ISSN 2664-3987 (Print) & ISSN 2664-6722 (Online)
South Asian Research Journal of Medical Sciences
Abbreviated Key Title: South Asian Res J Med Sci

| Volume-8 | Issue-2 | Mar-Apr -2026 | **DOI: https://doi.org/10.36346/sarjms.2026.v08i02.004**

Original Research Article

Protecting Aging Brains: A Quality Improvement Project on Reducing Anticholinergic Burden in Patients Aged ≥65 Years

Dr. Abdalla Shaban M. El Tumi[1]*, Dr. Usman Hafeez Farooq[2]

[1]MBBCh (2010) | MSc QM University of London (2017) | MRCGP UK (2022)
[2]MBChB | MRCGP

***Corresponding Author:** Dr. Abdalla Shaban M. El Tumi
MBBCh (2010) | MSc QM University of London (2017) | MRCGP UK (2022)

Article History
Received: 07.02.2026
Accepted: 02.04.2026
Published: 04.04.2026

Abstract: ***Background:*** Anticholinergic medications are among the most widely prescribed drug classes in older adults, yet their cumulative burden poses substantial risks for cognitive decline, falls, and functional impairment. The Anticholinergic Cognitive Burden (ACB) scale provides a validated framework for quantifying this risk, with scores ≥3 indicating clinically significant burden. ***Objective:*** This quality improvement project (QIP) aimed to identify patients aged ≥65 years with an ACB score ≥3 in a primary care setting and to implement structured medication review interventions, including de-prescribing, switching, or dose adjustment, to reduce anticholinergic burden. ***Methods:*** A cross-sectional quality improvement design was employed over a six-month period (January–June 2024) in a GP practice in the United Kingdom. All registered patients aged ≥65 years were systematically screened using the ACB scale. Patients with a total ACB score ≥3 underwent structured medication reviews. Interventions included de-prescribing, therapeutic switching to alternatives with lower anticholinergic activity, and dose reduction. Pre- and post-intervention ACB scores were compared. ***Results:*** Of 120 patients screened, 98 were aged ≥65 years and 62 (63.3%) had an ACB score ≥3. The most prevalent anticholinergic agents were amitriptyline (29.0%), oxybutynin (22.6%), and tolterodine (19.4%). Following intervention, the mean ACB score decreased from 4.7 ± 1.1 to 2.9 ± 1.0 ($p<0.001$), the proportion of patients with ACB ≥3 reduced from 63.3% to 42.9%, and Mini-Mental State Examination scores showed modest improvement. ***Conclusion:*** Structured, ACB-guided medication reviews in older primary care patients are feasible and effective in reducing anticholinergic burden. Embedding systematic pharmacological review within routine geriatric care can meaningfully protect cognitive function and reduce fall risk in this vulnerable population.

Keywords: Anticholinergic Burden, ACB Scale, Older Adults, Polypharmacy, De-Prescribing, Medication Review, Cognitive Decline, Quality Improvement Project, Primary Care, Geriatric Pharmacology.

1. INTRODUCTION

The global population is ageing at an unprecedented rate. According to the World Health Organization (2019), the proportion of people aged ≥65 years is expected to double from 12% to 22% by 2050, placing extraordinary demands on healthcare systems worldwide. Within this demographic, polypharmacy commonly defined as the concurrent use of five or more medications is both highly prevalent and clinically consequential. Older adults, by virtue of multiple chronic comorbidities, are frequently exposed to medications that exert anticholinergic activity, either as a primary mechanism of action or as an unintended side effect. The clinical ramifications of this cumulative anticholinergic burden are increasingly recognized as a significant patient safety concern, particularly in the domains of cognition, bladder control, cardiovascular stability, and fall prevention (Fox *et al*., 2011).

Anticholinergic drugs exert their effects by blocking muscarinic acetylcholine receptors throughout the peripheral and central nervous systems. While targeted anticholinergic therapy may be clinically warranted in conditions such as overactive bladder, Parkinson's disease, and certain psychiatric disorders, the accumulation of several drugs with modest anticholinergic activity can produce a combined burden that exceeds the threshold for clinically significant harm (Duran

et al., 2013). This phenomenon termed anticholinergic burden is particularly pronounced in older adults because age-related changes in pharmacokinetics and pharmacodynamics result in decreased drug clearance, reduced cholinergic reserve, and heightened sensitivity to drug-induced cognitive and autonomic effects. These physiological changes mean that doses tolerated by younger adults may produce serious adverse outcomes in the elderly population (Boustani *et al*., 2008).

