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Review Article

Green Pharmacy: An Age-friendly Sustainable Pharmaceutical Environment for Elderly Malaysians

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Abstract

Polypharmacy, or multiple drug usage, is common among growing elderly population worldwide as together with the increasing lifespan, usage of medicines to overcome the co-morbidities of old age becomes an inevitable necessity. This, however, exposes the elderly users to a greater risk of experiencing significant drug-related problems such as inappropriate prescribing, noncompliance with prescribed medication and adverse drug reactions/interactions leading to decrease in health-related quality of life. On a larger scale, drugs can also pose great challenges to our living environment as persistence of many pharmaceuticals and/or their transformation products, API contamination, can directly or indirectly affect the economic, environmental, and social dynamics, relating to ecosystems as well. To minimize the human and environmental impact of pharmaceuticals, the concept of Green Pharmacy, was introduced to create more sustainable practices by using plant-based herbal products that are less persistent in the environment and can degrade safely after use. In addition, herbal medicines with multiple active principles covering multiple potential targets and actions at the same time with a balanced, holistic and personalized manner seems desirable especially for the elderly experiencing Polypharmacy, when using Western Medicines. Herbal medicine use is a popular and common practice among elderly people in Malaysia, often for managing chronic diseases and for general health maintenance. Such usage is generally driven by factors like availability, cost, and a perception that traditional remedies have fewer side effects and are more natural, often taking a holistic, personalized approach to restore balance of the mind, body, and environment, which is sometimes perceived as a more natural philosophy than the targeted approach of conventional medicine. The current article is a review of series of research outputs initiated by the staff and students of the Faculty of Medicine and Health Sciences, University Tunku Abdul Rahman (UTAR), with the aim to enhance the physical and mental wellbeing of elderly individuals, to enable them to be less dependent and more contributively to societal life, not just in living longer, but to live better (quality, productive life), and at the same time controlling irrational use of medicines and Polypharmacy. Further discussions and recommendations were made on how the Green Pharmacy principles can be integrated into the healthcare of the aging, neglected population can be done to produce an Age-friendly Sustainable Pharmaceutical Environment for the Elderly Malaysians.

Keywords: Green Pharmacy; Age-friendly; Sustainable Pharmaceutical Environment; Elderly Malaysians

Introduction

Pharmaceutical care is defined as the responsible provision of drug therapy for the purpose of achieving definite outcomes that improve a patient's quality of life (QOL). In this context, the increasing elderly population are among those who could particularly benefit as the increase of co-morbidity with aging makes them more likely to take more medicines, and thus, exposing them to a greater risk of experiencing significant drug-related problems such as inappropriate prescribing, noncompliance with prescribed medication and adverse drug reactions/interactions leading to decrease in health-related QOL [1]. Aging is a natural process, also a biological phenomenon caused by irreversible cell and system deterioration resulting in imbalance or anomalies in the physiological functions including cognitive impairment, functional disability, and decreased mobility. Popularly known as 'Geriatric Syndrome', the disease and disabilities insidiously advance with age and eventually hinders the independence of the elderly with respect to activities of daily living (ADL), causing stress and tension among family members, and ultimately, unable to cope with the family routines, ended up under the responsibility and care of long-term assisted care facilities [2]. The geriatric syndrome is commonly misperceived to be an unavoidable part of old age, and medicinal plants/herbal medicine products (HMPs) are perceived by the elderly as important therapeutic resource to maintain health and longevity, relieving suffering even though it may not affect a cure.

Healthcare workers, as individuals and society, are responsible for ensuring that the healthcare needs of current and future generations are fully met. Pharmaceuticals offer significant benefits to patients on an individual level irrespective of age or the environment that they reside, but on a broader perspective, the same compounds can pose great challenges to our living environment. The persistence of many pharmaceuticals and/or their transformation products in our environment, directly and indirectly affect human health as well as economic, environmental, and social dynamics, in relation to ecosystems (e.g. increasing the risk of infection by multidrug-resistant bacteria and fungi) as well as to planetary boundary for novel entities, such as pharmaceutical (chemical) contamination of soil and clean water especially in low- and middle-income countries [3]. The introduction of Green Pharmacy Concept comes from the fact that it not only reduce the environmental footprint of healthcare services, but also integrates environmental responsibility into pharmaceutical practices, from drug design to disposal. In addition, it also benefits the healthcare of the elderly population by promoting personalized medicine, reducing Polypharmacy, and ensuring proper medication disposal which will lead to improved health outcomes and a more sustainable healthcare system [4]. However, challenges exists in integrating natural products, which are often considered traditional in its concept in healing, into modern medicine methods and principles. Since the term alternative medicine itself means they are not part of Conventional Medicine, and its standards and practices are more or less dependent on historical evidence and experiences rather than on scientific research like Western Medicine [5]. Another major obstacle is the diversity of principles and the paucity of literature on how the two systems can interact, and the sustainability in its clinical transformation to make the two ends meet, each complementing one another and removing any implied competition between professionals [5,6].

In response to these challenges, the Centre for Sustainable Healthcare (CSH) developed the "Principles of Sustainable Clinical Practice" to enable health services to identify, prioritise and implement actions that drive sustainable clinical transformation [7]. This include:

- **Prevention:** Promoting health and preventing diseases by tackling the causes of illness and inequalities
- **Patient self-care:** Empowering patients to take a greater role in managing their own health and healthcare
- **Lean service delivery:** Streamlining systems to minimize wasteful activities
- **Low carbon alternatives:** Prioritizing treatments and technologies with lower environment impact
- **Sustainable resource use**: Alternative treatment offering potential cost-effective and sustainable solution in healthcare.

