RMJ

Original Article

Anticholinergic Burden in Older Patients: An Exploratory Pilot Survey of Knowledge, Attitudes, and Practices Among Physicians in Taiwan

Piyawat Dilokthornsakul[1,2], Kun-Pin Hsieh[3*], Nantawarn Kitikannakorn[4*], Phyo Kyaw Myint[5], Phil Moss[6]

[1] Project for the Establishment of the Faculty of Pharmacy, Praboromarajchanok Institute, Chon Buri, Thailand

[2] Department of Pharmacy, Omkoi Hospital, Chiang Mai, Thailand

[3] School of Pharmacy, College of Pharmacy, Kaohsiung Medical University, Kaohsiung, Taiwan

[4] Department of Pharmaceutical Care, Faculty of Pharmacy, Chiang Mai University, Chiang Mai, Thailand

[5] Ageing Clinical & Experimental Research Team, Institute of Applied Health Sciences, University of Aberdeen, Aberdeen, UK

[6] Emergency Department Collaborative Research Group, St George's University Hospitals NHS Foundation Trust, London, UK

Citation: Dilokthornsakul P, Hsieh K, Kitikannakorn N, Myint PK, Moss P. Anticholinergic burden in older patients: an exploratory pilot survey of knowledge, attitudes, and practices among physicians in Taiwan. *Res Med J*. 20XX;XX(X): e282816. doi:10.33165/rmj.2028.e282688

*** Corresponding Author:**
kphsieh@kmu.edu.tw
nantawarn.k@cmu.ac.th

Received: 3 June 2026
Revised: 26 October 2026
Accepted: 28 October 2026
Published Online: 17 November 2026

Copyright © 2026 by the Author(s). Licensee RMJ. This article is licensed under the Creative Commons Attribution (CC BY) License.

Abstract

Background: Anticholinergic burden (ACB) is associated with adverse outcomes in older adults. In Taiwan, around 60% of adults aged 65 and over receive an anticholinergic medicine annually. Whether prescribers recognize this risk is unknown.

Objective: To describe physicians' knowledge, attitudes, and practices regarding ACB in older patients, and identify the resulting knowledge-practice gaps.

Methods: An anonymous online knowledge, attitudes and practices survey, used verbatim in English with permission from a UK study, was distributed to physicians at 92 Taiwanese hospitals (July 2024 and July-September 2025). Respondents aware of the term scored 10 medicines (0-3) against the ACB Calculator.

Results: Sixty-two physicians responded, 32 of them were emergency physicians. Only 14 (23%) were aware of the term. Among these 14, the mean number of medicines scored correctly was 1.9 of 10 (median [IQR], 0.5 [0.00-3.75]; range, 0-6), and 7 scored none correctly. Oxybutynin, the only medicine scoring 3, was correct in 2 of 14, while 7 answered 'do not know'. No respondent correctly classified all 10 medicines as having or lacking anticholinergic activity. Delirium was recognized by 6 of 14, but all 7 who answered selected urinary incontinence, which is not an anticholinergic adverse effect. Thirty-one of 60 (52%) rated assessment as important or very important, 23 were neutral, and 56 of 62 (90%) wanted further education. Of the 28 who prescribed anticholinergic medicines, 21 never calculated a burden score, 14 never considered ACB, and one did both routinely.

Conclusions: Most physicians were unaware of ACB and about half regarded it as important. Closing this gap will require education and prescribing decision support rather than awareness alone.

Keywords: Anticholinergic burden, Older adults, KAP framework, Taiwan

Article in Press

Introduction

Anticholinergic burden (ACB) refers to the cumulative effect of medications that block muscarinic acetylcholine receptors, producing peripheral effects such as dry mouth and constipation together with central effects including cognitive decline, delirium, and increased mortality risk.[1,2] Older adults are particularly susceptible because of reduced cholinergic reserve and the frequent use of multiple medicines (polypharmacy),[3] since medicines with individually modest anticholinergic activity compound when prescribed together. Frequent contributors include first-generation antihistamines, tricyclic and related antidepressants, and bladder antimuscarinics such as oxybutynin, tolterodine, and solifenacin. In England, use of a medicine with any anticholinergic activity among people aged 65 and over rose from 49.6% to 64.3% over 2 decades, and use of potent (score 3) anticholinergics nearly doubled, from 5.7% to 9.9%.[4] A cumulative burden of 3 or more is the threshold most often used to define clinically relevant exposure, and is associated with dementia, falls, frailty, and mortality.[2,5]

Several instruments quantify ACB and are not interchangeable: the Anticholinergic Cognitive Burden (ACoB) scale,[6] the German Anticholinergic Burden Score (GABS),[7] the Drug Burden Index (DBI),[8] the Anticholinergic Risk Scale (ARS),[9] and the Anticholinergic Drug Scale (ADS).[10] They differ in derivation, in whether they target central or peripheral effects, and in dose-sensitivity, and so assign different scores to the same medicine. In a systematic review that appraized 19 published scales using an adapted AGREE II tool, the ACoB scale and GABS achieved the highest quality ratings.[11] This study used the freely available ACB Calculator as the reference standard, as the tool most accessible to clinicians; it scores each medicine 0-3 by combining the ACoB scale and GABS, taking the higher value where they disagree.[12] Throughout this article, 'ACB' denotes the overall concept, while 'ACoB scale' and 'GABS' refer only to those 2 instruments.

In Taiwan, anticholinergic exposure is well documented. In 2016, approximately 60% of adults aged 65 and over receive at least one anticholinergic medicine, and use was associated with incident pneumonia (adjusted odds ratio [OR], 1.33),[13] In a nationwide study of 317 446 older adults admitted with acute cardiovascular events, a recent rise in anticholinergic burden was associated with these events, including myocardial infarction and stroke,[14] and in a 15-year cohort, dementia risk was increased among those with high cumulative burden or long-term use, although overall use was not associated with dementia.[15] Integrating ACB assessment into routine prescribing workflows, including clinical decision support, has been proposed as a remedy,[16] but whether prescribers recognize the risk at all is unknown. A recent UK survey found emergency medicine specialists had limited knowledge of ACB and rarely applied it, despite positive attitudes and appetite for training.[17] No comparable data exist for Taiwan. This exploratory pilot survey therefore described physicians' knowledge, attitudes, and practices regarding ACB in older patients, and identified the resulting knowledge-practice gaps.

Methods

Study Design, Setting, and Participants

This anonymous online survey was distributed through the REDCap platform, a secure web-based application for building and managing online surveys and databases, hosted at the University of Aberdeen, UK.[18] The survey was designed using the knowledge, attitudes and practices (KAP) framework[19] and was used verbatim, with the permission of

Article in Press

the original authors, from a nationwide survey previously conducted among emergency medicine specialists in the UK.[17] Reporting followed the STROBE statement for cross-sectional studies.[20] Because the number of physicians reached could not be determined and the achieved sample was small, the study is reported as an exploratory pilot survey. Ethical approval was granted by the Institutional Review Board of Kaohsiung Medical University, Taiwan.