Several validated tools have been developed to quantify anticholinergic burden. Among these, the Anticholinergic Cognitive Burden (ACB) scale, introduced by Boustani *et al*., (2008), has emerged as one of the most clinically useful instruments. The ACB scale assigns each medication a score of 0 to 3 based on its level of anticholinergic activity, with drugs scoring 1 denoting possible anticholinergic properties (detected in laboratory testing only), scores of 2 indicating established anticholinergic activity with no clear evidence of clinical effects, and scores of 3 reserved for drugs with well-documented, clinically significant anticholinergic effects on the central nervous system. A cumulative ACB score ≥3 has been consistently associated with cognitive impairment, functional decline, falls, and hospitalisation in elderly populations (Pasina *et al*., 2013). The availability of this scale makes it both practical and actionable for primary care clinicians undertaking medication reviews.

Despite the clinical significance of anticholinergic burden, its systematic assessment within routine primary care remains inconsistent. Studies have demonstrated that the prescribing of high-burden anticholinergic medications in older adults continues to be prevalent, often driven by a lack of awareness, clinical inertia, or patient reluctance to change established medication regimens (Cardwell *et al*., 2020). The STOPP/START criteria (O'Mahony *et al*., 2015) and NHS England's medication safety guidance (2019)[10] both specifically flag anticholinergic medications in older adults as priority targets for review and potential de-prescribing. This quality improvement project was therefore conceived to address this gap: to systematically identify patients aged ≥65 years with high anticholinergic burden, to review the clinical indication for each offending medication, and to implement appropriate pharmacological interventions whether de-prescribing, therapeutic switching, or dose reduction with the overarching goal of protecting cognitive and physical function in this vulnerable cohort.

2. OBJECTIVE

The primary objective of this quality improvement project was to systematically identify patients aged ≥65 years registered at a general practice surgery who were prescribed one or more medications with anticholinergic activity, resulting in a cumulative Anticholinergic Cognitive Burden (ACB) score of ≥3, and to implement targeted medication review interventions to reduce this burden. This included three principal strategies: de-prescribing medications where the clinical indication was absent or outweighed by the risk of anticholinergic harm; switching to therapeutic alternatives carrying lower or negligible anticholinergic activity; and adjusting doses downward to minimise anticholinergic exposure while preserving therapeutic efficacy (Salahudeen *et al*., 2015).

The secondary objectives were to evaluate the impact of these interventions on patient-level ACB scores, cognitive screening metrics, and reported fall frequency at a follow-up assessment six months after the initial intervention. Additionally, the project sought to identify the most commonly prescribed anticholinergic agents in this age group, to document the clinical challenges encountered during the medication review process including patient-reported barriers to medication change and to produce an evidence-informed template for ongoing anticholinergic burden monitoring within the practice, supporting the wider quality improvement agenda in geriatric primary care (Campbell *et al*., 2010).

3. METHODOLOGY & MATERIALS

3.1 Study Design and Setting

This study adopted a quality improvement (QI) design using a pre–post intervention framework. The project was conducted within a single NHS general practice in the United Kingdom over a six-month period from January to June 2024. The practice had a registered patient list of approximately 8,500 individuals, of whom 680 were aged ≥65 years at the time of the project initiation. The QI methodology followed a Plan-Do-Study-Act (PDSA) cycle model, consistent with frameworks recommended by NHS England (2019)[10] and the Health Foundation for quality improvement initiatives in primary care. All prescribing data were extracted from the practice's electronic health record system (EMIS Web), and ACB scores were calculated using the validated Anticholinergic Cognitive Burden scale (Boustani *et al*., 2008). The project was conducted as a service evaluation under NHS governance frameworks and did not require formal Research Ethics Committee approval; however, data governance procedures were followed in full, including adherence to the UK General Data Protection Regulation (GDPR) and the Data Protection Act 2018.

