PharmacoEconomics - Open (2021) 5:491–504
https://doi.org/10.1007/s41669-021-00267-6

ORIGINAL RESEARCH ARTICLE

Cost-effectiveness of a Province-wide Quality Improvement Initiative for Reducing Potentially Inappropriate Use of Antipsychotics in Long-Term Care in British Columbia, Canada

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Accepted: 12 April 2021 / Published online: 29 April 2021

Abstract

Background Potentially inappropriate use of antipsychotics (PIUA) raises serious concerns about safety, quality, and cost of care for residents in long-term care (LTC).

Objective This study aimed to estimate the cost-effectiveness of the Call for Less Antipsychotics in Long-Term Care (Clear) initiative compared with the status quo (pre-Clear, baseline).

Methods A model-based cost-utility analysis, from a public-payer perspective in British Columbia, was conducted using secondary data of residents in LTC homes from 2013 to 2019. Residents' health resource utilization and quality-adjusted life-year (QALY) measures were extracted from multiple administrative databases. Six Markov states were modelled for post-antipsychotic progression representing PIUA, appropriate use of antipsychotic, complete withdrawal, and death. The primary outcome was the incremental cost per QALY gained.

Results A cohort of 35,669 residents was included in the primary analysis. The Clear initiative, over 10 years, was estimated to have an incremental cost-effectiveness ratio (ICER) of CA$26,055 (2020 Canadian dollars) per QALY gained at an incremental cost of CA$5211 per resident and a QALY gain of 0.20. In the subgroup analyses, our findings were even more favourable for Clear wave 2 (ICER of CA$24,447 per QALY gained) and Clear wave 3 (ICER of CA$25,933 per QALY gained). At a willingness-to-pay of CA$50,000 per QALY gained, the probabilities of Clear waves 2 and 3 were 82% cost-effective.

Conclusion This study demonstrated incremental costs and yielded favourable ICERs for Clear compared with the baseline. More research is needed to understand the level of support for individual care homes to sustain the Clear initiative in the long run.

1 Introduction

Antipsychotic medications are often prescribed to patients diagnosed with Alzheimer's disease, particularly for managing behavioural and psychological symptoms of dementia (BPSD), including aggression, delusion, and agitation [1, 2]. However, the use of antipsychotics in patients without a diagnosis of psychosis is classified as 'potentially inappropriate' [3, 4]. Potentially inappropriate use of antipsychotics (PIUA) raises concerns about safety, quality of care, and costs, primarily due to the escalated demands on the healthcare system [5]. There is a strong body of scientific evidence surrounding the side effects of antipsychotics in the elderly, particularly those with dementia, including a sudden drop in

Key Points for Decision Makers

The quality improvement programmes targeting appropriate utilization of antipsychotics in long-term care homes require a minimal financial investment.

The health-related quality of life (HRQoL) score was relatively higher in residents who had stopped taking potentially inappropriate antipsychotics than those who were consistently taking the antipsychotic medications. The HRQoL scores were poor (i.e., much lower) in residents with intermittent use of antipsychotics.

A person-centred approach for reducing potentially inappropriate use of antipsychotics appears to be cost effective.

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blood pressure, sedation, falls, fractures, stroke, and death [6, 7]. Previously conducted studies also indicated a higher number of Emergency Department (ED) visits and prolonged inpatient hospitalization associated with PIUA [8, 9].

In Canada, over 419,000 people aged 65 years and older are living with dementia, and nearly 78,000 new dementia cases are diagnosed annually [10]. The prevalence of PIUA is much higher in the residents of long-term care (LTC) homes than in the general elderly population [11]. According to the Canadian Institute for Health Information (CIHI), the proportion of PIUA ranges from 14 to 40% in Canadian LTC homes, representing a considerable variation between provinces or regions [12]. For example, in 2018/19, the percentage of PIUA was as high as 39.8% (95% confidence interval [CI] 16.6–17.8) of LTC residents in the Labrador–Grenfell Health region versus 14% (95% CI 13.2–15) of LTC residents in Edmonton Zone [12]. Such provincial/regional differences further indicate contextual challenges with respect to the facility size, staffing, administrative structure, and organizational culture. All of these factors are pivotal to designing robust quality improvement (QI) programmes in LTC homes.

Reducing PIUA is a critical aspect of QI in LTC. In a rapidly changing environment, particularly in the context of LTC, where a one-size-fits-all approach is not applicable, there are implications for shifting resources in person-centred care for patients diagnosed with dementia [13]. According to the Alzheimer Society of Canada, a person-centred approach allows care providers to work with residents, their families, and informal caregivers to understand the underlying causes of BPSD better. Additionally, this model of care focuses on building resident's strengths/abilities as well as periodic medication reviews for discontinuing or reducing antipsychotics [14]. One such QI initiative is the Call for Less Antipsychotics in Long-Term Care (Clear) homes in British Columbia (BC) [15]. The Clear initiative was launched in 2013 (wave 1), followed by Clear wave 2 in 2015 and Clear wave 3 in 2017. The focus of Clear wave 1 was geared towards inter-professional teams and shared learning, including four regional in-person workshops, creating a website for free access to resources, and online webinars [16]. Building on Clear wave 1, the second wave engaged clinicians and pharmacists in the person-centred approach. Examples of strategies implemented across care homes in wave 2 included using non-pharmacological measures to respond to residents' needs, establishing a medication review plan for residents on antipsychotic medications, and implementing best practices for prescribing antipsychotics appropriately [17]. The third wave further strengthened programme activities, updated online resources, and involved regional health authorities to sustain the Clear initiative. Since the inception of the Clear initiative, LTC homes have formed action-and-improvement teams and received support through shared resources, improvement coaching, mentorship, and opportunities to collectively learn and participate in local, regional, and provincial activities [15].

In the policy context, health system planners and administrators need to know the evidence about the cost-effectiveness to inform resource allocation decisions. This became more relevant towards the end of Clear wave 3 because no subsequent waves were anticipated, and the evidence surrounding the economic impact of Clear was lacking. Additionally, previously conducted programme evaluations of Clear waves broadly focused on the implementation aspects, such as percent reduction of PIUA, participation in webinars or workshops, and qualitative excerpts from residents about the perceived benefits [16, 17]. The health-related quality of life (HRQoL) in residents, however, was not considered in the previous evaluations. The quality-adjusted life-years (QALY) is a generic measure of HRQoL that captures both the quality and the quantity of life lived and is commonly used in the economic evaluation of health interventions [18]. Thus, a comprehensive understanding of the Clear programme implementation costs and residents' quality of life is critical to fill the knowledge gap and further strengthen the policy argument for the spread, scale-up, and sustainability of the Clear initiative. This study aimed to estimate the cost-effectiveness of the Clear initiative compared with the status quo (i.e., pre-Clear, baseline) in BC.