Physicians from 92 hospitals located throughout all regions of Taiwan were invited, comprizing 3 major healthcare settings (medical centers, regional hospitals, and district hospitals), respondents who reported a clinical setting were working in hospital-affiliated outpatient clinics. The sampling frame was the list of hospitals taking part in the Taiwan Patient Safety Culture Survey conducted by the Joint Commission of Taiwan.[21]

Survey Instrument

The questionnaire used in the UK study[17] was administered in its original English form. No translation was undertaken; the English version implemented in REDCap was the instrument submitted to and approved by the Institutional Review Board. The instrument was used without modification, and no separate content validation, cognitive testing, or pilot testing were undertaken in the Taiwanese context. Internal-consistency statistics such as Cronbach α were not computed for the knowledge section, because those items constitute a factual test with a single reference answer per medicine rather than a set of indicators of a latent construct.

Among other items, the knowledge section asked respondents to indicate whether each of 10 medicines has anticholinergic properties (yes, no, or do not know), to assign each of the same medicines its burden score (0, 1, 2, 3, or do not know), and to indicate whether each of 10 conditions was associated with a high ACB (yes, no, or do not know). Ten medicines (bisoprolol, loperamide, sertraline, furosemide, amlodipine, quinine sulphate, oxybutynin, diazepam, isosorbide mononitrate, and metformin) were retained unchanged from the UK instrument so that results could be compared directly with the UK survey.[17] They are medicines commonly prescribed to older adults and span the range of reference scores, with 4 having no anticholinergic activity and 6 a score of 1 or more, so the item tested recognition of the absence as well as the presence of anticholinergic activity.

Survey Procedure

Data were collected in 2 phases: in July 2024, when only emergency physicians were invited (5 responses), and between July and September 2025, when invitations were extended to physicians of all specialties (57 responses). Hospital coordinators emailed invitations on behalf of the study team, comprizing an invitation letter, participant information leaflets, and the survey URL; a reminder followed one month later. Participation was voluntary and anonymous, with consent obtained electronically on the first page. Item formats included tick-box, multiple-choice, open-ended, Likert scales, and satisfaction rankings. The survey took around 10 minutes to complete and included the following sections: a) participant demographics (hospital classification and medical specialty), b) participant knowledge of the ACB (6 items), c) participant attitudes toward the ACB (4 items), d) prescribing practices related to the ACB (8 items), and e) survey feedback (2 items). The survey used a branching structure, so denominators differed between sections. Respondents who reported being unaware of the term 'ACB' were not shown the knowledge items, which would not have been meaningful for them. The attitude

Article in Press

and educational-need items, and the item on how often respondents document a patient's medication history, were presented to all 62 respondents. The items on considering ACB, calculating a burden score, and the action taken when a score is high were shown only to the 28 respondents who answered 'yes' to 'Do you prescribe anticholinergic medications in your current role?'; this action item allowed more than one response. Participant flow and the denominator for each section are shown in the flowchart (Figure 1). Respondents completing the survey entered a lucky draw for one of 10 gift cards, each valued at NT$300.

Statistical Analysis

Data were exported from REDCap and analysed descriptively. No formal sample size calculation was performed, and all physicians at the 92 targeted hospitals were eligible. Categorical data were presented as counts with the relevant denominator stated explicitly. Percentages were given only where the denominator was 30 or greater; findings based on smaller denominators were reported as raw frequencies to avoid conveying spurious precision. Because invitations were distributed by hospital coordinators, the number of physicians who received the invitation could not be confirmed and a response rate could not be calculated. Because the survey was anonymous and recorded only the type of hospital, not its identity, the number of hospitals that contributed respondents could not be determined. All analyses were performed in Excel, version 16.03 (Microsoft Corp). Quartiles were calculated by linear interpolation between ordered values; with 14 respondents, the first and third quartiles fell at the 4.25th and 10.75th ordered values.

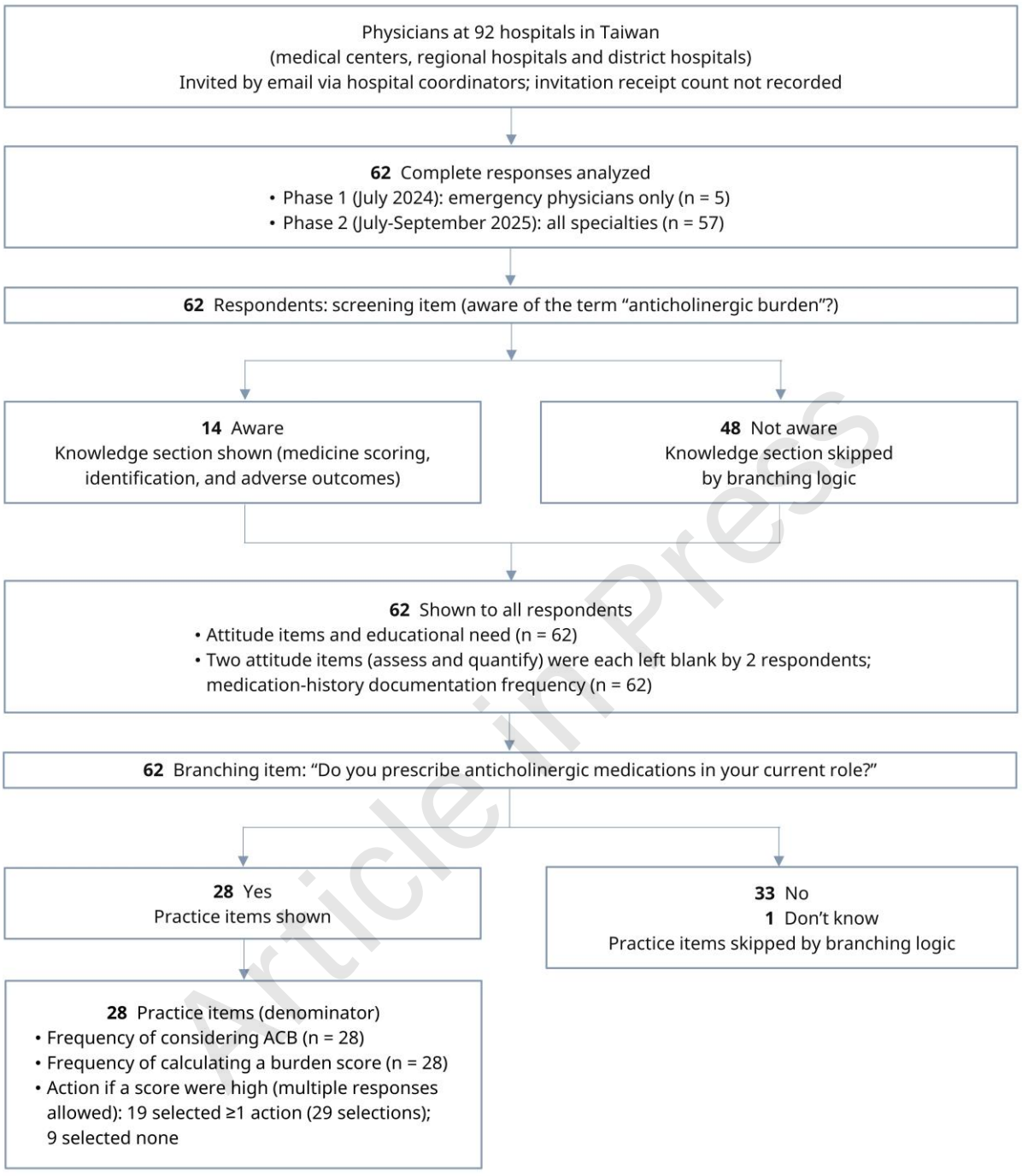
Knowledge was scored as follows. Respondents were asked to assign the exact burden score (0, 1, 2, or 3) to each of 10 medicines. One point was awarded where the response matched the ACB Calculator reference value; responses of 'do not know' and unanswered items were scored as incorrect, giving a possible total of 0 to 10. 'Do not know' was deliberately scored as incorrect rather than recoded as a score of 0, because a score of 0 would have been credited as correct for the 4 medicines whose reference score was 0. Because the distribution showed a pronounced floor effect, the median (IQR) were reported alongside the mean.