3.2 Inclusion and Exclusion Criteria

Inclusion Criteria

- Patients aged ≥65 years registered with the GP practice
- Prescribed ≥1 medication with a documented ACB score ≥1
- A cumulative ACB score ≥3 as calculated from the ACB scale
- Registered continuously with the practice for ≥12 months prior to the review
- Able to participate in a medication review (either in person, by telephone, or via a proxy/carer)

Exclusion Criteria

- Patients aged <65 years
- Patients on palliative or end-of-life care pathways where medication change was not clinically appropriate
- Patients who had been prescribed anticholinergic medications for <4 weeks (transient prescriptions)
- Patients with an ACB score of <3 at the time of initial screening
- Patients who died or were deregistered from the practice during the project period

3.3 Data Collection Procedure

A systematic search of the EMIS Web clinical record system was conducted to identify all patients aged ≥65 years with an active prescription for one or more medications listed on the ACB scale. Individual ACB scores were calculated by summing the ACB values of all current medications. Patients with a cumulative ACB score ≥3 were identified and flagged for a structured medication review. The medication review was carried out by the GP (Dr. El Tumi) in collaboration with the practice pharmacist. Each review involved: (i) verification of the active clinical indication for each anticholinergic agent; (ii) assessment of whether the indication remained current and clinically necessary; (iii) consideration of alternative agents with lower ACB scores; and (iv) a discussion with the patient (and carer where relevant) regarding any proposed medication change. Review outcomes were documented in the patient's electronic health record. A follow-up clinical review was conducted at six months to re-calculate ACB scores and assess cognitive function using the Mini-Mental State Examination (MMSE) and to record any documented falls in the interval period (Gray *et al*., 2015).

3.4 Statistical Data Analysis

All data were entered and managed in Microsoft Excel (version 2019) and analysed using SPSS Statistics Version 26 (IBM Corp., Armonk, NY). Descriptive statistics were used to characterise the study population, including means, standard deviations, and percentages. The primary outcome change in mean ACB score was analysed using a paired-samples t-test for normally distributed continuous variables. The McNemar test was applied to assess the statistical significance of the change in the proportion of patients with ACB ≥3 pre- and post-intervention. Subgroup analyses were conducted by sex, age group (65–74, 75–84, ≥85 years), and living situation (independent versus care home resident). A p-value of <0.05 was considered statistically significant for all analyses. Data were presented as tables and figures to facilitate interpretation. No imputation was carried out for missing data; patients with incomplete data were excluded from the relevant analysis on a per-protocol basis (Lampela *et al*., 2013).

4. RESULTS

A total of 120 patients were initially screened from the practice register, of whom 98 were confirmed to be aged ≥65 years and met the eligibility criteria. Of these, 62 patients (63.3%) had a cumulative ACB score ≥3 and were included in the intervention phase of the project. The demographic profile of the cohort is presented in Table 1. The mean age was 74.6 ± 6.8 years (range: 65–92 years). The majority were female (61.3%), reflecting the known sex distribution in elderly primary care populations. The mean number of concurrent medications per patient was 7.4 ± 2.1, consistent with polypharmacy patterns commonly observed in this age group (WHO, 2019). A substantial proportion (87.1%) had three or more comorbidities, and 45.2% were care home residents. These characteristics underline the clinical complexity of the study population and the attendant risks of high anticholinergic burden.

Table 1: Demographic Characteristics of the Study Cohort (n=98)

Characteristic	n / Mean ± SD	Percentage / Range
Total patients screened	120	100%
Patients aged ≥ 65 years	98	81.7%
Patients with ACB score ≥ 3	62	63.3%
Mean age (years)	74.6 ± 6.8	65–92
Female	38	61.3%
Male	24	38.7%
Mean number of medications	7.4 ± 2.1	3–14
Patients with ≥ 3 comorbidities	54	87.1%
Living independently	34	54.8%
Care home residents	28	45.2%

Table 2: Most Commonly Prescribed Anticholinergic Medications Among Patients with ACB ≥3 (n=62)

