster correlation coefficient		8.2 (5.3-12.5)	5.8 (3.41-9.71)
Median Odds Ratio		1.68 (1.49 - 1.89)	1.54 (1.36-1.73)

Table S5. Adjusted and unadjusted associations of patient and care home characteristics for antidepressant prescribing.

Variable	% (95% CI) of residents prescribed an antipsychotic	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Care home level			
Fife (n=57)	47.7 (44.5-51.0)	1	1
Tayside (n=90)	37.6 (34.7-40.6)	0.66 (0.55-0.78)	0.66 (0.56-0.79)
Small (<25 beds) (n=41)	41.7 (37.7-45.8)	1	
Medium (25-49 beds) (n=68)	43.8 (40.5-47.1)	1.10 (0.87-1.41)	
Large (50 + beds) (n=37)	39.3 (35.2-43.6)	0.93 (0.72-1.21)	
Local authority or voluntary (n=30)	44.4 (38.4-50.5)	1	
Private (n=117)	41.1 (38.6-43.7)	0.89 (0.70-1.12)	
Nursing home (n=71)	41.0 (37.6–44.4)	1	
Residential home (n=76)	42.6 (39.4–45.8)	1.04 (0.86-1.25)	
Single GP practice (n=26)	46.5 (42.2-50.9)	1	
Multiple GP practices (n=121)	40.8 (38.2-43.5)	0.80 (0.63-1.02)	
0-2 complaints upheld in 3 years (n=115)	41.4 (38.4-44.4)	1	
3+ complaints upheld in 3 years (n=32)	42.5 (39.3-45.7)	1.05 (0.85-1.31)	
Quality of Care and Support			
Excellent (n=66)	43.9 (40.4-47.6)	1	
Good (n=55)	41.1 (36.6-45.7)	0.91 (0.74-1.11)	
Inadequate (n=26)	37.7 (34.9-40.6)	0.78 (0.61-1.00)	
Quality of Environment			
Excellent (n=70)	41.3 (37.1-45.7)	1	
Good (n=57)	43.5 (40.8-46.3)	1.10 (0.90-1.34)	
Inadequate (n=20)	37.8 (34.1-41.7)	0.86 (0.65-1.13)	
Quality of Staff			
Excellent (n=73)	41.0 (37.0-45.2)	1	
Good (n=49)	43.6 (40.3-47.0)	1.09 (0.89-1.34)	
Inadequate (n=25)	39.7 (36.5-43.1)	0.94 (0.73-1.22)	
Quality of Management & Leadership			
Excellent (n=70)	41.3 (37.1-45.6)	1	
Good (n=49)	43.9 (41.2-46.7)	1.10 (0.90-1.35)	
Inadequate (n=28)	38.7 (35.2-42.3)	0.88 (0.69-1.13)	
Patient level			
No dementia (n=2318)	40.0 (37.2-42.9)	1	
Dementia (n=2160)	43.4 (40.4-46.4)	1.12 (0.99-1.27)	
Aged 60-74 (n=492)	50.6 (45.6-55.6)	1	1
Aged 75-84(n=1309)	47.0 (43.5-50.4)	0.84 (0.67-1.04)	0.83 (0.67-1.03)
Aged 85+ (n=2677)	37.4 (34.8-40.1)	0.55 (0.45-0.67)	0.55 (0.45-0.67)
Female (n=3198)	42.4 (39.7-45.1)	1	
Male (n=1280)	39.8 (36.7-43.0)	0.89 (0.78-1.02)	
Random effects			
Intracluster correlation coefficient		4.7 (3.1-7.1)	3.8 (2.3-6.0)
Median Odds Ratio		1.47 (1.35-1.60)	1.41 (1.29-1.53)

Table S6. Adjusted and unadjusted associations of patient and care home characteristics for Hypnotic/Anxiolytic prescribing.