Because exact-score agreement conflates 2 different abilities, recognizing that a medicine has anticholinergic activity at all, and grading its severity, a post hoc sensitivity analysis was performed in which each response was recoded as a binary judgement: 'any anticholinergic activity' (a response of 1, 2, or 3) versus 'none' (a response of 0), with 'do not know' and unanswered items counted as incorrect, as in the primary analysis. This was compared against a binary reference standard (4 medicines with a reference score of 0; 6 with a score of 1 or above). The proportion of correct binary judgements was calculated per respondent and per medicine.

The direct medicine-identification item was scored against the same binary reference standard. The adverse-outcome item was scored against the answer key of the original UK instrument:[17] falls, stroke, delirium, cardiovascular disease, and dementia were keyed as associated with a high ACB, and osteoporosis, sarcopenia, urinary incontinence, gastroesophageal reflux disease, and open-angle glaucoma as not associated. Selecting a condition keyed as not associated was scored as incorrect. The keying of urinary incontinence is consistent with its pharmacology: the recognized anticholinergic urinary adverse effect is retention, and antimuscarinic medicines such as oxybutynin are a treatment for urge incontinence.

Article in Press

Figure 1. Participant Flow Through the Branching Survey and Denominator for Each Section



Practice items were shown only to respondents who reported prescribing anticholinergic medicines.

Article in Press

Results

Demographics

Sixty-two physicians completed the survey. Emergency medicine was the largest specialty group (32 of 62), followed by internal medicine (9 of 62), family medicine (7 of 62), and a range of other specialties including orthopaedics, otorhinolaryngology, rehabilitation

medicine, clinical neurophysiology, geriatric medicine, and general medicine (14 of 62 in total). Most respondents practized in medical centerscentres (51 of 62); the remainder were based in regional hospitals (5), clinics (5), and one district hospital. Fourteen of the 62 respondents (23%) reported being aware of the term 'ACB' (Table 1).

Knowledge

Respondents who were aware of the term (n = 14) were asked to assign the exact ACB score to 10 commonly prescribed medicines: bisoprolol, loperamide, sertraline, furosemide, amlodipine, quinine sulphate, oxybutynin, diazepam, isosorbide mononitrate, and metformin. Responses were marked against the reference values (Table 2).

These 14 respondents provided 140 responses in total, 10 per respondent, of which 26 matched the reference value, giving a mean of 1.9 medicines scored correctly per respondent (median [IQR], 0.5 [0.00-3.75; range, 0-6). Seven of the 14 scored none correctly. Oxybutynin, the only medicine with a reference score of 3, was scored correctly by 2 of 14 respondents, while 7 of 14 answered 'do not know'; these same 7 respondents also reported being unable to score the remaining 9 medicines. Responses for each medicine were determined (Figure 2). When asked directly whether each medicine has anticholinergic properties, respondents classified a mean of 3.3 of 10 correctly (median [IQR], 3 [0-6]; range, 0-7); no respondent classified all 10 correctly, and 5 answered 'do not know' or did not answer for every medicine (Table 3).

In the binary sensitivity analysis, in which each response was recoded as 'any anticholinergic activity' (a response of 1, 2, or 3) versus 'none' (a response of 0), with 'do not know' and unanswered items counted as incorrect, the mean number of medicines classified correctly was 3.0 of 10 (median [IQR], 2 [0-6]; range, 0-7). Six of the 14 correctly identified oxybutynin as having anticholinergic activity, whereas only 3 recognized that amlodipine has none. Per-medicine results were detemined (Table 3). Among the 7 respondents who attempted to score the medicines, the mean number scored correctly rose from 3.7 of 10 under exact-score marking to 6.0 of 10 under binary marking.

Incorrect responses and uncertainty were common when respondents were asked which conditions are associated with a high ACB. Seven of the 14 answered 'do not know' to, or did not answer, every condition; the other 7 tended to endorse every condition listed, and 3 answered 'yes' to all 10. Falls and cardiovascular disease were identified as associated by 7 of 14, and stroke, delirium, and dementia by 6 of 14. Conditions keyed as not associated were frequently selected: urinary incontinence by 7 of 14, gastroesophageal reflux disease by 6, open-angle glaucoma by 5 (with a further 9 answering 'do not know'), and osteoporosis and sarcopenia by 4 each. No respondent correctly rejected urinary incontinence or open-angle glaucoma (Figure 3). The mean number of conditions classified correctly was 2.7 of 10.

Responses were marked against the answer key of the original UK instrument.[17] Falls, stroke, delirium, cardiovascular disease, and dementia are keyed as associated; osteoporosis, sarcopenia, urinary incontinence, gastroesophageal reflux disease, and open-angle glaucoma are keyed as not associated. Anticholinergic medicines are contraindicated in angle-closure, not open-angle, glaucoma, and their recognized urinary adverse effect is retention rather than incontinence. A response was scored correct when an associated condition was selected or a nonassociated condition was rejected; selecting a nonassociated condition was scored as incorrect, and 'do not know' or no answer was counted as incorrect.

Article in Press

Table 1. Demographic Characteristics of Physicians

Medical Specialty	Hospital Classification	No. of Physicians Aware of ACB		
		Total (N = 62)	Yes (n = 14)	No (n = 48)
Emergency medicine	Medical center	27	3	24
	Regional hospital	3	1	2
	District hospital	1	1	0
	Clinic	1	1	0
Family medicine	Medical center	6	1	5
	Clinic	1	1	0
Internal medicine	Medical center	7	1	6
	Regional hospital	2	1	1
Orthopedics	Medical center	1	0	1
Otorhinolaryngology (ENT)	Medical center	1	1	0
Rehabilitation Medicine	Clinic	1	0	1
Others	Medical center	9	3	6
	Clinic	2	0	2

Abbreviations: ACB, anticholinergic burden; ENT, ear nose throat.

Table 2. Reference Anticholinergic Burden Score of the 10 Medications Listed in the Survey

Medication	ACoB Scale	GABS	Reference Score*
Bisoprolol	0	0	0
Loperamide	1	0	1
Sertraline	0	1	1
Furosemide	0	0	0
Amlodipine	0	0	0
Quinine sulphate	0	0	0
Oxybutynin	3	3	3
Diazepam	1	1	1
Isosorbide mononitrate	1	0	1
Metformin	0	1	1

Abbreviations: ACoB, Anticholinergic Cognitive Burden; GABS, German Anticholinergic Burden Score.

* Reference scores were derived from the Anticholinergic Burden (ACB) Calculator, which assigns each medicine the higher of its Anticholinergic Cognitive Burden scale and German ACB Score values. Individual ACoB scale and GABS values for these 10 medicines were checked against the source publications.[6, 7] The Calculator's rule of taking the higher of the 2 values has not itself been validated. Medicines are listed in the order in which they appeared in the questionnaire.