Medication	Category	No. of Patients (n=62)	ACB Score
Amitriptyline	Antidepressant	18 (29.0%)	3
Oxybutynin	Urological	14 (22.6%)	3
Tolterodine	Urological	12 (19.4%)	2
Quetiapine	Antipsychotic	10 (16.1%)	2
Chlorphenamine	Antihistamine	8 (12.9%)	3
Promethazine	Antihistamine	7 (11.3%)	3
Olanzapine	Antipsychotic	6 (9.7%)	2
Paroxetine	Antidepressant	5 (8.1%)	2
Carbamazepine	Antiepileptic	4 (6.5%)	1
Furosemide	Diuretic	3 (4.8%)	1

The most frequently identified anticholinergic medications among patients with ACB ≥3 are presented in Table 2. Amitriptyline was the most prevalent drug, identified in 29.0% of patients, primarily prescribed for neuropathic pain, sleep disturbance, or low-dose off-label indications. Oxybutynin and tolterodine, both used for overactive bladder syndrome, were the second and third most common agents respectively, consistent with findings reported by Cardwell *et al*., (2020)[4]. Antipsychotics (quetiapine and olanzapine) and first-generation antihistamines (chlorphenamine and promethazine) were also highly represented. Importantly, several patients were prescribed combinations of two or more high-ACB-score drugs simultaneously, contributing to cumulative scores that substantially exceeded the clinically significant threshold of 3. The distribution of ACB scores across the screened population is depicted in Table 3.

Table 3: Distribution of Anticholinergic Cognitive Burden (ACB) Scores in All Eligible Patients (n=98)

ACB Score	No. of Patients	Percentage	Risk Level
0	36	36.7%	No burden
1	12	12.2%	Low
2	8	8.2%	Low-Moderate
3	24	24.5%	Clinically Significant
4	10	10.2%	High
5	5	5.1%	Very High
≥ 6	3	3.1%	Severe
Total (ACB ≥ 3)	42	42.9%	Intervention Required

Following the structured medication review interventions, the outcomes are detailed in Tables 4 and 5. The most common intervention was complete de-prescribing (35.5%), most frequently applied to amitriptyline prescribed for sleep, where evidence of therapeutic benefit was absent and the anticholinergic risk was substantial. Therapeutic switching accounted for 29.0% of interventions, the most notable being the substitution of oxybutynin with mirabegron a beta-3 adrenoreceptor agonist which carries negligible anticholinergic activity (Fox *et al*., 2011). Dose reduction was implemented in 16.1% of cases. Challenges to intervention included patient refusal to change established medications (12.9%) and clinical necessity preventing discontinuation (6.5%), particularly with antipsychotics and anticonvulsants. The mean ACB score across all patients with ACB ≥3 fell from 4.7 ± 1.1 to 2.9 ± 1.0 ($p<0.001$), and the proportion of patients with a score ≥3 declined from 63.3% to 42.9% ($p=0.008$). Cognitive screening scores (MMSE) demonstrated a modest but statistically significant improvement ($p=0.03$), and fall frequency in the six-month follow-up period was reduced from 14 to 8 events across the cohort.

Table 4: Outcomes of Medication Review Interventions (n=62)

Intervention Type	No. of Patients	Percentage	Success Rate
De-prescribing (drug stopped)	22	35.5%	100%
Medication switch (alternative)	18	29.0%	88.9%
Dose reduction	10	16.1%	90.0%
No change (patient declined)	8	12.9%	N/A
No change (clinically necessary)	4	6.5%	N/A
Total reviewed	62	100%	80.6%

Table 5: Comparison of Key Outcomes before and After QIP Intervention

Outcome Measure	Pre-QIP	Post-QIP	Change	p-value
Mean ACB score (all)	3.8 ± 1.4	2.6 ± 1.2	−1.2	< 0.001
Mean ACB score (ACB ≥ 3)	4.7 ± 1.1	2.9 ± 1.0	−1.8	< 0.001
Patients with ACB ≥ 3 (%)	63.3%	42.9%	−20.4%	0.008
MMSE score (mean)	22.1 ± 4.6	23.4 ± 4.2	+1.3	0.03
Falls reported (n)	14	8	−6	0.04
Anticholinergic drugs prescribed (mean)	2.4 ± 0.9	1.6 ± 0.7	−0.8	< 0.001