2 Materials and Methods

2.1 Study Design and Perspective of Analysis

This study utilized a model-based, cost-utility analysis using the guidelines of the Canadian Agency for Drugs and Technology (CADTH) and the Panel on Cost Effectiveness in Health and Medicine [19, 20]. All costs were calculated from the perspective of a single public payer (i.e., BC Ministry of Health).

2.2 Target Population, Setting, and Costs of Health Resource Utilization (HRU)

The resident-level data were obtained from the BC Ministry of Health for Continuing Care Reporting System (CCRS) for a cohort of residents identified as PIUA from the Residential Assessment Instrument (RAI) 2.0 from April 1, 2012, to March 31, 2019. A resident taking antipsychotics without a diagnosis of psychosis, excluding residents with delusions, hallucination, Huntington's chorea, schizophrenia, and end-of-life residents, was classified as potentially inappropriate [21]. The RAI assessments are completed by nurses every 3 months for every resident in the LTC home [22]. A unique study identification code for each resident from the

RAI database was linked to four databases including the Discharge Abstract Database (DAD) [23], National Ambulatory Care Reporting System (NACRS) [24], PharmaNet (PhNet) [25], and Medical Services Plan (MSP) [26]. Key variables in these databases included residents' physical and health conditions, medications and services, visits by general practitioners, ED visits, hospital admissions, and discharge outcomes.

Descriptive analysis was performed to calculate the frequency and proportion of antipsychotic use, adverse events (i.e., falls and fractures), and health facility utilization. Using a case-mix-group (CMG) methodology, the resource intensity weight (RIW) was multiplied by the cost of standard hospital stay (for the period 2013–2018) to calculate the hospitalization cost per resident–admission [27]. For ambulatory care, standard costs of GP and ED were multiplied by the number of visits to calculate the cost per resident–occurrence [28]. The costs of antipsychotic medications were extracted from the MSP database [26]. All costs were adjusted using the Canadian Consumer Price Index for Health and are expressed in 2020 Canadian dollars (CA$). Previously conducted economic studies indicated clustering effect on costs, care-seeking practices, and HRQoL in healthcare facilities within a larger health system [29, 30]. In the context of LTC, where some care homes tend to have a much older population, residents may have severe comorbidities compared with other care homes. Other factors such as bed capacity, public-versus-private ownership, geographical location, staffing ratio, etc., differ between care homes. We used a generalized linear mixed-effect model to estimate the mean cost per resident, accounting for age, sex, education (fixed variables), and clustering by LTC home (random variable).

2.3 Programme-Related Costs

Personnel time spent on Clear activities was determined through an online survey of care providers and administrative staff in LTC homes. The unit cost of personnel time (hourly wage) was calculated from the Health Employer Association of BC (HEABC) collective agreement for 2019–2022 [31]. On the programme side, Clear spending was determined from the institutional financial reports from 2013 to 2019. Major cost buckets included resource development, monitoring, supportive supervision, and fee for clinical leadership. The total cost was divided by the number of assessments to calculate the cost per resident–assessment.

2.4 Health-Related Quality-Adjusted Life-Years (HRQoL)

The RAI database captures resident-level information on socio-demographic characteristics, clinical conditions including comorbidities, daily living activities, vision, speech, hearing, cognition, pain, and depression [23]. A previous study mapped RAI variables to Health Utility Index (HUI) version 3 attributes and provided weighted utility scores using Canadian tariffs [32]. We used these utility weights for RAI variables and applied the following validated equation to calculate the HRQoL scores:

$$\begin{aligned}\text{HRQoL Score} = 1.371\big(&\text{Utility}_{\text{vision}} \times \text{Utility}_{\text{hearing}} \\ &\times \text{Utility}_{\text{speech}} \times \text{Utility}_{\text{ambulation}} \\ &\times \text{Utility}_{\text{dexterity}} \times \text{Utility}_{\text{emotion}} \\ &\times \text{Utility}_{\text{cognition}} \times \text{Utility}_{\text{pain}}\big) - 0.37\end{aligned}$$

2.5 Economic Model

In our study, the Markov model was adopted (Moriarty et al. 2019) [33] because of its ability to model recurrent adverse events (i.e., falls leading to hip fracture), post-event healthcare-seeking (i.e., hospitalization and/or emergency admissions), and mortality, which is an ongoing risk over time. The Markov model was chosen to allow for time dependency, a particularly important consideration in the context of older people receiving PIUA in LTC homes. Six mutually exclusive health states were modelled, including (1) PIUA, 0 days, (2) PIUA 1–6 days, (3) PIUA 7 days, (4) Appropriate antipsychotic use, (5) Completely withdrawn from antipsychotics, and (6) Death (Fig. 1). Three PIUA states represent the frequency of antipsychotic drug use in the last 7 days from the assessment date, as reported in the RAI database. The RAI assessments are done at the time of admission in an LTC home (i.e., initial assessment) and are repeated on a quarterly basis (see electronic supplementary material [ESM], Supplementary Appendix Table S1: time-varying transition probabilities). All patients entered the model under PIUA states (i.e., PIUA 1–6 days = 5%, and PIUA 7 days = 95%) and made transitions (to or from) or remained within any five states (except death state) in the subsequent quarterly cycles. There was a one-way transition to the death state, and those who died remained in the same state throughout the model cycles. The background annual mortality parameter was obtained from Statistics Canada for the BC population aged 78+ years [34]. Model structures were assessed for face validity by the research team (including geriatric clinicians), and models were cross-validated and compared to other published models concerning potentially inappropriate prescriptions [33]. We used double programming to validate the models. The model was first constructed in TreeAge Pro 2021 [35], and input parameters were assigned for all health states. Secondly, the model structures and corresponding values were exported in Microsoft Excel 2010 to detect structural or coding errors. The model structures programmed in TreeAge Pro and exported to Excel are included in Fig. 1.

2.6 Cost-Utility Analysis

Table 1 displays model input parameters derived from linked administrative databases, an online survey of care providers and administrators in LTC homes, a review of financial records, and grey literature. We analyzed costs and HRQoL in a 3-month (quarterly) cycle to calculate the incremental cost-effectiveness ratio (ICER). In the base-case analysis, we calculated ICERs for the Clear initiative compared with the status quo (pre-Clear baseline period). The ICER was calculated by dividing the difference in total costs (i.e., Clear versus status quo) by the difference in the outcomes (i.e., change in the HRQoL before and after Clear). Additionally, subgroup analyses were performed for each Clear wave 1, 2, and 3 compared with a common reference point of baseline. We calculated percent change in PIUA both within and between Clear waves compared with baseline (see Supplementary Appendix Table S1 in the ESM). Because each Clear wave's duration was roughly 2 years, we assumed a fixed average percent reduction in PIUA in the subsequent years. According to Statistics Canada, the life expectancy for adults aged 65 years in BC is 20.7 years [36]. In our study, the mean age of residents was 78.3 years (standard deviation ±10); therefore, we used a time horizon of 10 (i.e., to age 88 years) with a half-cycle correction. The long-term findings were extrapolated from 2-year QI data and so associated with some degree of uncertainty. Both costs and QALYs were discounted at 1.5% following the recent CADTH guidelines [19]. A sensitivity analysis was applied to test robustness with multiple scenarios by varying the effect size, Clear costs, and annual discount rate. In order to address the parameter uncertainties associated with the costs and outcome variables, the probabilistic analysis was applied using Monte Carlo simulations to draw values at random from 10,000 iterations. ICERs were reported using a standard willingness-to-pay (WTP) threshold of CA$50,000 per QALY gain.