Green Pharmacy as a Patient-centred Holistic Approach to minimize Polypharmacy and Environmental Impact of Pharmaceuticals

To minimize the human and environmental impact of pharmaceuticals, the concept of Green Pharmacy, generally defined as "the sum of all measures that should be taken to minimize the environmental impact of pharmaceuticals" was developed [4]. Two important principles underlying the concept include Green Chemistry Principles and Product Stewardship.

Green Chemistry Principle emphasizes the integration of environmental considerations into all aspects of pharmaceutical industry from drug development, production to distribution and disposal with the aim to minimize the environmental impact of pharmaceuticals (API contamination) and promote sustainable practices in pharmacy (wastage of resources) while Product Stewardship is concerned with the selection of suitable, eco-friendly medicinal products and its sustainable use in areas of greatest need and impact on health, as well as preventing unnecessary waste from Polypharmacy [3,4].

In order to understand the impact of Green Pharmacy application in the elderly Malaysians, the present article reviews the pattern of herbal medicine products used by the elderly Malaysian population, residing either at home or at the Assisted Living Residences (ALRs) in Klang Valley, Selangor, Malaysia, before, during and post-Covid19 Pandemic period [8]. The project first started as a sub-project under the long-term programme, the 'Investigation of the Current Status, Common Barriers and Enabling Factors of Geriatric Syndrome in the Elderly across a Spectrum of Domains' which was initiated by the staff from Medical, Nursing and Physiotherapy Programs under the Faculty of Medicine and Health Sciences, UTAR. The main objective of the programme was to introduce the Active Aging Concept among the elderly, by enhancing their physical and mental wellbeing, and enabling them to be less dependent and more contributive to societal life, not just in living longer, but to live better. In the elderly, maintaining autonomy and independence has been marked as a key goal in the policy frame-work for health and active aging [9]. In order to meet the main objective, each program, medical, physiotherapy and nursing programs also have separate sub-projects on their own including studies on epidemiology, nutrition, mental health, cognitive and affective disorders, functional performance and effect of exercise, and the current review is on the last sub-project, 'Prevalence of Polypharmacy and the Use of Alternative (Chinese) Medicine in the Elderly Malaysians'. Activities of all projects were integrated to support the main programme while pooling the materials and human resources to reduce the time and cost. In addition to the academic staff, the programme was also assisted by the Year 2 Medical Students' during their 8-weeks Block 2 Community Project (around August to October) annually. The last sub-project aims to study the use of alternative medicines (Chinese Medicines) to reduce Polypharmacy, and this was gradually transformed and translated into a Green Pharmacy after the Covid19 pandemic [10].

Application of green pharmacy towards the elderly Malaysian population

Herbal medicine use is common among elderly people in Malaysia, often for managing chronic diseases and for general health maintenance and such usage is driven by factors like availability, cost, and a perception that traditional remedies have fewer side effects and are more natural, being less processed, and free of "harmful chemicals". [11]. The initial project 'Prevalence of Polypharmacy and the Use of Alternative (Chinese) Medicine in the Elderly Malaysians' started as a cross-sectional descriptive study on elderly Malaysians (age ≥60 years, both sexes) residing at home or in Assisted Living Residences (ALR) in Klang Valley area from August 2016 - July 2020), which was stopped short due to the Movement Control Order (MCO) enforced during the Covid19 outbreak [8]. During the initial project, in addition to the collection of data, the care-takers and residents were exposed to workshops and hands-on training on active aging, nutrition and avoiding inappropriate use of medicines especially on Beer's Criteria. During and after the Covid19 pandemic, donations of food, nutrition and essential medicines was done and activities and education on mental health, realistic self-care and responsible self-medication was initiated to reduce the burden of care, especially among in the ALRs care-takers [12]. Residents who agreed to participate in the programme were interviewed and given health assessments, followed by counselling and workshops on the importance of self-care, nutrition, exercises and drug use. Residents who fulfil the inclusion criteria (mainly the freedom from mental illness and degenerative disorders) and agreed to sign an informed consent were included in the questionnaire assessment and face to face in-depth interview after approval by the Scientific Research and Ethical Committee (SREC), UTAR. Data collection tools consist of pre-tested semi-structured interview questionnaire, on demographic, socio-economic and clinical factors affecting the domains of QOL, Brown Bag Review, a special design IDI on patterns of drug use by the elderly, classified using Multum Classification [13]. Appropriateness of use in the elderly was also assessed using 'Beers Criteria'. The main drawback was the impracticability to identify clearly, the acute, irregular, and chronic usage of medicines and thus, the underlying rationale had to be worked out by co-morbidities for which drugs were used. The medicines were identified/confirmed: using MIMS Malaysia (2017-18) and Clinical Manual of Chinese Herbal Patent Medicines (3rd Ed, 2000) [14]. However, although the majority of the Western medicines can be readily identified, majority of the alternative

medicines used, especially local products, remained unidentified. The following tables show the outputs of the project with particular attention on follow-up intervention studies in implementing realistic self-care, and assessing the impact of alternative medicines in responsible self-medication to reduce the burden of care in the ALRs done, and many of which are still ongoing.