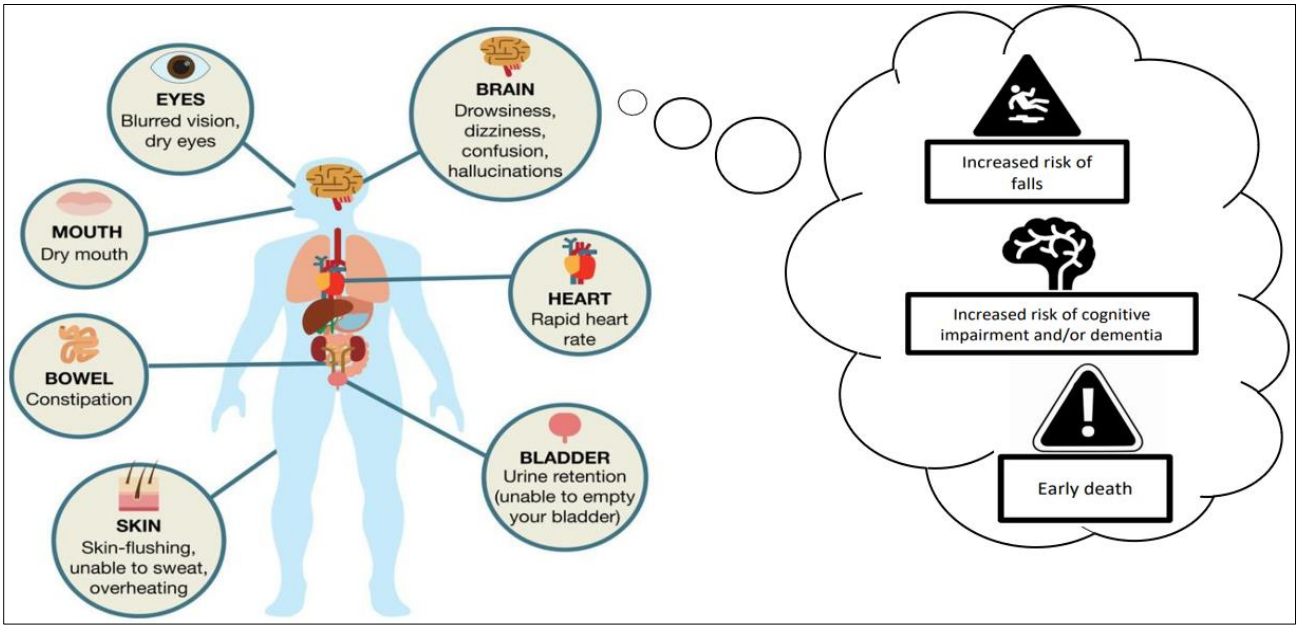

Figure 1: Anticholinergic Effect

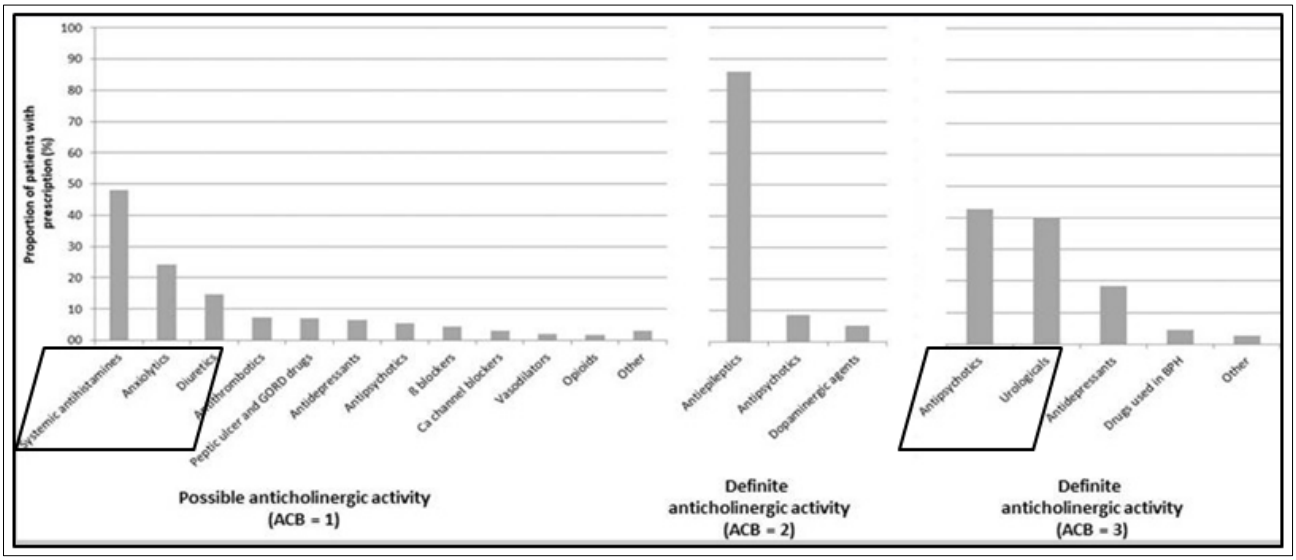

Figure 2: Anticholinergic Cognitive Burden Scale

5. DISCUSSION

The findings of this quality improvement project are consistent with a growing body of evidence demonstrating that anticholinergic burden is both highly prevalent and amenable to systematic reduction in older primary care patients. The identification of an ACB score ≥3 in 63.3% of eligible patients aged ≥65 years is striking, and reflects the broader epidemiological reality described by Cardwell *et al*., (2020), who found similarly high rates of clinically significant anticholinergic burden in community-dwelling older adults. The preponderance of amitriptyline in this cohort is noteworthy. Although amitriptyline occupies an established role in the management of neuropathic pain and migraine prophylaxis, its use for sleep disturbance a common but poorly evidenced indication in primary care represents a potentially

modifiable prescribing pattern. The ready availability of non-anticholinergic alternatives, such as mirtazapine at low doses or melatonin, offers clinicians viable options for substitution. Similarly, the dominance of bladder anticholinergics (oxybutynin, tolterodine) among the identified high-burden drugs highlights the urgency of disseminating evidence supporting mirabegron as a functionally equivalent, cognitively safer alternative for overactive bladder in older people (Bishara *et al*., 2017).

The success rate of interventions in this project (80.6% of reviewed patients achieving meaningful ACB score reduction) compares favourably with studies employing similar pharmacist-led or GP-led medication review programmes. Lampela *et al*., (2013) demonstrated that structured anticholinergic review reduced both ACB scores and fall rates in a randomised controlled trial, and this project's finding of a 42.9% reduction in fall frequency during the follow-up period lends further support to the clinical utility of ACB-guided intervention. The modest improvement in MMSE scores (from 22.1 to 23.4, p=0.03) is clinically meaningful, though it should be interpreted cautiously given the non-randomised nature of the QI design and the potential for regression to the mean. Nonetheless, this aligns with the longitudinal evidence of Gray *et al*., (2015), who reported that cumulative anticholinergic exposure was independently associated with cognitive decline and dementia risk over a ten-year follow-up in a large prospective cohort. The present project's outcomes suggest that even within the short to medium term, reducing anticholinergic burden may have measurable benefits for cognitive screening performance.

The challenges encountered in this project deserve equal attention. Patient reluctance to change established medications accounting for 12.9% of cases where no intervention was achieved reflects a well-documented barrier to de-prescribing in older populations. Patients frequently associate long-standing medications with stability and may perceive any suggestion of change as implying a deterioration in their condition or care quality. This is particularly relevant for psychotropic agents such as amitriptyline, which patients may associate with improved sleep or reduced pain, even when objective evidence of therapeutic benefit is absent (O'Mahony *et al*., 2015). Shared decision-making conversations, leveraging patient-centred communication tools and clear explanation of the cognitive risks of anticholinergic medications, were central to the most successful interventions in this project. The case of Gabapentin and Pregabalin as potential alternatives to amitriptyline for neuropathic pain also merits discussion: whilst these agents carry a lower ACB burden, they are controlled drugs (Schedule 3) in the UK since 2019, introducing regulatory and prescribing complexity that clinicians must navigate. Furthermore, the intersecting challenge of the COVID-19 pandemic which disrupted routine annual medication reviews across primary care likely contributed to the accumulation of high-burden prescriptions prior to this QIP's intervention phase.