Table 3. Number of the 14 Aware Respondents Answering Correctly, by Medicine, Under Exact-Score Marking, Binary Recoding, and the Direct Identification Item

Medication	Reference Score	Exact Score Correct	Binary Recoding Correct*	Direct Identification Correct**
Bisoprolol	0	4	4	4
Loperamide	1	3	5	5
Sertraline	1	2	5	7
Furosemide	0	3	3	3
Amlodipine	0	3	3	6

Article in Press

Table 3. Number of the 14 Aware Respondents Answering Correctly, by Medicine, Under Exact-Score Marking, Binary Recoding, and the Direct Identification Item (Continued)

Medication	Reference Score	Exact Score Correct	Binary Recoding Correct*	Direct Identification Correct**
Quinine sulphate	0	1	1	1
Oxybutynin	3	2	6	6
Diazepam	1	3	6	8
Isosorbide mononitrate	1	2	4	3
Metformin	1	3	5	3
Total (mean per respondent)	NA	26 (1.9)	42 (3.0)	46 (3.3)

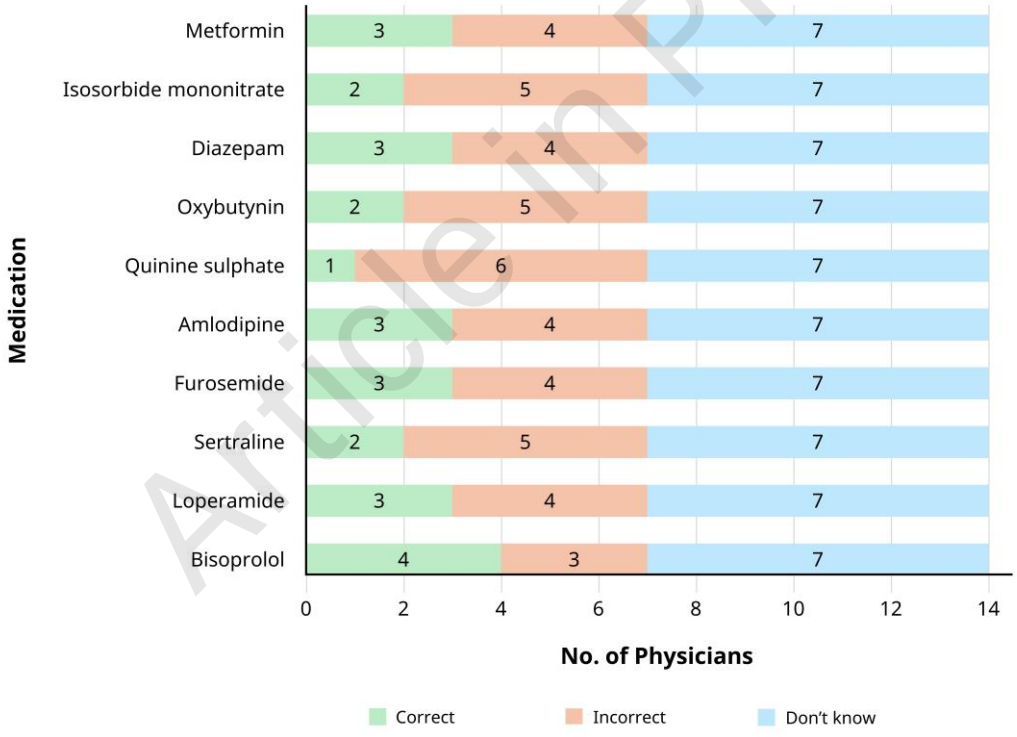
Abbreviation: NA, not applicable.

'Do not know' and unanswered items were scored as incorrect; 7 of the 14 respondents answered 'do not know' or did not answer for every medicine in the scoring item.

* Each score was recoded as any anticholinergic activity (1, 2, or 3) or none (0) and compared with the reference score recoded in the same way.

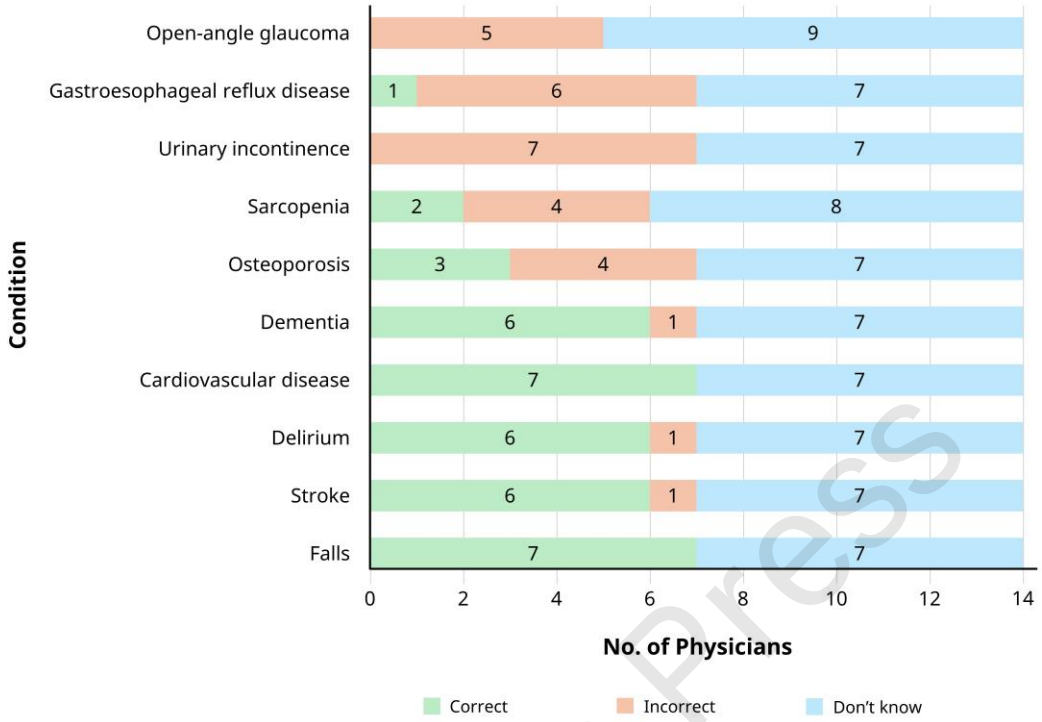
** Respondents answered yes, no, or do not know to whether each medicine has anticholinergic properties.

Figure 2. Responses When Asked to Assign the Anticholinergic Burden Score of 10 Commonly Used Medicines in Older Patients



Article in Press

Figure 3. Responses When Asked Which Conditions Are Associated With a High Anticholinergic Burden in Older Patients



Article in Press

Attitude

Respondents' views on the importance of evaluating ACB were determined. Of the 60 respondents who answered this item (2 left it blank), 6 rated assessment of ACB in patients as 'very important' and 25 as 'important' (31 of 60, 52%), while 23 were neutral, 4 rated it of low importance, and 2 not important at all. For awareness of the consequences of prescribing anticholinergic medicines to older adults, 5 rated this 'very important' and 30 'important' (35 of 62, 56%), with 22 neutral, 3 of low importance, and 2 not important at all. Therefore, just over half of respondents regarded ACB as important, while a substantial minority were neutral or dismissive (Figure 4).

The largest single group comprised respondents who were unaware of ACB, but nonetheless expressed a need for further education (43 of 62). Overall, 56 of 62 respondents (90%) indicated that they needed additional education on ACB (Figure 5); these comprized 13 of the 14 respondents who were aware of ACB and 43 of the 48 who were not.