3 Results

3.1 Baseline Characteristics

A cohort of 35,669 residents from 312 LTC homes was included in the primary analysis. Small variations were observed in participants' characteristics in terms of clinical diagnosis, length of stay, and discharge outcomes in the post-Clear period compared with baseline. Of 35,669 residents, 53% of residents were over 85 years old ($n = 18,762$), 60% of residents were female ($n = 21,613$), 87% of residents were English speaking ($n = 31,182$), and ~ 21% of residents attended high school ($n = 7309$). The leading medical diagnoses included hypertension ($n = 14,034$; 39%), and Alzheimer disease ($n = 5378$, 15%). Approximately 45% of residents stayed < 12 months in the LTC home ($n = 15,918$), and over 50% of residents have died in this cohort ($n = 22,604$) (Table 2).

3.2 Resident-Level Outcomes

A total of 381,434 resident RAI assessments were analyzed, translating into an average of 11 RAI assessments per resident. Of 46,111 resident assessments in the baseline, the PIUA was reported in 58% of assessments ($n = 26,563$). The proportions of PIUA decreased to 52% in Clear wave 1 ($n = 55,029$ out of 105,142), 44% in Clear wave 2 ($n = 49,290$ out of 111,395), and 42% in Clear wave 3

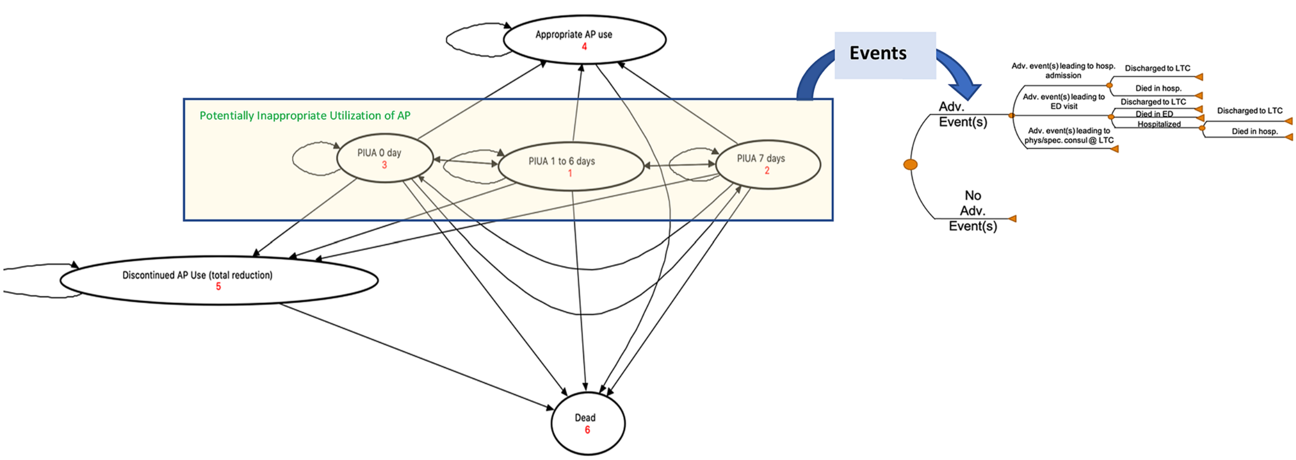


Fig. 1 Markov model. *ADV* adverse, *AP* antipsychotics, *ED* emergency department, *LTC* long-term care, *PIUA* potentially inappropriate use of antipsychotics

Table 1 Model input parameters in the cost-effectiveness analysis

Variable name	Value	Low	High	Distribution	Source
Average costs per resident, in CA$					
ED, per visit	434	326	543	Gamma	NACRS database BC
MSP for ED, per visit	86	65	108	Gamma	MSP database BC
Inpatient hospitalization, per admission	13,747	10310	17184	Gamma	DAD database BC
MSP for an inpatient hospitalization, per admission	93	70	116	Gamma	MSP database BC
MSP for care home consultation, per visit	45	34	56	Gamma	MSP database BC
Antipsychotic medications, per claim	13	10	16	Gamma	PhNet database BC
Onsite Clear implementation, per resident–assessment	327	245	409	Gamma	Clear—online survey
Clear (all waves combined) development and support, per resident–assessment	187	140	234	Gamma	Clear—review of financial report
Clear wave 1 development and support, per resident–assessment	272	204	340	Gamma	Clear—review of financial report
Clear wave 2 development and support, per resident–assessment	119	89	149	Gamma	Clear—review of financial report
Clear wave 3 development and support, per resident–assessment	229	172	286	Gamma	Clear—review of financial report
Adverse events per resident, probability					
Hip fracture, baseline	0.015	0.0135	0.0165	Beta	RAI database BC
Hip fracture, overall Clear (waves 1–3)	0.014	0.0126	0.0154	Beta	RAI database BC
Hip fracture, Clear wave 1	0.014	0.0126	0.0154	Beta	RAI database BC
Hip fracture, Clear wave 2	0.014	0.0126	0.0154	Beta	RAI database BC
Hip fracture, Clear wave 3	0.013	0.0117	0.0143	Beta	RAI database BC
Inpatient hospital admission, baseline	0.035	0.0315	0.0385	Beta	RAI database BC
Inpatient hospital admission, overall Clear (waves 1–3)	0.034	0.0306	0.0374	Beta	RAI database BC
Inpatient hospital admission, Clear wave 1	0.035	0.0315	0.0385	Beta	RAI database BC
Inpatient hospital admission, Clear wave 2	0.035	0.0315	0.0385	Beta	RAI database BC
Inpatient hospital admission, Clear wave 3	0.033	0.0297	0.0363	Beta	RAI database BC
ED visit, baseline	0.030	0.0270	0.0330	Beta	RAI database BC
ED visit, overall Clear (waves 1–3)	0.027	0.0243	0.0297	Beta	RAI database BC
ED visit, Clear wave 1	0.029	0.0261	0.0319	Beta	RAI database BC
ED visit, Clear wave 2	0.028	0.0252	0.0308	Beta	RAI database BC
ED visit, Clear wave 3	0.024	0.0216	0.0264	Beta	RAI database BC
Inpatient hospital admission from ED	0.42	0.3780	0.4620	Beta	RAI database BC
Background mortality	0.027	0.0230	0.0311	Beta	Statistics Canada, BC province
ED mortality	0.001	0.0009	0.0011	Beta	RAI database BC
Inpatient hospital admission mortality	0.00047	0.0004	0.0005	Beta	RAI database BC
Average potentially inappropriate use of antipsychotics per resident, %					
Baseline	58	52	64	Log Normal	RAI database BC
Overall Clear (waves 1–3)	46	41	51	Log Normal	RAI database BC
Clear wave 1	52	47	57	Log Normal	RAI database BC
Clear wave 2	44	40	48	Log Normal	RAI database BC
Clear wave 3	42	38	46	Log Normal	RAI database BC
0 days, baseline	30	28	33	Log Normal	RAI database BC
0 days, overall Clear (waves 1–3)	40	36	44	Log Normal	RAI database BC
0 days, Clear wave 1	37	33	41	Log Normal	RAI database BC
0 days, Clear wave 2	42	38	46	Log Normal	RAI database BC
0 days, Clear wave 3	41	37	45	Log Normal	RAI database BC
1–6 days, baseline	4	3.6	4.4	Log Normal	RAI database BC
1–6 days, overall Clear (waves 1–3)	3	2.7	3.3	Log Normal	RAI database BC
1–6 days, Clear wave 1	3	2.7	3.3	Log Normal	RAI database BC
1–6 days, Clear wave 2	3	2.7	3.3	Log Normal	RAI database BC
1–6 days, Clear wave 3	3	2.7	3.3	Log Normal	RAI database BC
7 days, baseline	66	59	73	Log Normal	RAI database BC