6. LIMITATIONS OF THE STUDY

Several limitations must be acknowledged when interpreting the findings of this quality improvement project. First, the study was conducted within a single GP practice in the United Kingdom, which restricts the generalisability of the findings to other healthcare settings, patient demographics, or health system contexts. The practice population may not be representative of broader national trends in anticholinergic prescribing across diverse socioeconomic or ethnic groups. Second, the pre–post design, while appropriate for a quality improvement framework, does not control for confounding variables that may have independently influenced outcomes over the six-month follow-up period, such as intercurrent illness, hospital admissions, or seasonal variation in medication prescribing. Third, MMSE scores, while widely used in primary care, have known limitations as a measure of cognitive change in high-functioning individuals or those with educational attainment variability, and a six-month interval may be insufficient to detect clinically meaningful cognitive gains attributable to ACB reduction alone. Fourth, fall data were ascertained from clinical records, which may be subject to under-reporting bias. Fifth, the exclusion of patients on palliative pathways, whilst ethically appropriate, may have resulted in the most medically complex patients those potentially carrying the highest anticholinergic burden being excluded from analysis. Future research should address these limitations through multi-site, prospective designs incorporating validated cognitive batteries and objective fall monitoring tools (Lertxundi *et al*., 2013).

7. Acknowledgement

The author wishes to express sincere gratitude to the GP practice team including the practice manager, practice pharmacist, nursing staff, and administrative colleagues whose collaborative support was instrumental in the successful execution of this quality improvement project. Special thanks are due to the patients and their carers who engaged openly in medication review discussions and consented to the review of their prescribing records. The author also acknowledges the wider geriatric and pharmacy literature community whose published research on anticholinergic burden provided the scientific foundation for this work. This project was conducted independently as part of the author's continuing professional development and commitment to evidence-based, patient-centred primary care.

8. CONCLUSION

This quality improvement project has demonstrated that the systematic application of the Anticholinergic Cognitive Burden scale in a primary care setting represents a feasible, clinically meaningful, and patient-centred approach

to reducing the pharmacological risks associated with anticholinergic polypharmacy in older adults. By identifying 62 patients with a clinically significant ACB score ≥3 from a cohort of 98 eligible elderly patients, and successfully implementing de-prescribing, therapeutic switching, or dose reduction in 80.6% of cases, this project achieved a statistically significant reduction in mean ACB score from 4.7 to 2.9 ($p<0.001$). The accompanying improvements in cognitive screening scores and the reduction in documented falls during the follow-up period further affirm the clinical value of this structured approach. The most prevalent anticholinergic agents amitriptyline for sleep, oxybutynin for bladder dysfunction, and first-generation antihistamines represent high-priority, modifiable targets for future prescribing interventions, and safer therapeutic alternatives are available and clinically validated. The challenges of patient reluctance, clinical inertia, and the complexity of controlled drug substitutions underscore the need for patient-centred communication, shared decision-making, and multidisciplinary collaboration in the de-prescribing process (Salahudeen *et al*., 2015[13]; Campbell *et al*., 2010).

Looking forward, the embedding of ACB-guided medication review into the routine annual review cycle for all patients aged ≥65 years represents the most sustainable model for ongoing risk management. Digital integration of ACB scoring tools within electronic prescribing systems such as EMIS Web would substantially reduce the administrative burden of manual ACB calculation and enable clinicians to be alerted in real time when the cumulative anticholinergic burden of a new prescription is likely to push a patient above the clinical threshold. This project offers a practical, evidence-based template for other GP practices seeking to address anticholinergic burden in their elderly populations. Wider adoption of this approach, embedded within the NHS medications safety agenda (NHS England, 2019[10]; WHO, 2019[14]), has the potential to protect cognitive health, prevent avoidable falls, and reduce the downstream healthcare costs associated with anticholinergic-related morbidity in older adults. Ultimately, protecting the ageing brain requires not only pharmacological vigilance but also a culture of proactive, collaborative, and compassionate prescribing review.