Variable	% (95% CI) of residents prescribed an antipsychotic	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Care home level			
Fife (n=57)	15.8 (13.7-18.3)	1	
Tayside (n=90)	17.7 (15.4-20.2)	1.12 (0.88-1.43)	
Small (<25 beds) (n=41)	15.5 (12.6-19.0)	1	
Medium (25-49 beds) (n=68)	16.5 (14.5-18.7)	1.05 (0.76-1.45)	
Large (50 + beds) (n=37)	18.0 (14.9-21.6)	1.20 (0.85-1.70)	
Local authority or voluntary (n=30)	14.5 (11.9-17.5)	1	
Private (n=117)	17.4 (15.5-19.5)	1.23 (0.90-1.68)	
Nursing home (n=71)	18.3 (16.0-20.9)	1	1
Residential home (n=76)	15.0 (12.9-17.5)	0.75 (0.59-0.95)	0.80 (0.63-1.01)
Single GP practice (n=26)	14.9 (12.0-18.3)	1	
Multiple GP practices (n=121)	17.3 (15.5-19.3)	1.19 (0.86-1.65)	
0-2 complaints upheld in 3 years (n=115)	16.8 (15.0-18.7)	1	
3+ complaints upheld in 3 years (n=32)	17.6 (13.8-22.1)	1.02 (0.76-1.35)	
Quality of Care and Support			
Excellent (n=66)	16.1 (13.9-18.4)	1	
Good (n=55)	16.9 (14.0-20.2)	1.11 (0.85-1.45)	
Inadequate (n=26)	19.0 (15.2-23.5)	1.25 (0.90-1.72)	
Quality of Environment			
Excellent (n=70)	15.2 (13.0-17.7)	1	
Good (n=57)	18.6 (16.1-21.4)	1.29 (1.00-1.67)	
Inadequate (n=20)	18.5 (13.8-24.5)	1.21 (0.85-1.73)	
Quality of Staff			
Excellent (n=73)	15.2 (13.0-17.6)	1	
Good (n=49)	19.6 (16.7-22.8)	1.42 (1.09-1.85)	
Inadequate (n=25)	17.1 (13.3-21.7)	1.16 (0.83-1.61)	
Quality of Management & Leadership			
Excellent (n=70)	16.2 (13.9-18.7)	1	
Good (n=49)	17.3 (14.4-20.6)	1.08 (0.82-1.41)	
Inadequate (n=28)	18.4 (14.8-22.7)	1.19 (0.86-1.63)	
Patient level			
No dementia (n=2318)	16.3 (14.4-18.4)	1	
Dementia (n=2160)	17.6 (15.7-19.8)	1.12 (0.96-1.32)	
Aged 60-74 (n=492)	24.4 (20.4-28.9)	1	1
Aged 75-84(n=1309)	18.0 (15.6-20.6)	0.72 (0.56-0.93)	0.73 (0.57-0.95)
Aged 85+ (n=2677)	15.1 (13.3-17.0)	0.60 (0.47-0.76)	0.62 (0.48-0.79)
Female (n=3198)	17.0 (15.3-19.0)	1	
Male (n=1280)	16.7 (14.2-19.6)	0.90 (0.75-1.08)	
Random effects			
Intracluster correlation coefficient		7.3 (4.7-11.3)	6.5 (4.1-10.3)
Median Odds Ratio		1.63 (1.45-1.83)	1.58 (1.41-1.78)

Table S7. Adjusted and unadjusted associations of patient and care home characteristics for high anticholinergic burden (mARS ≥3).

Variable	% (95% CI) of residents prescribed an antipsychotic	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Care home level			
Fife (n=57)	11.3 (9.68-13.1)	1	
Tayside (n=90)	12.6 (11.1-14.2)	1.13 (0.91-1.41)	
Small (<25 beds) (n=41)	13.6 (11.0-16.8)	1	
Medium (25-49 beds) (n=68)	11.9 (10.4-13.5)	0.86 (0.64-1.15)	
Large (50 + beds) (n=37)	11.7 (10.0-13.8)	0.85 (0.63-1.16)	
Local authority or voluntary (n=30)	14.0 (11.5-17.1)	1	
Private (n=117)	11.7 (10.5-13.0)	0.80 (0.61-1.05)	
Nursing home (n=71)	12.5 (11.0-14.1)	1	
Residential home (n=76)	11.5 (9.9-13.2)	0.90 (0.73-1.11)	
Single GP practice (n=26)	14.1 (11.8-16.8)	1	
Multiple GP practices (n=121)	11.7 (10.5-13.0)	0.79 (0.60-1.04)	
0-2 complaints upheld in 3 years (n=115)	12.1 (10.8-13.5)	1	
3+ complaints upheld in 3 years (n=32)	11.9 (9.9-14.3)	0.98 (0.76-1.26)	
Quality of Care and Support			
Excellent (n=66)	12.8 (11.2-14.6)	1	
Good (n=55)	11.9 (10.0-14.1)	0.94 (0.74-1.18)	
Inadequate (n=26)	10.6 (8.6-13.0)	0.82 (0.61-1.09)	
Quality of Environment			
Excellent (n=70)	12.1 (10.5-14.0)	1	
Good (n=57)	11.9 (10.3-13.7)	0.99 (0.79-1.25)	
Inadequate (n=20)	12.3 (9.6-15.5)	1.01 (0.74-1.39)	
Quality of Staff			
Excellent (n=73)	12.8 (11.2-14.6)	1	
Good (n=49)	11.2 (9.6-13.1)	0.87 (0.69-1.10)	
Inadequate (n=25)	11.6 (9.1-14.7)	0.90 (0.67-1.20)	
Quality of Management & Leadership			
Excellent (n=70)	12.3 (10.7-14.2)	1	
Good (n=49)	11.9 (10.3-13.8)	0.97 (0.76-1.23)	
Inadequate (n=28)	11.6 (9.2-14.5)	0.95 (0.71-1.26)	
Patient level			
No dementia (n=2318)	14.6 (13.1-16.3)	1	1
Dementia (n=2160)	9.3 (8.0-10.9)	0.60 (0.50-0.73)	0.61 (0.51-0.74)
Aged 60-74 (n=492)	22.2 (18.7-26.1)	1	1
Aged 75-84(n=1309)	14.1 (12.3-16.1)	0.57 (0.44-0.75)	0.62 (0.47-0.81)
Aged 85+ (n=2677)	9.2 (8.0-10.5)	0.35 (0.27-0.45)	0.37 (0.28-0.47)
Female (n=3198)	12.0 (10.9-13.3)	1	
Male (n=1280)	12.1 (10.2-14.3)	1.00 (0.82-1.22)	
Random effects			
Intracluster correlation coefficient		2.8 (1.1-7.1)	2.3 (0.7-6.9)
Median Odds Ratio		1.34 (1.16-1.55)	1.30 (1.11-1.52)