No.	Name	Address	No. of residents
1	St Mark's Cozy Home	Kg. Baru Sg. Buloh	60
2	Grace Home	Pandamaran, Port Klang	26
3	Amitabha Centre	Jalan Kuchai Lama, Kuala Lumpur,	25
4	Chik Sin Thong Old Folks Home	Tengku Ampuan Rahimah, Klang	29
5	Orang Tua Al- Ikhlas	Kampung Pulau Merant, Puchong	30
6	Belleview home	Bukit Gasing, Petaling Jaya	60
7	Kim Loo Teng Temple Home	Setapak, Kuala Lumpur	21
8	Sri Jayanti Metta Care Centre	Setapak, Kuala Lumpur	16
9	Rumah Orang Tua Ampang	Ampang, Kuala Lumpur	50
10	My Father's Home	Damansara Perdana PJ	80
11	House of Joy	Semenyih, Selangor	31
12	Rumah Victory	Puchong, Selangor	58
13	On On Old Folks Home	Setapak, Kuala Lumpur	12
14	Rumah Kasih Charity Home	Taman Setapak	10
15	Pusat Jagaan Rumah Love and Care	Tmn Sakapp, Kajang	16
16	Rumah Charis Home for the aged	Puchong, Kuala Lumpu	25
17	Sg Way Old Folk Home	Seri Setia, Sg Way	50
18	Ti-Ratana Welfare Society	Desa Petaling, Kuala Lumpur	50
19	Rumah Warga Tua Sg Long	Bdr Sg Long	30
20	Rumah Sejahtera Seri Kembangan	Seri Kembangan	17
21	Yee Sin Old Folks Home	Subang Jaya	20
22	Lovely Nursing Home	Taman Universiti, PJ	68
23	Rumah Caring	Taman Cahaya, Kajang	28
24	Ruman Warga Tua Seri Tanjung	Kg Damai, Kuang	20

Table 1: Assisted Living Residences in Klang Valley area under study (n = 832).

A total of 317 elderly Malaysians, 103 living at Home With Family (HWF) and 214 institutionalized in 24 Assisted Living Residences (ALR) fulfilled the selection criteria (Table 1) and their socio-demographic characteristics were shown in Table 2.

Demographic Characteristics	Home (with Family) (n = 103)	Assisted Living Residences (n = 214)	Significant level (p)
	Number (%)	Number (%)	
Gender			
Male	48 (46.6)	76 (35.5)	
Female	55 (53.4)	138 (64.5)	
Age (years)			
Male	63.6 ± 4.1	68.9 + 7.9	

Female	68.6 ± 6.7	73.1 ± 10.4	
Education			
Primary or lower	20 (19.4)	95 (44.3)	
Secondary	40 (38.8)	106 (49.5)	
College or higher	43 (41.7)	13 (6.2)	<0.05
Burden of disease			
Chronic comorbidities	24 (23.3)	125 (58.4)	<0.05
Minor ailments only/healthy	79 (**76.7**)	89 (41.5)	
Perceived difficulty in ADL	8 (7.7)	48 (22.3)	<0.05

Table 2: The overall general characteristics of the elderly Malaysians under study.

The elderly living at home with family (HWF) were more highly educated than those from ALR (41.7% vs 6.2% having college education, OR 2.3), healthier (76.6% vs 41.5%, OR 6.8), with lesser comorbidities (23.3% vs 58.4%, OR 2.2), and with less disability in activities of daily living (7.7% vs 22.3%, OR 6.6), respectively. The main reason for elderly ending up in ALR were more of lack of support (47.8%) than health reason (14.3%). The main co-morbidities affecting the activities of daily living (ADL) are shown in Table 3.

Major Comorbidities	**Home (with Family) (n = 103)**	**Assisted Living Residences (n = 214)**
	Number (%)	Number (%)
Category of major comorbidities		
Cat 1 (Zero, no ADL difficulty)	43 (41.7)	49 (22.9)
Cat 2 (1-2, little or no ADL diff)	48 (46.6)	97 (45.3)
Cat 3 (≥3, with some ADL diff)	12 (11.7)	68 (31.8)
Pattern of comorbidities diagnosed		
Cardio-metabolic Diseases		
Hypertension	20 (19.4)	112 (52.3)
Diabetes	13 (12.6)	68 (31.8)
Lipid metabolism disorders	10 (9.7)	51 (23.8)
Stroke/CVA	2 (1.9)	32 (14.9)
IHD/Heart failure	6 (5.8)	29 (13.5)
MSK - OA/RA/gout/back pain	12 (11.6)	42 (19.6)
Respiratory Disorders - COPD	8 (7.7)	12 (5.6)
Mental illness – Dep/Sch/Epi/Park	2 (1.9)	16 (7.4)
GERD, liver, gall bladder	7 (6.8)	18 (8.4)
Other burden of diseases	9 (8.7)	13 (6.1)

Table 3: Major comorbidities affecting the Activities of Daily Living (ADL) of the elderly.

The ALR elderly had more co-morbidities, and also suffer more multiple co-morbidities (31.8%) having three or more than those at home (HWF) (11.7%) and were largely cardio-metabolic origin. The major classes of drugs used by the elderly in the two residences are shown in Table 4.

Major Classes of Drugs	Home (with Family)	Assisted Living Residences	Significant level (p)
	Number (%)	Number (%)	
Number of drugs taken per person			
None	61 (59.2)	83 (38.8)	
Less than 5	29 (28.1)	35 (16.4)	
5-7	12 (11.7)	73 (34.1)	<0.05
More than 7	1 (0.9)	23 (10.7)	<0.05
Pattern of Drug Class			
Drugs for Cardio-metabolic Diseases			
Antihypertensives	20 (19.4)	90 (42.1)	<0.05
Antidiabetics	13 (12.6)	59 (27.6)	
Anti-lipid agents	10 (9.7)	53 (24.7)	
Antiplatelets	2 (1.9)	32 (14.9)	<0.02
CVS drugs (heart failure/angina)	9 (8.7)	29 (13.5)	
Analgesics (OA/back pain/gout)	12 (11.6)	24 (11.2)	
Respiratory agents (COPD)	8 (7.7)	12 (5.6)	
CNS/psychotherapeutic agents	2 (1.9)	18 (8.4)	<0.02
GI agents (GERD)	7 (6.8)	11 (5.1)	
Others (Herbal/nutritional suppl)	6 (5.8)	23 (10.7)	

Table 4: Major classes of drugs (Western) contributing to Polypharmacy.