Table 1 (continued)

Variable name	Value	Low	High	Distribution	Source
7 days, overall Clear (waves 1–3)	57	51	63	Log Normal	RAI database BC
7 days, Clear wave 1	60	54	66	Log Normal	RAI database BC
7 days, Clear wave 2	55	50	61	Log Normal	RAI database BC
7 days, Clear wave 3	56	50	62	Log Normal	RAI database BC
Average appropriate use of antipsychotics per resident, %					
Baseline and Clear waves	15	13	17	Beta	RAI database BC
Effect size (total reduction in antipsychotics use), %					
Clear wave 1	9	8	10	Beta	Calculated, RAI BC
Clear wave 2	23	21	25	Beta	Calculated, RAI BC
Clear wave 3	27	24	31	Beta	Calculated, RAI BC
Average overall Clear (waves 1–3)	20	18	22	Beta	Calculated, RAI BC
Health-related quality of life per resident on antipsychotics, utility score					
0 days	0.859	0.7731	0.9449	Beta	RAI database BC
1–6 days	0.843	0.7587	0.9273	Beta	RAI database BC
7 days	0.855	0.7695	0.9405	Beta	RAI database BC
Discounting, %					
Annual rate of discount	1.5	0	5	Beta	CADTH

BC British Columbia, *CADTH* Canadian Agency for Drugs and Technology, *DAD* Discharge Abstract Database, *ED* emergency department, *MSP* Medical Services Plan, *NACRS* National Ambulatory Care Reporting System, *PhNet* Pharma Net, *RAI* Residential Assessment Instrument

(n = 50,544 out of 119,786). Overall, a moderate percentage of residents (13–17%) in PIUA states later transitioned into the appropriate antipsychotic state (i.e., diagnosed with psychosis) in the subsequent cycles. The proportion of residents on 0 days of PIUA was as high as 40% in Clear compared to baseline, where it was 30% (i.e., 10% reduction). Similarly, the frequency of PIUA was reduced in 41% of residents (1–6 days) in Clear compared with the baseline. Similarly, the proportion of residents on PIUA for 7 days declined to 57% in Clear compared with baseline, where it was 66% (see Supplementary Appendix Table S1 in the ESM). The HRQoL was marginally higher (i.e., mean score 0.859) in residents who stopped taking antipsychotics (0 days) compared with a mean score of 0.854 in residents who were taking antipsychotic medications 7 days a week. The HRQoL was lower (mean score 0.843) in residents taking antipsychotic medication for 1–6 days per week (Fig. 2). Hospital admission was 3.5% (n = 921 out of 26,563) in the baseline compared with 3.3% (n = 1655 out of 50,544) in Clear wave 3. Similarly, the emergency visits declined to 2.4% (n = 1234 out of 50,544) in Clear wave 3 compared with 3% for baseline (n = 788 out of 26,563). The proportion of residents reported with hip fractures, other fractures, and the use of trunk restraint declined minimally in Clear waves 1, 2, and 3 compared with baseline (Table 3).

3.3 Clear Costs

Table 4 reports on the Clear-related costs borne by the BC Patient Safety and Quality Council (BCPSQC). Approximately CA$2.2M was spent on the Clear initiative in BC (all waves inclusive). Clear wave 1 represents a total of CA$819,218 (~CA$272 per resident assessment) compared with CA$669,199 (~CA$229 per resident assessment) in Clear wave 3. The costs were lower (~CA$119 per resident assessment) in Clear wave 2 due to a large cohort of residents using antipsychotics. Overall, the main spending buckets were personnel compensation, including benefits (72%), and professional clinical leadership fees (11%).

3.4 Model-Based Cost-Effectiveness Analysis

The Clear initiative (i.e., all waves combined), over 10 years, was estimated to have an incremental cost of CA$5211 and incremental QALY of 0.20 per resident (i.e., the ICER was CA$26,055 per QALY gained). In the sub-group analysis, Clear waves 2 and 3 yielded much lower ICERs (i.e., the ICERs were CA$24,447 per QALY gained in wave 2 and CA$25,933 per QALY gained in wave 3) compared with the baseline over 10 years (Table 5). When the percentage of inappropriate antipsychotic use was decreased from 46 to 41% (i.e., a 10% reduction), the ICER was estimated to be lower (i.e., CA$22,840 per QALY gain) in the overall Clear strategy compared with baseline. Similarly, when the average cost of Clear implementation by sites was assumed

Table 2 Participants' characteristics, clinical diagnosis, length of stay and discharge