Practice

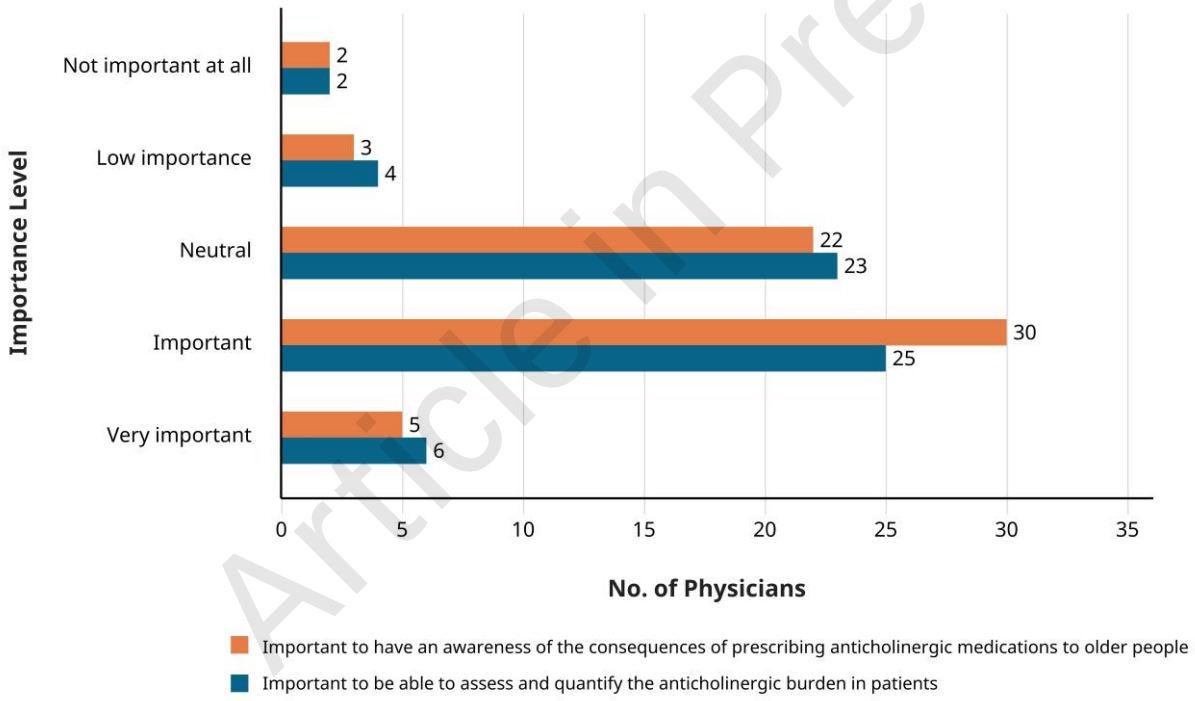
Of the 62 respondents, 28 reported prescribing anticholinergic medications; 20 of these 28 were among the 48 respondents who were unaware of ACB and its potential consequences; 33 did not prescribe them and 1 was unsure. Only the 28 who reported prescribing them were shown the practice items (Figure 1).

Twenty-eight respondents reached the questions on whether they consider ACB and use a burden score in practice. Of these, 21 of 28 reported that they never calculated

a burden score, and 14 of 28 that they never considered ACB at all; all 14 of the latter also never calculated a score. Only one respondent, a family physician working in a clinic, reported consistently evaluating ACB and using the score. Two respondents who never considered ACB and never used a burden score had also rated both attitude items as 'not important at all' (Figure 6).

All 62 respondents were asked how often they document a patient's medication history in their current role: 34 never, 2 rarely, 9 sometimes, 13 often, and 4 always. The item on what respondents would do if a burden score were high was shown to the 28 practice respondents and allowed more than one response; 19 selected at least one action, giving 29 selections in total, and 9 selected none. Eleven would discuss the result with the patient, 7 would inform the admitting clinical team, 6 would inform the general practitioner (GP), and 5 would do nothing (Figure 7). Twelve of these 19 had reported that they never calculated a burden score, so their answers describe intended rather than actual practice; one respondent selected both 'inform GP' and 'do nothing'.

Figure 4. Respondents' Views on the Importance of Evaluating Anticholinergic Burden