The drug used ranged from none (for zero co-morbidities) to 12.6% and 44.8% using 5 or more for major co-morbidities in the HWF and ALR groups respectfully. Irrespective of where the elderly stays, all the drugs, specifically used for treatment of major comorbidities mentioned were Western medicines, and the Chinese/herbal medicines were mainly used for alleviation of minor ailments of disease, old age (Geriatric Syndrome) or as health supplement. The main ailments for which the Chinese/herbal medicines were used is shown in Table 5.

Minor Ailments	Home (with Family)	Assisted Living Residences
	Number (%)	Number (%)
Fever, Cough and Cold	36 (34.9)	59 (27.5)
Stiffness, Aches and Pain	24 (23.3)	53 (24.7)
Gastrointestinal disturbances	20 (19.4)	12 (5.6)
Heatiness (uncomfortable)	12 (11.6)	41 (19.1)
Weakness, lethargy	8 (7.8)	36 (16.8)
Wellness health supplement	9 (8.7)	42 (19.6)

Table 5: Minor ailments for which Chinese/Herbal Medicines were used.

For both residences, fever, cough and cold, stiffness, aches and pain are the main ailments which come and go, and to some degree affecting the ADL. Regarding the patterns of use and means of having access to CM, majority have long history of use of more than 5 years (42-60%), and the main access is through buying from traditional practitioners during their visits, and subsequently buying on their own (self-medication, 38-40%; Table 6). However, those at ALR seem to rely heavily on relatives and friends for access as well (27.6%).

Chinese/Herbal Medicine Use	Home (with Family) (n = 49)	Assisted Living Residences (n = 76)
	Number (%)	Number (%)
Duration of use		
< 2 years (> 6 months)	11 (22.4)	10 (13.1)
2-5 years	17 (34.7)	21 (27.7)
> 5 years	21 (42.9)	45 (59.2)
Main Means of Access (in general)		
Self (buy-take)	23 (46.9)	21 (27.6)
Relatives/Friends	7 (14.3)	30 (39.5)
Practitioner (visit/buy)	19 (38.8)	27 (35.5)
Identification of Medicine needed		
Symptom (no knowledge)	4 (8.2)	32 (42.1)
Purpose (identify by purpose)	21 (42.8)	25 (32.9)
Name (identify by name)	24 (49.0)	19 (25.0)
Self-perceived on knowledge on use		
Very good	2 (4.1)	15 (19.7)
Good	25 (51.0)	50 (65.8)
Fair	22 (44.9)	11 (14.5)

Table 6: Patterns of Chinese/Herbal Medicine use among Different Residences.

In order to implement realistic self-care, and self-medications among those with acceptable cognitive ability and mental state, an in-depth interview was carried out. The findings indicated that most seniors at ALR only identified the drug needed as that for selective symptoms or ailments or purpose (e.g. bloating, weakness, joint pains) rather than by their specific names. Majority of the users perceived themselves as having good knowledge of use if not the name of the medicine. Regarding the perception and acceptance towards Chinese/herbal medicines, majority (77-90%) agreed to have benefited in one way or another, with little untoward effects. The majority explained the benefit of Chinese/herbal medicines (CM) as suitable for self-medication (46-81%), believing them to be just as effective in relieving minor ailments as with Western Medicines, being safer and cheaper in terms of promotion of wellbeing. Surprising, those at ALR seem to be well aware of the dangers of Chinese/herbal medicines, saying that it is also not suitable for daily use (without specific purpose), nor for everyone. The also realise the need to consult a physician and not to take Chinese or herbal medicine together with Western medicine. This was reflected by finding that 91.7% of those at ALR never shared their medicines with others, while 65.4% of those living at home (HWF) shared their medicines, especially with family members. The preference for Chinese/herbal medicine is based on a strong belief that they benefit old people (30-45%). The additional reasons given by those at ALR are because their family also uses them (accepted by family, 32.9%), given by family and friends during their visit (bringing medicines make them visit the ALR), needing no prescription (32.9%), and health security (71.1%). For seniors living at home, the main reason is to take control of their own health, reducing burden on the family, in terms of labour and cost (Table 7-9).

Chinese/Herbal Medicine Acceptance	Home (with Family) (n = 49)	Assisted Living Residences (n = 76)
	Number (%)	Number (%)
Benefit Compared to Western medicine		
Just as effective	9 (18.3)	25 (32.9)
Safer	13 (26.5)	23 (30.3)
Cheaper	11 (22.4)	15 (19.7)
Suitable for self-medication	23 (46.9)	61 (80.3)
Suitable for health and well being	10 (20.4)	33 (43.4)
Awareness of dangers of CM/CAM		
Not for daily use	10 (20.4)	54 (71.1)
Not for everyone (Physician)	12 (24.5)	36 (47.0)
Not combine with Western	13 (26.5)	63 (82.9)
Risk-benefit experienced		
Perceived benefit	38 (77.5)	68 (89.5)
Adverse effects experienced	3 (6.1)	9 (11.8)

Table 7: Perception and Acceptance of Chinese/Herbal Medicine.

Attitude towards Chinese/Herbal Medicine	Home (with Family) (n = 49)	Assisted Living Residences (n = 76)
	Number (%)	Number (%)
Have strong belief in benefit	15 (30.6)	34 (44.7)
Traditionally/used by family	9 (18.4)	25 (32.9)
Recommend/bought by others	4 (8.2)	30 (39.5)
Fed up (with Western Medicine)	4 (8.2)	11 (14.4)
Reduce/alternative West	14 (28.6)	12 (15.8)
Reduce cost to family	17 (34.7)	13 (17.1)
Supplement (aging/health/longevity)	8 (16.3)	54 (71.1)
Easily accessible	7 (14.3)	3 (3.9)
No prescription	9 (18.4)	25 (32.9)

Table 8: Attitude and Choice towards Chinese/Herbal Medicine.