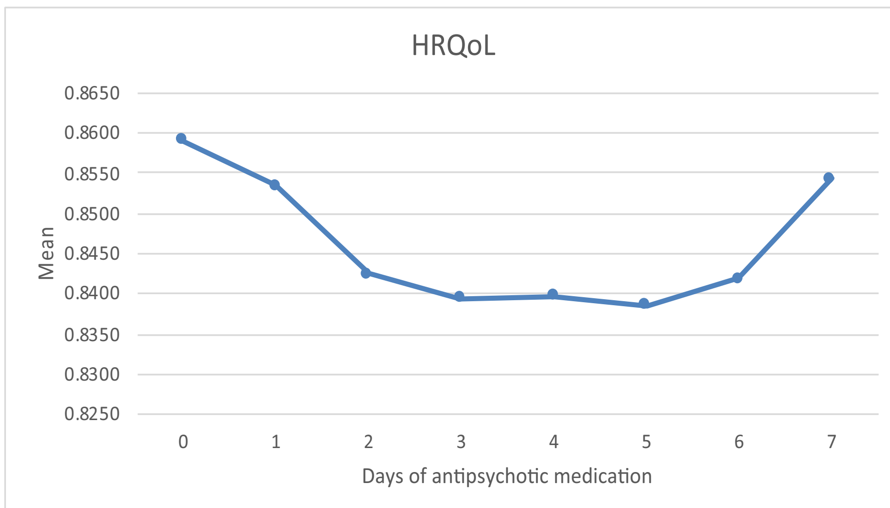
Variables	Baseline	Clear waves			Total
		1	2	3	
Number of residents	13,700	7728	7155	7086	35,669
Gender					
Female, *n* (%)	8866 (64.7)	4636 (60.0)	4109 (57.4)	4002 (56.5)	21,613 (60.6)
Age group (in years), *n* (%)					
65–74	1602 (11.7)	977 (12.6)	941 (13.2)	997 (14.1)	4517 (12.7)
75–84	4522 (33.0)	2771 (35.9)	2578 (36.0)	2519 (35.5)	12,390 (34.7)
85+	7576 (55.3)	3980 (51.5)	3636 (50.8)	3570 (50.4)	18,762 (52.6)
Language					
English	12,022 (87.8)	6799 (88.0)	6165 (86.2)	6195 (87.4)	31,182 (87.4)
Panjabi	104 (0.8)	73 (0.9)	88 (1.2)	102 (1.4)	367 (1.0)
Chinese	27 (0.2)	215 (2.8)	169 (2.4)	145 (2.1)	557 (1.6)
Italian	138 (1.0)	90 (1.2)	88 (1.2)	86 (1.2)	402 (1.1)
Others	1409 (10.3)	550 (7.1)	645 (9.0)	558 (7.9)	3161 (8.9)
Education					
No schooling	230 (1.7)	123 (1.6)	111 (1.6)	92 (1.3)	557 (1.6)
8th grade or less	2332 (17.0)	1260 (16.3)	1034 (14.4)	1001 (14.1)	5627 (15.8)
9th to 11th grade	2220 (16.2)	1211 (15.7)	1114 (15.6)	1128 (15.9)	5673 (15.9)
High school	2723 (19.9)	1576 (20.4)	1565 (21.9)	1445 (20.4)	7309 (20.5)
Technical or trade school	975 (7.1)	653 (8.4)	577 (8.1)	580 (8.2)	2785 (7.8)
Some college	936 (6.8)	573 (7.4)	548 (7.7)	608 (8.6)	2664 (7.5)
Bachelor's degree	727 (5.3)	511 (6.6)	475 (6.6)	533 (7.5)	2245 (6.3)
Graduate degree	391 (2.9)	230 (3.0)	214 (3.0)	244 (3.4)	1080 (3.0)
Unknown	3166 (23.1)	1591 (20.6)	1518 (21.2)	1455 (20.5)	7729 (21.7)
Selected medical diagnosis					
Hypertension	2971 (21.7)	3772 (48.8)	3635 (50.8)	3655 (51.6)	14,034 (39.3)
Asthma	156 (1.1)	187 (2.4)	160 (2.2)	184 (2.6)	688 (1.9)
Alzheimer disease	1191 (8.7)	1451 (18.8)	1373 (19.2)	1363 (19.2)	5378 (15.0)
Kidney disease	525 (3.8)	730 (9.5)	775 (10.8)	823 (11.6)	2854 (8.0)
Activity of daily living					
Independent	6743 (49.2)	4040 (52.3)	3685 (51.5)	3655 (51.6)	18,124 (50.8)
Supervision	1447 (10.6)	1066 (13.8)	1106 (15.5)	1026 (14.5)	4644 (13.0)
Limited assistance	1374 (10.0)	831 (10.8)	697 (9.7)	683 (9.6)	3584 (10.0)
Extensive assistance	1024 (7.5)	587 (7.6)	580 (8.1)	547 (7.7)	2739 (7.7)
Total dependence	2582 (18.8)	987 (12.8)	885 (12.4)	943 (13.3)	5397 (15.1)
Activity did not occur	530 (3.9)	216 (2.8)	203 (2.8)	232 (3.3)	1181 (3.3)
Self performance—eating					
Independent	6823 (49.8)	4206 (54.4)	3824 (53.4)	3749 (52.9)	18,602 (52.1)
Supervision	3318 (24.2)	2176 (28.2)	2101 (29.4)	2133 (30.1)	9728 (27.3)
Limited assistance	1307 (9.5)	616 (8.0)	547 (7.6)	524 (7.4)	2993 (8.4)
Extensive assistance	928 (6.8)	362 (4.7)	317 (4.4)	328 (4.6)	1936 (5.4)
Total dependence	1315 (9.6)	361 (4.7)	365 (5.1)	346 (4.9)	2388 (6.7)
Activity did not occur	9 (0.1)	7 (0.1)	1 (0.0)	6 (0.1)	23 (0.1)
Facility length of stay, months					
< 12	2557 (18.7)	3391 (43.9)	3992 (55.8)	5978 (84.4)	15,918 (44.5)
12–24	1492 (10.9)	1455 (18.8)	1497 (20.9)	949 (13.4)	5393 (15.1)
> 24	9651 (70.4)	2882 (37.3)	1666 (23.3)	159 (2.2)	14,358 (40.4)
Reasons for discharge					
Deceased	11,116 (81.1)	5235 (67.7)	4021 (56.2)	2232 (31.5)	22,604 (63.4)

Table 2 (continued)

Variables	Baseline	Clear waves			Total
		1	2	3	
Hospital—inpatient acute care	260 (1.9)	167 (2.2)	196 (2.7)	150 (2.1)	774 (2.2)
Hospital —inpatient psychiatric care	25 (0.2)	38 (0.5)	38 (0.5)	37 (0.5)	138 (0.4)
Hospital—inpatient continuing care	16 (0.1)	9 (0.1)	12 (0.2)	17 (0.2)	54 (0.2)
Hospital—inpatient rehabilitation	10 (0.1)	4 (0.05)	1 (0.01)	7 (0.1)	22 (0.1)
Hospital—ambulatory health service	11 (0.1)	2 (0.02)	2 (0.03)	4 (0.1)	19 (0.1)
Residential care—24-h nursing care	493 (3.6)	429 (5.5)	539 (7.5)	734 (10.4)	2195 (6.1)
Residential care—board and care	91 (0.7)	94 (1.2)	104 (1.5)	138 (1.9)	427 (1.2)
Private home—without care	96 (0.7)	74 (1.0)	71 (1.0)	61 (0.9)	303 (0.8)
Private home—with care	60 (0.4)	58 (0.7)	31 (0.4)	30 (0.4)	179 (0.5)
Other or unknown discharge disposition	46 (0.3)	28 (0.4)	40 (0.6)	43 (0.6)	157 (0.4)
Still in LTC	1475 (10.8)	1592 (20.6)	2099 (29.3)	3633 (51.3)	8797 (24.6)