Article in Press

Figure 5. Awareness of Anticholinergic Burden and Reported Educational Needs

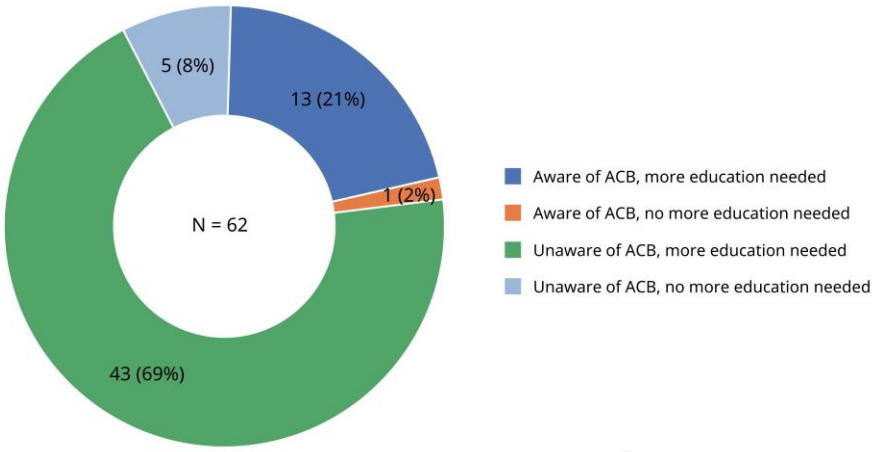
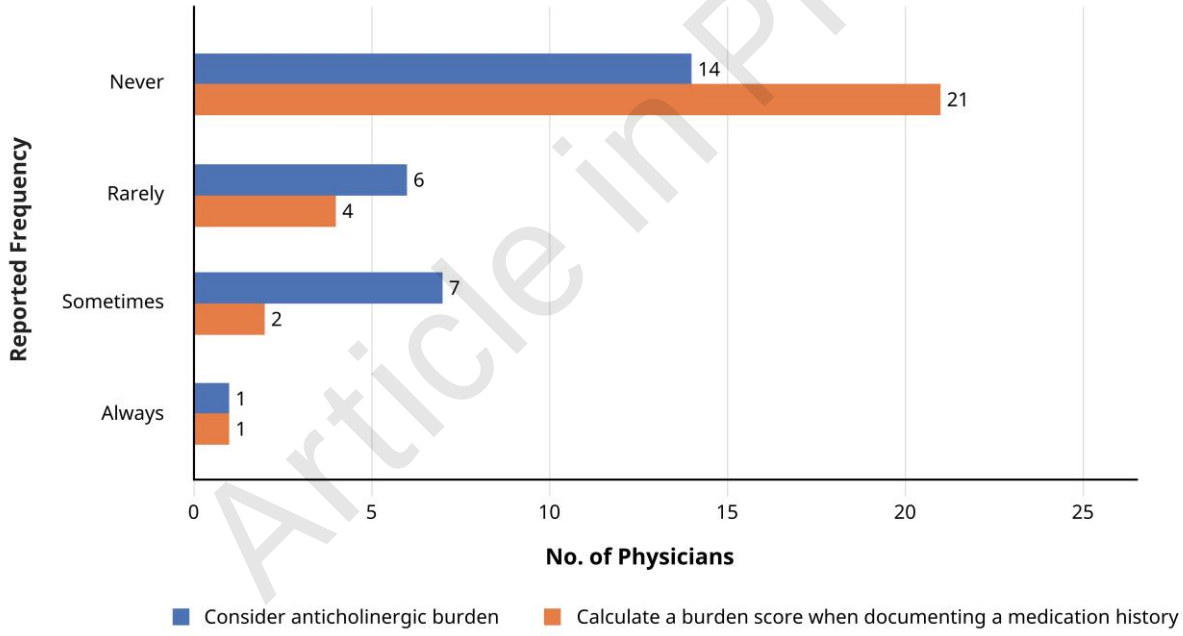
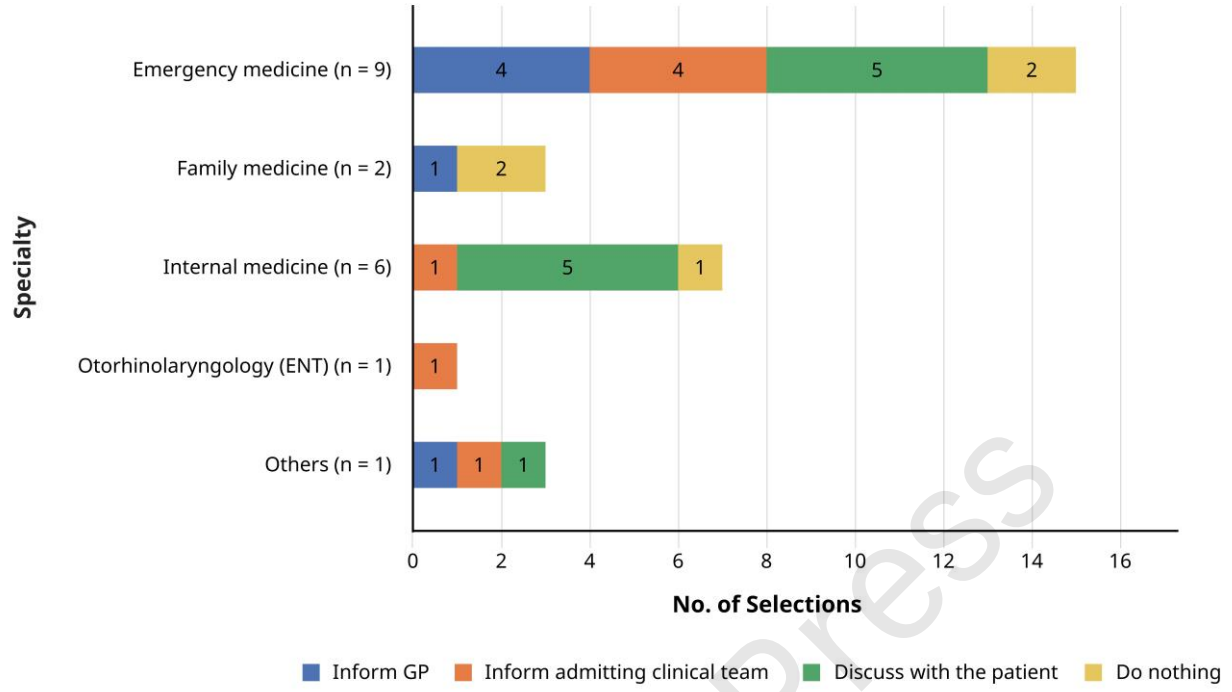


Figure 6. Reported Frequency of Considering Anticholinergic Burden and of Calculating a Burden Score When Documenting a Medication History



Article in Press

Figure 7. Reported Actions in Response to a High Anticholinergic Burden Score, by Specialty



Abbreviations: ENT, ear nose throat; GP, general practitioner.

Article in Press

Discussion

This exploratory pilot survey found that most responding physicians in Taiwan were unfamiliar with the concept of ACB. Only 14 of 62 recognized the term, and among those who did, working knowledge was poor: a mean of 1.9 of 10 medicines scored correctly, and no respondent correctly classified all 10 medicines as having or lacking anticholinergic activity. Attitudes were considerably more favorable: 31 of 60 regarded ACB assessment as important or very important, and 56 of 62 wanted further education. Only one of the 28 respondents who prescribed anticholinergic medicines applied a burden score routinely. Therefore, the dominant finding is a gap between what physicians believed matters and what they were currently equipped to do.

These findings closely mirrored the nationwide UK survey from which the instrument was adapted, in which 54.6% of emergency medicine specialists were aware of ACB but mean knowledge scores were only 2.9 of 10 for medicines and 4.1 of 10 for adverse effects, 69.4% rarely or never considered ACB, 81.3% never calculated a score, and only 1.3% always did so.[17] Awareness was lower in this sample and knowledge scores lower still (1.9 vs 2.9 of 10 for medicines and 2.7 vs 4.1 of 10 for adverse outcomes), but the shape of the finding is the same in both health systems, and in both the gap between attitude and practice was wide. This survey extends the UK work beyond emergency medicine to a range of specialties, which suggests the problem is not confined to acute care. Comparable published evidence from other Asian health systems remains limited.

Two aspects of the knowledge findings warrant emphasis. First, oxybutynin was scored correctly by only 2 of the 14 respondents who were aware of ACB, and half of them

answered 'do not know'. It was the only medicine in the list with a reference score of 3, and is identified as potentially inappropriate in older adults by both the AGS Beers Criteria[22] and STOPP/START version 3[23] because of its strong anticholinergic properties. That a bladder antimuscarinic was flagged explicitly in 2 widely disseminated sets of prescribing criteria goes unrecognized by physicians who already know the term suggests that awareness of the concept and recognition of the drugs that generate it are acquired separately. Therefore, education built around a short list of specific high-burden medicines may be more productive than education around the concept alone. Second, knowledge of clinical consequences was characterized less by gaps than by poor discrimination. Respondents who attempted the item recognized the outcomes keyed as associated, but they also endorsed most of the conditions keyed as not associated, and 3 endorsed all 10. The listed outcomes are also of 2 kinds: delirium and cognitive impairment are direct central anticholinergic effects, whereas falls, stroke, cardiovascular events, and dementia are broader clinical outcomes associated epidemiologically with a high cumulative burden,[2,14,28] so recognizing the latter does not necessarily indicate understanding of the mechanism. Urinary incontinence warrants particular caution. It was keyed as not associated, because the recognized anticholinergic urinary effect is retention and antimuscarinic medicines such as oxybutynin are a treatment for urge incontinence, although retention can cause overflow incontinence, so a respondent selecting it may have had this in mind, and its selection should not be read as a definite knowledge deficit. The pattern of error also differed by item: open-angle glaucoma, included as a distractor, was over-selected, suggesting that respondents applied a general association between anticholinergic medicines and glaucoma without distinguishing angle-closure from open-angle disease. Over-inclusion of this kind is clinically conservative, but it indicated that knowledge is held at the level of drug class rather than of the specific mechanism, which is the level at which prescribing decisions are made.

The sensitivity analyses help to separate the 2 components of knowledge that exact-score marking conflates. Recognizing whether a medicine has any anticholinergic activity was easier than grading its severity: among the 7 respondents who attempted the scoring item, the mean number correct rose from 3.7 to 6.0 of 10 when responses were recoded as binary judgements. Even so, recognition was incomplete. Half of the aware respondents answered 'do not know' to, or did not answer, every medicine, no respondent classified all 10 correctly on either the recoded or the direct identification item, and answers were sometimes internally inconsistent: 6 respondents stated directly that amlodipine has no anticholinergic properties, but only 3 assigned it a score of 0. Therefore, the low exact scores reflect limited recognition of anticholinergic medicines, not only strict marking against a single reference scale.