Reasons for Using	Reasons for not using
Effective in relieving ailments	Healthy, no need to use
Greater control of my own health	No confidence, believe more in Western Medicine
Decrease visits to physicians	Waste of money, not cheap
Decrease Western Medicine use	Practitioner, not accessible (time, distance)
Avoid bad effects of Western Medicine	Rely on family and friends to buy
Decrease reliance on family/friends	Family issues (not accepted, prohibit)
Still cheaper than Western Medicine	Inconvenient in preparing, slow
No need for prescription	Already taking Western, not want more
Slow aging, antioxidant, natural	Create a false sense of security

Table 9: Main reasons for using and not using Chinese/herbal medicine.

Impact of the living environment on the elderly mental health

The environment of the elderly differs between ALRs since the human resources, space and facilities is dependent to a large extent on their mode of operation which range from those that require full payment for the residents to those that are fully charity and/or NGO funded, and thus are free of charge. In the former case, residents can choose to have their own carers including nurses. They also are more likely to have regular visits from family members. In the latter case, the carers are employed by the home to service all residents. Further, unlike paying residents, visits from relative and friend are often few and far between, thereby limiting their social contact. It is noted that ALR, nursing homes are only meant to provide necessary care and safety when seniors became dependent on help that cannot be provided by the family effectively [15]. It is further noted that elderly living with their families were younger, more educated, and with less disability in terms of their activities of daily living than those from ALR who were older and with more comorbidities and disability of old age (Table 3). These factors would be expected to contribute to the overall QOL of the elderly.

However, QOL is a multidimensional and dynamic concept which comprises multiple domains, inclusive of physical health and safety, the psychological state, level of independence, social relationships, and their relationships to the salient features of their environment [16]. Thus, while the differences between ARLs with respect to human resources, space and facilities would have an effect, family contact and relationship is believed to be pivotal in the QOL of residents. It can be seen that seniors from ALR showed a significantly lower QOL for both Domain 2 and 3 of the WHOQOL-BREF. This indicate the lacking of psychological support and social contact (Table 10). This is supported by the finding of higher use of psychotic medications by the elderly at ALR (Table 4). This has also been reported in other studies [17], hence the recommendation that living with family at home as long as possible is not only desirable for economic and/or health policy reasons but also for achieving higher QOL since family life, social integration, work, normality and autonomy are the guiding axes for the attribution of meaning to QOL among the elderly subjects [15,16].

Domains of WHOQOL-BREF	Home (with Family) Mean (±SD)	Assisted Living Residences Mean (±SD)	Significant level (p)
Domain 1 - Physical	67.1 ± 14.5	66.9 ± 11.7	
Domain 2 - Psychological	70.7 ± 16.2	65.3 ± 14.4	<0.05
Domain 3 - Social	74.1 ± 18.7	67.1 ± 19.8	<0.01
Domain 4 - Environmental	67.5 ± 12.5	69.6 ± 18.7	

Table 10: Comparative Scores of QOL Domains of the residences staying at home or at ALR.

On the other hand, interviews indicated that lack of support (alone at home, lack of self-care, security and sufficiency) and burden on their families (whole family working) are the main reasons for some elderly ending up in ALR apart from health reasons (14.3%). This leads to a significant proportion of the elderly, who claimed to be healthy and not taking any drugs for any major co-morbidity. (Table 2, 3) landing up in the ARLs. However, irrespective of where the elderly stays, at home or at ARLs, medicines remain an important part of their life, a necessity companion, a security in growing old gracefully, maintaining health and vitality, which are considered global priority to achieve the UN Sustainable Development Goals, in particular Goal 3, which aims to ensure healthy lives and promote wellbeing [18]. While drugs, specifically used for treatment of major comorbidities are found mainly to be Western medicines, Chinese/herbal medicines are found to be mainly used as health supplement or for alleviation of minor ailments of old age (Table 4 and 11). The main ailments for which Chinese/herbal medicines are used are; fever, cough and cold, stiffness, aches and pain, ailments which tend to come and go but nevertheless, also affect the ADL (Table 12). However, specific information on the herbal medicines and their uses, which are diverse, and cannot be adequately identified or stated using Western medical terminology [19].

Chinese Medicine	Minor Ailments for which it was used	Alternative to inappropriate Western medicine (Beer's Criteria)
Pao Sheng (泡参)	Relief heatiness (uncomfortable episodes of feeling cold, chills or hot and sweaty)	Anti-allergic drugs, cyproheptidine, phenothiazines
Pei Pa Koa	Throat demulcent, expectorant, relieve sore throat, coughs, hoarseness and aphonia	Cough mixtures, antihistamines, diphenhydramine
Po Chai Pills	Collection of gas, bloating, indigestion, nausea, heartburn, constipation and diarrhea	Anticholinergics, antiulcer drugs, antispasmotics, laxatives, metoclopramide
Tong Ren Tang	Symptoms of cold and flu	Antihistamines, chlorpheneramine, NSAIDS, orphenadrine
Er Chen Tang (陈汤)	Asthma, symptoms of Upper Respiratory Tract Infection	Sympathomimetics, theophylline, steroids, pseudoephidrine
Shexiang Zhuanggu Gao	Aches and pain of muscles and joints	Analgesics, NSAIDS, muscle relaxants
Herbal Tea	All forms of arthritis, control blood pressure and blood sugar.	Analgesics, antihypertensives and antidiabetics

Table 11: Examples of Chinese/Herbal Medicines alternatives used by some seniors at home (HWF).