LTC long-term care

Fig. 2 Health-related quality of life



Variables (Mean)	Use of Antipsychotics			Diff (0 and 1-6)	Diff (0 and 7 doses)
	0 dose	1-6 doses	7 doses		
QoL	0.859	0.843	0.854	-0.017	-0.005

HRQoL = Health-related Quality of Life; QoL= Quality of Life

Table 3 Adverse events and health resource utilization

Variables	Baseline	Clear waves			Total
		1	2	3	
Resident assessments (inappropriate use of antipsychotics), *N*	26,563	55,029	49,290	50,544	181,426
Hip fracture	394 (1.5)	759 (1.4)	707 (1.4)	669 (1.3)	2529 (1.4)
Other fractures	293 (1.1)	557 (1.0)	540(1.1)	487 (1.0)	1877 (1.0)
Trunk restraint use	2115 (8.0)	4438 (8.1)	3501 (7.1)	3106 (6.1)	13,160 (7.3)
Health resource utilization					
Hospitalizations	921 (3.5)	1910 (3.5)	1727 (3.5)	1655 (3.3)	6213 (3.4)
Emergency visits	788 (3.0)	1595 (2.9)	1374 (2.8)	1234 (2.4)	4991 (2.8)
Physician consultations	8742 (32.9)	19,625 (35.7)	19,108 (38.8)	20,942 (41.4)	68,417 (37.7)

to increase from CA$327 to CA$409 per resident (i.e., a 25% inflation), the ICER was estimated to be higher (i.e., CA$29,872 per QALY gain). In other scenarios, when changes were made in the discount rate and Clear programme costs borne by the BCPSQC, minimal variations were observed in the ICERs under the strategy of overall Clear waves (1–3) compared with the baseline (Fig. 3). In the probabilistic analysis, ICERs were favourable for Clear waves 2 and 3, and overall. For example, the cost-effectiveness plane revealed most ICER points under the WTP threshold of CA$50,000 per QALY gained (Fig. 4). In the cost-effectiveness acceptability curve, the probabilities of Clear waves 2 and 3 were 82% cost effective under the CA$50K WTP threshold. However, Clear wave 1 was approximately 36% cost effective at the same threshold (Fig. 5).

4 Discussion

This study demonstrated a significant reduction in the PIUA in LTC homes in the post-Clear period compared with the baseline. The financial analysis indicated minimal costs of the Clear initiative from the perspective of the public payer in BC. The subgroup analyses, however, revealed variation in the ICERs between Clear waves. For example, Clear wave 1 had a relatively higher ICER of CA$96,011 per QALY gained compared with Clear wave 2 (ICER of CA$24,447). In understanding these differences, the first explanation may be that programme-level spending in Clear wave 1 was much higher at CA$819,218 (38% out of total Clear spending of CA$2,177,555). Clear wave 1 was more resource intensive in terms of setting up data flow and communication pathways, developing resources including production and graphic design, initial planning, and engagement meetings with care homes than the subsequent waves. Second, it may be that the Clear initiative was in the early stage of the rollout; therefore, it did not make a large impact on PIUA,

Table 4 Clear initiative yearly spending 2013–2019

Budget line	Wave 1		Wave 2		Wave 3		Total
	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018	2018–2019	
Data & communications	181.83	–	–	–	–	–	181.83
Workshop fees	27,945.82	21486.59	20219.03	17533.91	10207.69	6279.38	103,672.42
Conference fees (staff)	–	160.00	–	1882.03	24.29	–	2066.32
Subscription fees	–	–	–	17.53	–	–	17.53
Production	12,200.49	2053.12	1318.67	412.60	7069.53	–	23,054.41
Graphic design	3352.63	3587.50	1544.06	–	–	–	8484.19
Sundry other	–	62.26	–	–	–	–	62.26
Sponsorships	2485.94	–	–	–	–	–	2485.94
Meeting expense	3250.53	–	–	1090.80	615.03	323.85	5280.21
Postage	480.72	–	1074.43	40.01	426.10	51.26	2072.52
Delivery and courier	–	–	158.78	313.64	387.85	155.07	1015.34
Consultants general	–	–	–	31129.87	27140.56	–	58,270.43
Prof fees (non-physicians)	11,495.37	60198.24	22796.92	35709.16	39367.62	67266.05	236,833.36
Prof fees (physicians)	38,059.13	36100.33	7205.28	2150.17	631.43	2866.54	87,012.88
Prof fees (travel)	488.87	1052.69	1825.86	1007.58	3312.90	562.96	8250.86
Honorariums	–	–	–	–	–	250.00	250.00
Board local travel	59.15	–	–	–	–	–	59.15
Staff local	224.40	280.98	373.30	61.66	561.78	154.39	1656.51
Staff provincial	9112.21	8794.91	5297.30	14081.05	17028.15	12335.81	66,649.43
Staff out of province	518.33	1293.03	–	1313.39	92.87	–	3217.62
General office supplies	–	–	–	70.56	190.15	15.54	276.25
Personnel compensation, including benefits	287,146.64	287,146.64	260,254.65	260,254.65	275,845.67	196,036.97	1,566,685.22
Total	397,002.06	422,216.29	322,068.28	367,068.61	382,901.62	286,297.82	2,177,554.68

Table 5 Cost effectiveness of Clear initiative in BC over a 10-year time horizon

Strategy	Discounted cost, CA$	Incremental cost, CA$	Discounted QALYs	Incremental QALYs	ICER (Incr. Cost/ Incr. QALYs), CA$
All referencing common baseline					
Baseline	943	–	4.02	–	–
Clear wave 1	9584	8641	4.11	0.09	96,011
Clear wave 2	5588	4645	4.21	0.19	24,447
Clear wave 3	6389	5446	4.23	0.21	25,933
Overall (waves 1–3)	6154	5211	4.22	0.20	26,055