The disparity between favourable attitudes and limited knowledge and practice, seen here and in the UK,[17] may have several explanations. Expressing an attitude costs nothing, whereas acting on ACB requires a reference tool at the point of prescribing, time required for a short consultation, and the confidence to alter another prescriber's medicines. Physicians who recognize the term may have acquired it passively, without ever applying a scale to a real medication list. ACB is also cross-cutting rather than specialty-specific: no single clinician owns the cumulative medication list, so responsibility is diffuse. Self-reported attitudes are also susceptible to social desirability bias, which would tend to widen any apparent gap. These explanations are not mutually exclusive, and each implies a different remedy: embedded decision support, applied rather than didactic training,

Article in Press

explicit allocation of responsibility for medication review, and objective measurement of prescribing behaviour.

The clinical relevance of these gaps in Taiwan is considerable. Approximately 60% of adults aged 65 and over receive an anticholinergic medicine annually, and such exposure is associated with pneumonia (adjusted OR, 1.33).[13] A nationwide case-case-time-control study of 317 446 hospitalized older adults, of whom 248 579 entered the crossover analyses, found that a recent increase in burden was associated with acute cardiovascular events (case-case-time-control OR, 1.38, 95% CI, 1.34-1.42 for scores of 1-2; OR, 2.03, 95% CI, 1.98-2.09 for scores ≥ 3, vs 0).[14] Low prescriber recognition may contribute, although a cross-sectional survey cannot establish this. A Thai cohort similarly found nearly 38% of older inpatients had a score of 3 or more at discharge, often higher than on admission.[24]

Two complementary interventions follow. The first is education. The Royal College of Emergency Medicine curriculum does not address ACB explicitly,[25] and to the authors knowledge neither do Taiwanese postgraduate curricula, yet almost all respondents requested further training. Short, case-based modules organized around specific high-burden medicines and delivered through existing continuing-education channels would be a low-cost starting point. The second is decision support. Because prescribing in Taiwan is captured within a single-payer system, burden scores could be computed automatically and surfaced as an alert at prescribing or discharge, which would not depend on individual recall. Comparable UK proposals have centred on pharmacist collaboration and flagging within general practice systems.[17] Medication review at admission and discharge using the ACoB scale, the Beers Criteria,[22] or STOPP/START,[23] remains the practical corollary. A cumulative score of 3 or more, the threshold used throughout this article, is widely taken to indicate clinically relevant burden, and exposure at this level has been linked to cognitive impairment and dementia.[12,26-28]

Limitations

Several limitations should be borne in mind. First, the sample was small and self-selected. Because invitations were distributed by hospital coordinators, the number of physicians who received one is unknown, so no response rate could be calculated. The UK survey on which this study was modelled achieved a response rate of 2.8%,[17] and self-selection towards clinicians already interested in the topic is likely in our sample too. Therefore, findings are hypothesis-generating rather than population-level estimates. Second, the sample was skewed towards emergency medicine and medical centers, which affects each KAP domain differently. Emergency physicians see the acute manifestations of anticholinergic excess but rarely conduct medication review, so the knowledge gap may be overstated relative to geriatricians. The settings in which ACB is most modifiable are those about which we have least information. Third, the reference standard is one of several defensible ones. Sertraline scores 0 on the ACoB scale and ARS but 1 on the ADS and GABS, and metformin and diazepam vary likewise. Respondents familiar with another scale may have been marked incorrect while holding defensible knowledge. Moreover, the ACB Calculator's rule of taking the higher of the ACoB scale and GABS values where they disagree is itself a composite algorithm that has not been validated, and this study relied on its web implementation; although the individual scale values for the 10 medicines were checked against the source publications, the composite scores were not independently validated. Future studies could reduce dependence on any one scale by using a consensus list of anticholinergic medicines or scale-agnostic clinical vignettes. Fourth, exact 0-3 marking

Article in Press

conflates recognition of anticholinergic activity with grading of severity, and will understate the former; so the binary sensitivity analysis was added for this reason. The answer key for the adverse-outcome item was also inherited from the UK instrument, and some items, notably urinary incontinence, admit more than one defensible interpretation. Fifth, practices were self-reported and unverified, and answers to the action item were largely hypothetical, because most respondents who answered it had never calculated a score. Respondents who completed the survey were entered into a lucky draw, which may also have influenced who chose to take part. Data were collected in 2 phases a year apart, which may have introduced period effects, although only 5 responses came from the first phase. Finally, the questionnaire was used without adaptation for Taiwan. It was administered in English, and no content validation, cognitive testing, or pilot testing was undertaken, so comprehension of individual items was not verified. This may have contributed to nonresponse and to the high proportion of 'do not know' answers. The medication list was also assembled in a UK setting. Items requiring a fine distinction, such as open-angle versus angle-closure glaucoma, may have been read as referring to the condition in general, so errors on such items should be interpreted as imprecision rather than as absence of knowledge. Before the instrument is used more widely in Taiwan, it should be translated, culturally adapted, and validated locally, including content validation and cognitive testing with Taiwanese physicians.

Conclusions

In this exploratory pilot survey, awareness of ACB among physicians in Taiwan was low. Among those who recognized the term, few could score common medicines or reliably identify which medicines have anticholinergic activity, and although outcomes associated with a high burden were often recognized, they were not distinguished from conditions with no such association. Attitudes were nonetheless favourable in about half of respondents, and demand for education near-universal, yet almost no respondent applied a burden score in practice. Therefore, the gap is one of knowledge and translation rather than motivation, and is likely closed more effectively by embedding burden assessment in prescribing systems and curricula than by awareness-raising alone. Because these findings rest on a knowledge instrument that was not validated in Taiwan and on a small, self-selected sample, they require confirmation in larger studies that include primary care and geriatric practice and that measure prescribing behaviour objectively.

Article In Press

Additional Information

Acknowledgments: The authors would like to extend our sincere gratitude to the REDCap online platform hosted at the University of Aberdeen, UK.

Ethics Approval: This study received ethical approval from the Institutional Review Board of Kaohsiung Medical University, Taiwan (T-KMU-43514) on 27 June 2024. Two approval numbers apply because recruitment was conducted in 2 sequential phases using the same protocol and instrument.; KMUHIRB-E(II)-20240236 covered the initial phase, which invited emergency physicians only, and KMUHIRB-E(II)-20250159 covered the subsequent extension to physicians of all specialties.

Clinical Trial Consideration: This study does not report on a clinical trial.

Financial Support: This study was supported by the income funds of the Faculty of Pharmacy, Chiang Mai University (R39-F43, Nantawarn Kitikannakorn).

Conflict of Interest: All authors declare no conflicts of interest. All authors have fully considered the policy on competing interests and confirm that there are no professional interests, personal relationships, or personal beliefs that could be perceived to influence the work reported.

Declaration of AI Assistance: The authors used a generative AI tool (Claude) in the preparation of this manuscript. The AI was utilized for language refinement, including grammar and clarity. All AI-generated content is based on real data and has been thoroughly reviewed and verified by the authors to ensure accuracy, validity, and integrity. The authors take full responsibility for the content presented.