Since people growing old are more likely to develop one or more chronic illnesses, as well as the likelihood of experiencing minor ailments and disabilities of old age, medicines are often given to help them sustain a healthy state and lead more active lives [20]. As modern guidelines often recommend specific drugs indicated for specific ailments, presence of multiple co-morbidities will result in many patients using many drugs. The situation, often called Polypharmacy, has been linked to negative health outcomes such as adverse drug reactions, interaction problems, poor patient adherence, and hospitalisations. Efforts to reduce Polypharmacy without compromising the patients in obtaining optimal treatment is recommended, although currently, there has yet been no universal definition on how Polypharmacy should be reduced and contradictory studies have shown that under-treatment still occurs frequently among patients using many drugs [21]. In addition, Polypharmacy can become worse when patients consult different physicians for different ailments and transfer of information on drug use is often not optimal and drug prescriptions are not coordinated [22]. Furthermore, drugs are becoming more available to patients, especially drugs not requiring prescriptions (over the counter medications) which are often given for side effects of prescription drugs prescribed for major comorbidities or for minor day to day ailments and disability of old age. Such minor ailments can be depressing, irritating and if left untreated, significantly affect the activities of daily living, and augmenting physical and mental stress, depression, disability and the overall four domains of QOL. These non-prescription drugs, although well tolerated at younger age, may be intolerable for the old (Beer's Criteria) and studies have shown that such 'inappropriate medications' in the elderly, such as diphenhydramine in cough syrup, antihistamines for skin allergy and anticholinergics for gastrointestinal ailments has increased the occurrence of adverse drug reactions, drug-drug interactions [23], functional impairment, falls, fractures and hospitalization [17]. Table 11 shows that many drugs considered 'inappropriate' for the elderly, has been used by those at the ALR for minor ailments whereas these can be avoided or replaced by herbal medicine products and Chinese Medicines (Table 12).

Name of Medicines	Ailments for which it is used	To be avoided
Diphenhydramine, Doxylamine, Promethazine	Dizziness, cough syrup/expectorants	Totally
Benztropine, Trihexylphenidyl	Parkinsons' disease, tremors	Totally
Antipsychotics - Chlorpromazine	Psychosis, schizophrenia	Totally
Antidepressants - Amitryptyline	Depression	Totally
Sedatives – Benzodiazepines, Zolpidem	Anxiety, sleep disorders	Totally
Metoclopramide, Laxatives	Stomach fullness, nausea, vomiting	Totally
Pain killers (NSAIDs) – Aspirin, Indomethacin, Opiates - Codeine	Headache, aches and pain, cough syrup/ tablets.	Long-term use
Muscle relaxants – Beclofen, Danthrolene	Muscle strain, neck sprain	Totally
Antidiabetics - Glyburide	Type II diabetes	Totally
Anticholinergics – Hydroxyzine, Meclizine, Oxybutynine, Olanzapine	Colicy pain in the abdomen, nausea, vomiting, diarrhoea.	Cognitive impairment
H2 Blockers – Omeprazole group	Heart burns, gastritis	Totally
Diuretics, Antihypertensives	Hypertension	Blood pressure - falls

Table 12: Medicines identified as 'Inappropriate' by Beer's Criteria but frequently used in the ALRs.

Potential opportunities and challenges faced in the use of plant-based herbal medicine products to reduce polypharmacy

Global healthcare expenditure is growing exponentially every year, more than twice the rate of GDP in higher income countries. According to the World Bank, the compound annual growth rate in health expenditures for Organization for Economic Co-operation and Development (OECD) countries was 2.7% between 2015 and 2019, while growth rate in GDP per capita declined by 5% and one contributing factor is that aging populations have increased healthcare needs [24]. Indeed, increasing life expectancy in the elderly and the increasing prevalence of non-communicable diseases among them increases the demand and utilization of healthcare services including the use of Traditional and Complementary Medicines [25]. This increasing economic burden due to healthcare cost comes not only from the treatment of diseases but also from the cost of medicines and the adverse effects and medication errors related to its use [26]. In addition, because of the multiple disabilities and co-morbidity that accompany old age (Called the Geriatric Syndrome), certain drugs suitable for younger adults, as indicated by the Beer's Criteria, should best be avoided in the elderly because of their potential to cause more harm than good [26, 27]. Green pharmacy is the use of natural, plant based remedies and herbal medicine products (HMPs) to promote health and alleviate stress-related ailments and this approach is considered more environmentally friendly compared to conventional pharmaceutical drugs. Herbal treatments have been shown to complement or even substitute modern therapies especially in chronic and disabling diseases, offering gentler and easily accessible therapeutic intervention with fewer side effects as compared to synthetic medications used in the Western Medicine, especially when given long term [8,28].

Although it was hard to identify the name, and content of the alternative medicines used by the elderly, it can be identified and confirmed that majority are plant-based, and many have been using such alternative medicines, almost regularly, for many years (Table 6). Thus, the most important part in reducing the healthcare burden of the families, ARLs and the Healthcare System is to implement simple, low-cost options that may improve realistic self-care and allow responsible self-medication by the elderly themselves. Improving drug safety, reducing Polypharmacy, improving patients' compliance and preventing medication errors cannot be done unless the challenges are met. In order to fully understand the challenges (and opportunities) that Green Pharmacy can bring, it would seem rationale to use the "Principles of Sustainable Clinical Practice" to identify the actions, positive and negative, required for sustainable and practical transformation.

Prevention: Promoting health and preventing diseases by tackling the causes of illness and inequalities

"Geriatric syndrome", although designated as chronic diseases, is neither a disease nor a discrete illness with a known cause, but rather a clinical presentation of a collection of multifactorial co-morbid manifestations resulting from multiple underlying factors and impairments of old age occurring across different body systems. Since this is more of a chronic degenerative wear and tear of old age with several etiological factors and multiple mechanisms involved, preventing and treating each and every chronic disease and disability with Western Medicines have led to use of multiple drugs to tackle different targets leading to Polypharmacy and also increasing the frequency of adverse interactions and side effects (Table 4). Since majority of drugs used, especially for cardio-metabolic syndrome, are often prescribed long-term, compliance remains questionable. Many drugs seen in the Brown Bag review were expired, and similar drugs with different brands prescribed by different physicians for different diseases is not uncommon. The concept of Green Pharmacy goes well in this regard to reduce Polypharmacy by introducing non-pharmacological approaches like healthy, active lifestyle and supplemented by plant-based remedies where appropriate, especially those who have already turned towards natural remedies as shown in Table 7, 8) and for the reasons shown in Table 9. The main reasons reported were the high cost, adverse effects and relative inaccessibility (need of prescription, doctor and someone to accompany them), for which the use of alternative medicines could avoid. Indeed, not all conditions can be effectively treated with natural remedies alone, and in majority of cases, conventional medicine is necessary for major diseases especially for management of acute or severe conditions, for life-threatening situations, saving or relief of extreme suffering. Thus, Green Pharmacy should be seen as a complementary approach rather than a replacement for conventional healthcare [29].