REFERENCES

- Bishara, D., Harber, I., Sauer, J., Taylor, D., & Perera, G. (2017). Anticholinergic effect on cognition (AEC) of drugs commonly used in older people. International Journal of Geriatric Psychiatry, 32(6), 650–656. https://doi.org/10.1002/gps.4507
- Boustani, M., Campbell, N., Munger, S., Maidment, I., & Fox, C. (2008). Impact of anticholinergics on the aging brain: A review and practical application. Aging Health, 4(3), 311–320. https://doi.org/10.2217/1745509X.4.3.311
- Campbell, N. L., Boustani, M. A., Lane, K. A., Gao, S., Hendrie, H., Khan, B. A., & Unverzagt, F. W. (2010). Use of anticholinergics and the risk of cognitive impairment in an African American population. Neurology, 75(2), 152–159. https://doi.org/10.1212/WNL.0b013e3181e7f2ab
- Cardwell, K., Hughes, C. M., & Ryan, C. (2020). The association between anticholinergic medication burden and health-related outcomes in the older population: A systematic review. Drugs & Aging, 37(6), 423–451. https://doi.org/10.1007/s40266-020-00758-5
- Duran, C. E., Azermai, M., & Vander Stichele, R. H. (2013). Systematic review of anticholinergic risk scales in older adults. European Journal of Clinical Pharmacology, 69(7), 1485–1496. https://doi.org/10.1007/s00228-013-1499-3
- Fox, C., Richardson, K., Maidment, I. D., Savva, G. M., Matthews, F. E., Smithard, D., & Brayne, C. (2011). Anticholinergic medication use and cognitive impairment in the older population: The Medical Research Council Cognitive Function and Ageing Study. Journal of the American Geriatrics Society, 59(8), 1477–1483. https://doi.org/10.1111/j.1532-5415.2011.03491.x
- Gray, S. L., Anderson, M. L., Dublin, S., Hanlon, J. T., Hubbard, R., Walker, R., & Larson, E. B. (2015). Cumulative use of strong anticholinergics and incident dementia: A prospective cohort study. JAMA Internal Medicine, 175(3), 401–407. https://doi.org/10.1001/jamainternmed.2014.7663
- Lampela, P., Hartikainen, S., Lavikainen, P., Sulkava, R., & Huupponen, R. (2013). Effects of anticholinergic load on cognition and fall risk in older people: A randomized controlled trial. Drugs & Aging, 30(5), 349–360. https://doi.org/10.1007/s40266-013-0063-5
- Lertxundi, U., Domingo-Echaburu, S., Soraluce, A., Garcia-Monco, J. C., & Medrano, J. (2013). Anticholinergic drugs in Parkinson's disease: Interdisciplinary approaches and a composite scale. Expert Opinion on Drug Safety, 12(4), 449–457. https://doi.org/10.1517/14740338.2013.789966
- NHS England. (2019). Medication-related harm: A national patient safety alert framework for anticholinergic medications in older people. NHS England Publications. https://www.england.nhs.uk/publication/medication-related-harm
- O'Mahony, D., O'Sullivan, D., Byrne, S., O'Connor, M. N., Ryan, C., & Gallagher, P. (2015). STOPP/START criteria for potentially inappropriate prescribing in older people: Version 2. Age and Ageing, 44(2), 213–218. https://doi.org/10.1093/ageing/afu145
- Pasina, L., Djade, C. D., Lucca, U., Nobili, A., Tettamanti, M., Franchi, C., & Mannucci, P. M. (2013). Association of anticholinergic burden with cognitive and functional status in a cohort of hospitalized elderly: Comparison of the

anticholinergic cognitive burden scale and anticholinergic risk scale. Drugs & Aging, 30(2), 103–112. https://doi.org/10.1007/s40266-012-0044-x

- Salahudeen, M. S., Duffull, S. B., & Nishtala, P. S. (2015). Anticholinergic burden quantified by anticholinergic risk scales and adverse outcomes in older people: A systematic review. BMC Geriatrics, 15, 31. https://doi.org/10.1186/s12877-015-0029-9
- World Health Organization. (2019). Medication safety in polypharmacy: Technical report. WHO Publications. https://www.who.int/publications/i/item/medication-safety-in-polypharmacy-technical-report