BC British Columbia, *CA$* Canadian dollars, *QALYs* quality-adjusted life-years

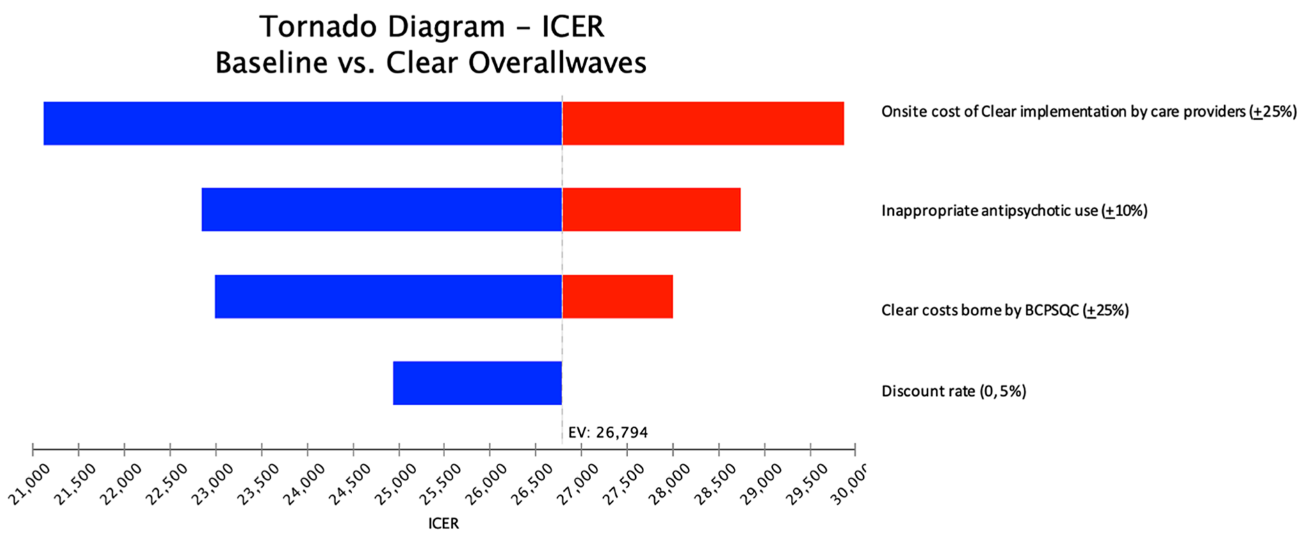


Fig. 3 Tornado diagram of one-way sensitivity analysis. The blue bars represent scenarios in which ICER is decreased. The red bars represent scenarios in which ICER is increased. *BCPSQC* British Columbia Patient Safety and Quality Council, *Clear* Call for Less Antipsychotics in Long-Term Care, *EV* expected value, *ICER* incremental cost-effectiveness ratio

translating into lower QALY gains of 0.09 in Clear wave 1 compared with baseline. Time to behaviour change is also important to consider, as the current prescribing practices within some LTC homes may have prevented any changes in antipsychotic use during Clear wave 1. In addition, staff may not have seen any changes in the residents' activities of daily living and/or agitation levels in the early phase of the Clear initiative. Our findings are corroborated with a previously conducted trial-based cost-effectiveness analysis of PARO (a therapeutic robotic seal) to reduce agitation and medication use in residents identified with dementia. In that study, investigators found higher costs and no significant reduction in medication use and resident agitation over a 10-week intervention period [37]. Similarly, other studies involving a short duration (≤ 1-year period) also found higher costs and no (or even negative) benefits of QI interventions [38, 39]. Thus, our study findings, particularly that ICERs decreased in the subsequent Clear waves, put forward a strong advocacy argument for a longer duration of QI interventions in LTC.

As many provinces encourage less antipsychotic use in LTC, it is argued that there may be a shift/increase in other medications (e.g., benzodiazepines as needed) commonly used for sedation. Unfortunately, this cannot be fully determined as the current study analyzed secondary data (i.e., Pharmanet database) only for antipsychotic medication claims. More research is needed to evaluate the unintended consequences of antipsychotics reduction in LTC. Our findings illustrate the technical efficiency of a province-wide QI initiative that aimed to support a large number of LTC homes to provide person-centred care for residents with BPSD [40]. Nonetheless, promoting non-pharmacological interventions and periodic medication reviews for all LTC residents may be challenging in small care homes because of limited staffing capacity and resources [41]. This leads to a broader policy question whereby some care homes would require more support for implementing QI strategies and

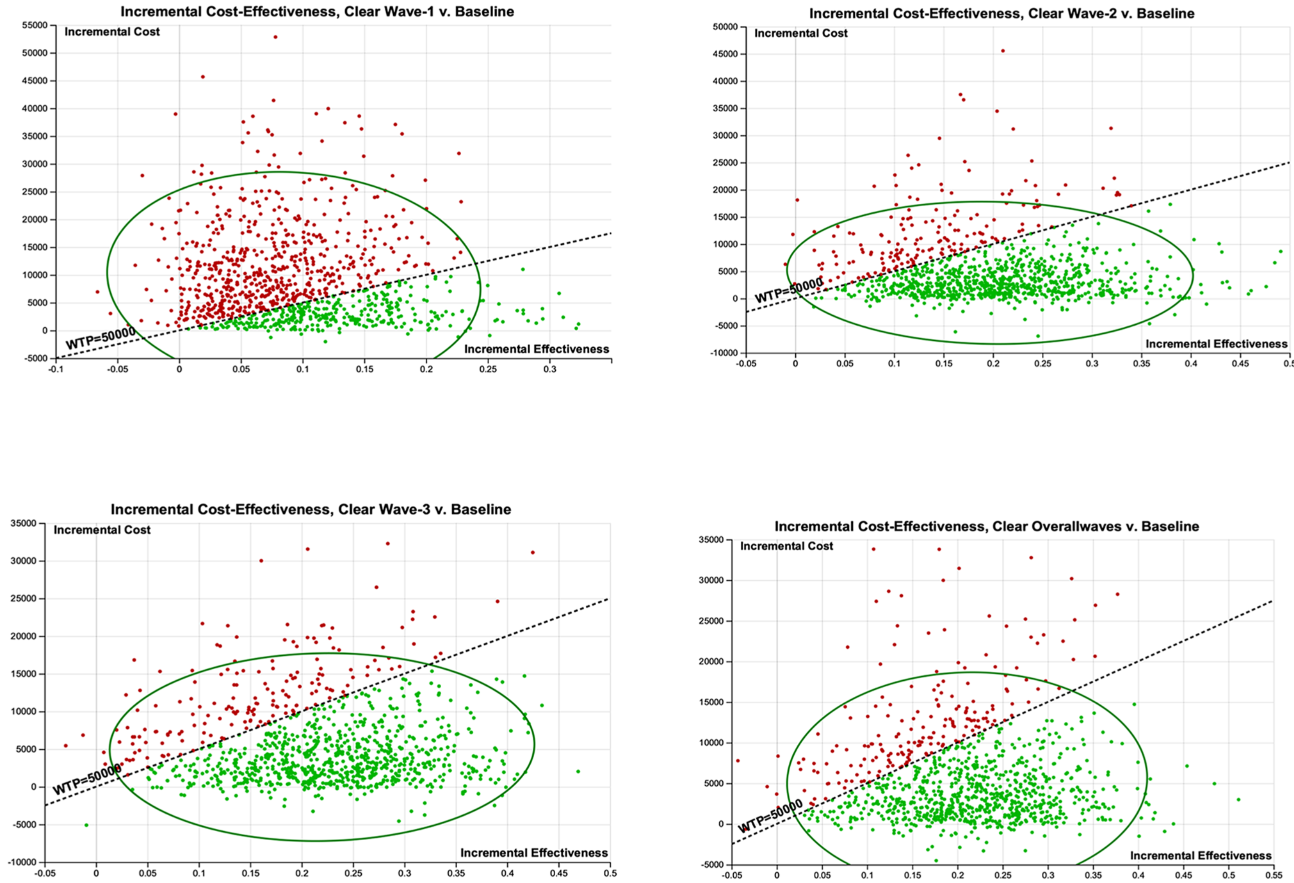
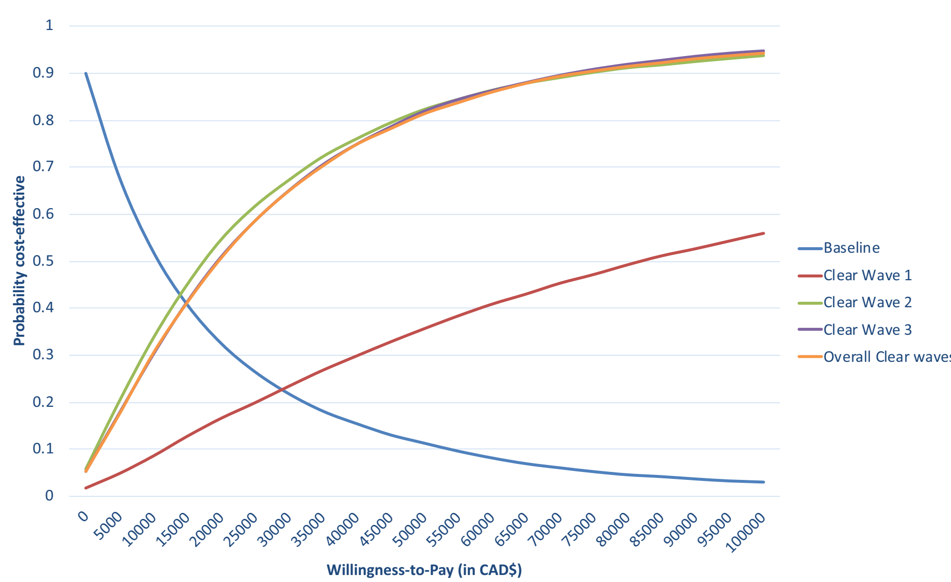