It can be seen that majority of the Polypharmacy arises from the use of medicines for minor ailments of old age which can be irritating, and cause suffering even if not life-threatening (Table 5). The singletarget–singlecompound or onedisease–onedrug paradigm of Western Medicines leads to Polypharmacy whereas herbal medicines, possessing multiple active principles that cover multiple potential targets and actions at the same time in a

balanced, holistic and personalized manner seems desirable. The distinctive characteristic of plant-based herbal medicine products rely on the extensive range of bioactive secondary metabolites, which contributes to their outstanding chemical diversity [30]. The metabolites include a variety of compounds, such as alkaloids, flavonoids, terpenoids, and phenolic substances, among others which play a pivotal role in plant-pathogen interactions and plant immune response development [31]. These stress-inducible phytochemicals also play an ecological role in having the adaptive capacity to coping with stress and constraints of the challenging and changing environment, a defence mechanism against outside insults (bacteria, herbivores, and climate changes). In traditional and complementary medicine, these secondary metabolites have been used for their therapeutic qualities and are essential constituents of traditional pharmacopeia. The incorporation of secondary metabolites originating from plants into traditional pharmacopeia underscores the significance of biodiversity in promoting human health and the utility of natural substances for the discovery and advancement of drugs [32]. One main, but indirect cause of Polypharmacy is the sense of insecurity of the elderly felt without drugs to maintain health, longevity and vitality as they age, and herbal supplements to them, seems an ideal health companion, also a reason to be responsible for their own health. Indeed, it can be seen that herbal medicine, as part of traditional medicine, is still the mainstay of about 75-80% of the world population, mainly in the developing countries. It is mainly used for primary health care because of better cultural acceptability, better compatibility with the human body and lesser side effects but in the last few years there have been seen a major increase in their use in the developed world for other conditions as well. It is now recognized that about half the population of industrialized countries regularly use complementary medicine and surprisingly, higher education, higher income, and poor health has been identified as predictors of its use [33, 34].

Patient self-care: Empowering patients to take a greater role in managing their own health and healthcare

Health is a lifelong, multidimensional adaptive process comprising of intersecting biological, psychological, social, environmental, and spiritual systems. The capacity of people to manage their own health; 'self-care', is often overlooked as an important, population-health promotion mechanism. The current medicalized system focused on the acute care of the already sick, within costly and high-tech institutions, such as hospitals, and under the professional control of physicians [35]. Health and wellness can neither be fully understood by studying sickness or disease, nor will the treatment of disease lead to health and wellness. It is more important to understand the salutary (i.e., health promoting) factors related to the producing good effects such as active, healthy and productive living life style may be more beneficial than an idle, inactive life style, relying on medicines and health-promoting supplements to fill in the gap of laziness and ignorance [36]. It can be seen that no matter where the elderly stays, and despite the pathogenic onslaught of all these factors that threaten health. It can be seen that, remarkably, most elderly at the ALRs are able to remain well and live happy and productive lives even without medicines (38.8%-59.2%; Table 4), and such is the product of active living, family mentality among the residents and self-care, without which, they cannot survive [12,37].

Self-care is what a person does by themselves to establish and maintain health, preventing and dealing with disease. This concept includes health, nutrition, lifestyle, socioeconomic, environmental factors, as well as self-medication. Individuals now take greater personal responsibility for their health and are seeking more information to make appropriate decisions about their treatment either from reliable sources or from websites. In treatment of minor illness, when problems are self-limited, self-care can be used, preferably a non-pharmacological therapy, and then, if needed, move on to choose an OTC medicine, or herbal medicine product, that is safe and effective, and ensuring that it is used correctly [37]. Majority of drug-related problems in elderly are still regarded as preventable mortality and morbidity provided that certain drugs be used rationally, while others, although suitable for younger adults, be best avoided in the elderly with multiple comorbidities and functional impairments, and their potential to cause more harm than good (Beer's Criteria) and should be avoided or replaces by alternatives described previously [27].

Lean service delivery: Streamlining systems to minimize wasteful activities

Assisted living Residences (ALR) are places that provide overall care of elderly involving 24-hour supervision, housekeeping, meal preparation, and assistance with activities of daily living, but are not nursing homes and do not accept people with mental illness and disability or diseases requiring nursing care. However, in view of the above risks involved in care of the elderly residents, assisted living has gradually evolved from the above original social or 'hospitality' model, to a more medically oriented model and residence administrators became caught between their role in