Author Contributions:
Conceptualization: All authors
Formal Analysis: Piyawat Dilokthornsakul
Funding Acquisition: Nantawarn Kitikannakorn
Investigation: Piyawat Dilokthornsakul, Kun-Pin Hsieh
Methodology: All authors
Supervision: Nantawarn Kitikannakorn
Visualization: Nantawarn Kitikannakorn
Writing – Original Draft: Nantawarn Kitikannakorn
Writing – Review & Editing: All authors

Article In Press

References

1. Suresh AV, Sargent P. Reducing anti-cholinergic burden in older patients. *Clin Med.* 2022;22(Suppl 4): 75-76. doi:10.7861/clinmed.22-4-s75
2. Hilmer SN, Gnjidic D. The anticholinergic burden: from research to practice. *Aust Prescr.* 2022;45(4): 118-120. doi:10.18773/austprescr.2022.031
3. Masnoon N, Shakib S, Kalisch-Ellett L, Caughey GE. What is polypharmacy? A systematic review of definitions. *BMC Geriatr.* 2017;17(1):230. doi:10.1186/s12877-017-0621-2
4. Grossi CM, Richardson K, Savva GM, et al. Increasing prevalence of anticholinergic medication use in older people in England over 20 years: cognitive function and ageing study I and II. *BMC Geriatr.* 2020;20(1):267. doi:10.1186/s12877-020-01657-x

5. Coupland CAC, Hill T, Dening T, Morriss R, Moore M, Hippisley-Cox J. Anticholinergic drug exposure and the risk of dementia: a nested case-control study. *JAMA Intern Med.* 2019;179(8):1084-1093. doi:10.1001/jamainternmed.2019.0677
6. Boustani M, Campbell N, Munger S, Maidment I, Fox C. Impact of anticholinergics on the aging brain: a review and practical application. *Aging Health.* 2008;4(3):311-320. doi:10.2217/1745509X.4.3.311
7. Kiesel EK, Hopf YM, Drey M. An anticholinergic burden score for German prescribers: score development. *BMC Geriatr*. 2018;18(1):239. doi:10.1186/s12877-018-0929-6
8. Hilmer SN, Mager DE, Simonsick EM, et al. A drug burden index to define the functional burden of medications in older people. *Arch Intern Med.* 2007;167(8):781-787. doi:10.1001/archinte.167.8.781
9. Rudolph JL, Salow MJ, Angelini MC, McGlinchey RE. The anticholinergic risk scale and anticholinergic adverse effects in older persons. *Arch Intern Med.* 2008;168(5):508-513. doi:10.1001/archinternmed.2007.106
10. Carnahan RM, Lund BC, Perry PJ, Pollock BG, Culp KR. The anticholinergic drug scale as a measure of drug-related anticholinergic burden: associations with serum anticholinergic activity. *J Clin Pharmacol.* 2006;46(12):1481-1486. doi:10.1177/0091270006292126
11. Lisibach A, Benelli V, Ceppi MG, Waldner-Knogler K, Csajka C, Lutters M. Quality of anticholinergic burden scales and their impact on clinical outcomes: a systematic review. *Eur J Clin Pharmacol.* 2021;77(2):147-162. doi:10.1007/s00228-020-02994-x
12. King R, Rabino S. ACB Calculator. 3 July 2024. Accessed March 20, 2024. https://www.acbcalc.com
13. Lee CY, Cheng YD, Cheng WY, Tsai TH, Huang KH. The prevalence of anticholinergic drugs and correlation with pneumonia in elderly patients: a population-based study in Taiwan. *Int J Environ Res Public Health.* 2020;17(17):6260. doi:10.3390/ijerph17176260
14. Huang WC, Yang AS, Tsai DH, Shao SC, Lin SJ, Lai EC. Association between recently raised anticholinergic burden and risk of acute cardiovascular events: nationwide case-case-time-control study. *BMJ.* 2023;382:e076045. doi:10.1136/bmj-2023-076045
15. Liu YP, Chien WC, Chung CH, Chang HA, Kao YC, Tzeng NS. Are anticholinergic medications associated with increased risk of dementia and behavioral and psychological symptoms of dementia? A nationwide 15-year follow-up cohort study in Taiwan. *Front Pharmacol*. 2020;11:30. doi:10.3389/fphar.2020.00030
16. Phutietsile GO, Nishtala PS. Rethinking anticholinergic burden in older adults: innovative approaches to detection and management. *Expert Rev Clin Pharmacol.* 2025;18(8):551-562. doi:10.1080/17512433.2025.2546142
17. Dilokthornsakul P, Stewart C, Moss P, et al. Evaluating the anticholinergic burden in older patients: comprehensive insights from a nationwide survey among emergency medicine specialists in the UK. *Geriatrics.* 2025;10(6):137. doi:10.3390/geriatrics10060137
18. Harris PA, Taylor R, Minor BL, et al. The REDCap consortium: building an international community of software platform partners. *J Biomed Inform.* 2019;95:103208. doi:10.1016/j.jbi.2019.103208
19. Launiala A. How much can a KAP survey tell us about people's knowledge, attitudes and practices? Some observations from medical anthropology research on malaria in pregnancy in Malawi. *Anthropol Matters*. 2009;11(1):1-13. doi:10.22582/am.v11i1.31
20. von Elm E, Altman DG, Egger M, et al. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet.* 2007;370(9596):1453-1457. doi:10.1016/S0140-6736(07)61602-X
21. Joint Commission of Taiwan. *Taiwan Patient Safety Culture Survey Annual Report 2022.* Joint Commission of Taiwan; 2023.
22. By the 2023 American Geriatrics Society Beers Criteria® Update Expert Panel. American Geriatrics Society 2023 updated AGS Beers Criteria® for potentially inappropriate medication use in older adults. *J Am Geriatr Soc*. 2023;71(7):2052-2081. doi:10.1111/jgs.18372

Article in Press

23. O'Mahony D, Cherubini A, Guiteras AR, et al. STOPP/START criteria for potentially inappropriate prescribing in older people: version 3. *Eur Geriatr Med.* 2023;14(4):625-632. doi:10.1007/s41999-023-00777-y
24. Tiranaprakij P, Srisuma S, Putthipokin K, Ruangritchankul S. Anticholinergic burden and clinical outcomes among older adults admitted in a tertiary hospital: a prospective cohort study. *PLoS One.* 2025;20(9):e0332946. doi:10.1371/journal.pone.0332946
25. Royal College of Emergency Medicine. *Emergency Medicine Curriculum 2021*. Royal College of Emergency Medicine; 2021. Accessed 1 September 2026. https://rcem.ac.uk/em-curriculum
26. Bishara D, Harwood D, Sauer J, Taylor DM. Anticholinergic effect on cognition (AEC) of drugs commonly used in older people. *Int J Geriatr Psychiatry*. 2017;32(6):650-656. doi:10.1002/gps.4507
27. Fox C, Richardson K, Maidment ID, et al. Anticholinergic medication use and cognitive impairment in the older population: the medical research council cognitive function and ageing study. *J Am Geriatr Soc.* 2011;59(8):1477-1483. doi:10.1111/j.1532-5415.2011.03491.x
28. Richardson K, Fox C, Maidment I, et al. Anticholinergic drugs and risk of dementia: case-control study. *BMJ.* 2018;361:k1315. doi:10.1136/bmj.k1315

Article in Press