Fig. 4 Cost-effectiveness plane. The green dots represent scenarios in which ICER is below the CA$50K threshold. The red dots represent scenarios in which ICER is above the CA$50K threshold

Fig. 5 Cost-effectiveness acceptability curve



perhaps organizational incentive to sustain QI initiatives in the long run [42]. For example, regional health authorities might provide an enhanced institutional budget conditional on participating in such province-wide QI initiatives. Questions about the type and extent of support required by individual care homes could be further explored through implementation science research embedded in the planning phase of QI initiatives.

Despite other similar antipsychotic reduction initiatives in LTC across Canada, the Clear initiative is unique for its scope and scale. Examples of other initiatives in Canada include (1) the Alberta Appropriate Utilization of Antipsychotics (AUA) initiative [43] and (2) the pan-Canadian AUA collaborative initiative led by the Canadian Foundation for Healthcare Improvement in Prince Edward Island, New Brunswick, and Ontario [44]. Notably, many of these QI initiatives have been active for years and focused much less on non-technical skills. However, the Clear initiative emphasizes non-technical skills, including leadership, decision-making, situation awareness, communication, and teamwork, which are essential for team culture. By implementing a broader QI framework, the Clear initiative improved residents' quality of life, reduced HRU costs and ensured sustainability and ongoing engagement.

4.1 Strengths and Limitations

To the best of our knowledge, this is the first comprehensive cost-utility analysis of the QI initiative aiming to reduce PIUA in LTC in Canada. A large resident-level data pool from multiple administrative sources is a key strength of this study. This study used a provincial perspective, so residents who did not participate in the Clear initiative were also included in the cohort. Because data were encrypted, we could not stratify our analysis based on participation, geographical location, rurality, care home size determined by bed capacity, and type of funding received from health authority versus privately operated—this is a limitation of the secondary data analysis. Unlike the interventional studies in which the causal relationship (i.e., the effect of drug therapy or procedure on the HRQoL) can be quantitatively established, QI strategies predominately rely on soft indicators of change (time trends) and/or qualitative (anecdotal) experiences of change agents. We recognize the limitation of the pre-and-post study design and that many other factors (e.g., changes in policy, care home practices, attrition of care providers, etc.) were challenging to evaluate as part of this study. Moreover, the out-of-pocket costs and time/productivity losses (i.e., opportunity costs) could significantly burden residents' families. For example, residents who are awake (i.e., no longer chemically restrained with the PIUA) may require additional family/caregiver involvement in daily living activities. However, we did not find significant differences in residents' hospitalization rates in the Clear waves compared with the baseline (Table 3). Since we analyzed secondary data, evaluating the burden of indirect costs to family/caregivers was beyond this study's scope. Therefore, our study reports the Clear initiative's cost effectiveness using a less encompassing public-payer perspective, and more research is needed to evaluate societal costs.

5 Conclusions

Our findings show that the Clear initiative in BC, compared with the status quo (baseline), appears to be cost-effective in improving residents' quality of life. The person-centred approach, as part of the Clear initiative, suggested that care providers were able to engage with residents and their family members in the decision-making process of reducing PIUA, and in many cases, helped residents through various non-therapeutic strategies to achieve this goal. This study also highlights financial implications, albeit minimal, associated with an incremental cost for implementing Clear-related tasks for care homes. More research is needed on how small sites, which may have limited resources, could be supported by regional health authorities to sustain this initiative in the long run.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s41669-021-00267-6.

Acknowledgements We thank BCPSQC staff (ASI team, HSI team and Clear Clinical faculty) for ongoing support, data request submission, office space, and analytical software access. We are grateful to the administrative staff and care providers in LTC homes for their time and online survey participation. We thank Eric Young for helping with the data access and Joelle DesChatelets for proof editing the manuscript.

Declarations

Funding This review was undertaken as part of the postdoctoral fellowship work jointly funded by the Canadian Institutes of Health Research (CIHR), Institute of Health Services and Policy Research (IHSPR), the Michael Smith Foundation for Health Research (MSFHR) and British Columbia Patient Safety & Quality Council (BCPSQC).

Competing interests The authors declare that they have no competing interests.

Ethics approval This study was approved by the IRB of the University of British Columbia (H18-03581).

Consent to participate Not applicable.

Consent for publication Not applicable.

Availability of data and materials All data and materials will be provided upon request.

Code availability Not applicable.

Author contributions AK, CK, and CM conceived the idea of the study. AK designed the model, undertook the literature review and wrote the first draft of the manuscript. All authors contributed to the subsequent redrafting of the manuscript and approved the final version.

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