maintaining a home-like environment for residents and nursing care involving assistance for personal care and managing complex medication regimens. However, assigning unrealistic responsibility to already overworked staff can backfire, causing them to leave or commit more errors, usually due to stress and fatigue. Since majority of the people are capable of self-care, and especially those running on donations and with limited volunteer care-takers, some elderly with limited disabilities (Categories 1 and 2; Table 3) often help in the running the ALRs (cooking and cleanliness of the environment) and helping those needing assistance (Category 3; Table 3). Such practices brings in not only the family mentality among the members which is desirable for both physical, psychological, social and environmental wellbeing (Table 10) within the ALRs. It is also not uncommon to find herbal gardens and pots of plants in some ALRs. Our elderly project ongoing intervention study focuses to enhance realistic self-care and responsible self-medication, by carrying out workshops and educational activities by Year 2 Medical Students during their community projects annually. The projects assess the health and active state of the elderly (using in-body composition measurements, BMI, functional balance and mobility) under supervision of doctors, physiotherapists and nurses from our university. Simple, practical and low-cost options like distributing fresh-water bottles at bed-side, keeping medication organizers, translation of information on medicines, written in large letters and hang at the side of the bed, to avoid regular taking of medications away from busy-times like breakfast, lunch, if possible, and to avoid interruptions during handling of medicines etc. The main aim was to educate the care-takers and those elderly with little or low disability (Categories 1 and 2; Table 3) on responsible self-medication and thus relieving the care-takers of their burden in medication and be able to concentrate more on those who are in more need of assistance (Category 3: Table 5). However, education on Western Medicine seems easier for Medical Students learning Western Medicine, alternative medicines used vary widely and with lack of knowledge and information (translation barrier between principles), the main advice given rests mainly on not to take them together or with Western Medicine to prevent interactions. It has been initiated to collaborate with those students studying Traditional Medicines to be included in the project in future.

Low carbon alternatives: Prioritizing treatments and technologies with lower environment impact

Green Pharmacy represents a return to nature's wisdom and a holistic approach to health and wellness. It celebrates the healing power of plants, the interconnectedness of mind, body, and environment, and the importance of sustainability. While not a panacea for all ailments in the elderly, the Green Pharmacy offers an alternative or complementary approach to conventional medicine, allowing individuals to take control of their health in a natural and sustainable way and at the same time, reducing the burden of Polypharmacy. Incorporation of herbal medicine and herbal medicine products can also enhance patient satisfaction through a more holistic approach to health, focusing on prevention and maintenance of overall well-being rather than merely treating symptoms or disease itself. The concept of a plant's whole extract being is greater than the sum of its isolated chemical components (systems or network of biology and medicine), suggests that acting on multiple potential targets and actions, is desirable to cover multiple targets at the same time with multiple active principles to produce a more effective and balanced therapeutic effect especially for minor ailments of daily living. Thus, in the elderly, herbal medicine products remains most suitable for treatment of non-life-threatening conditions where knowledge from traditional use is available to indicate the clinical benefits in treating the respective ailment [28]. In addition to herbal medicine products having potential to reduce Polypharmacy, these can also minimize the eco-toxicity and environmental impacts of medicines associated with industrial production, incorrect disposal, misuse/abuse in farming, often seen with the use of Western Medicine [21]. On the other hand, together with the growth and development of herbal medicines, demands for natural resources may increase and ultimately deplete the resources if appropriate control and interventions are carried out. Excessive use of plants can also create more waste and carbon emissions during its production and manufacturing. Strategies concerning the conservation and sustainable use of medicinal plant resources such as in situ and ex situ conservation and cultivation practices) and resource management (e.g. good agricultural practices) and biotechnical approaches to improve yield and modify the potency of medicinal plants has been mentioned [38].

Sustainable resource use: Alternative treatment offering potential cost-effective *and* sustainable *solution in healthcare*

Developing drugs using plant-based pharmaceutical techniques offers an efficient, cost-effective, and safe alternative to conventional procedures using animal cell cultures or microbial fermentation. Therefore, drugs derived from natural compounds in plants can offer patients greater and quicker access to medications [39]. However, the major pitfall is the lack of stringent regulation and

standardization across the TCIM industry [40, 41]. While the sector offers many sustainable solutions, the absence of globally enforced standards for sourcing medicinal plants and animal products could exacerbate environmental issues rather than alleviate them [42, 43]. Impact of overharvesting extends beyond ecological degradation. Plants harvested unsustainably may be collected at the wrong times, reducing their medicinal properties, or may be contaminated with pesticides or other harmful substances if not properly regulated and this can also affect the potency and safety of herbal medicines [44]. Ensuring that herbs are sourced sustainably, contributes to maintaining the integrity and therapeutic efficacy of herbal remedies as well. Emphasizing the need for standardized processes, the detection and prevention of contaminants, the authentication of herbal ingredients, and the adherence to regulatory standards, highlights the need of integration of traditional knowledge and modern scientific approaches in achieving optimal quality control outcomes to promote consumer trust, safeguarding public health, and fostering the responsible use of herbal medication products [45]. Currently, in Malaysia, steps have been taken aims to regulate the practice of T&CM within recognized practice areas [46] and a 10-year blueprint (2018-2027) of the Traditional and Complementary Medicine Division [33,34] has mentioned, in detail, the requirements needed to regulate all traditional and complementary medicines in integrating them into the national health-care system identified under National Policy of Traditional and Complementary Medicine [47,48].

Conclusion

The underlying hypothesis is that, since disease morbidity and use of medicines are closely intertwined, the Green Pharmacy project can facilitate the integration of herbal-based Traditional Medicines into the current health system in Malaysia and in contributing to implementation of Green Pharmacy principles into improving the overall health and well-being of the population [49]. One of the most exciting developments in modern herbal medicine is the integration of technology in the cultivation and study of medicinal plants. With the help of advanced genetic techniques, researchers are now able to identify and enhance specific phytochemicals that confer medicinal properties. This precision breeding not only promises to boost the efficacy of herbal remedies but also ensures a consistent quality of herbal products, addressing one of the long-standing challenges in herbal medicine. Biotechnology is paving the way for novel delivery systems that increase the bioavailability of herbal compounds. Innovations such as nano-encapsulation and liposomal delivery are making it possible for herbs to be absorbed more efficiently by the human body, thereby enhancing their therapeutic potency. However, the standardization and regulatory requirements of Herbal Medicine Products (HMPs) is mandatory to its integration into the current health system [47].

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Conflict of Interest

There is no conflict of interest.

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