

RESEARCH ARTICLE

Will medical cannabis treatment reduce pharmaceutical residues in the aquatic environment? A case study from an elderly nursing home

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Abstract: High drug consumption and polypharmacy, especially in the elderly, is one of the 21st century phenomenon. It has different undesirable side effects, which may directly affect the environment. It is known that pharmaceutical residues are excreted via patients' urine or feces to waste water, which is then discharged to the environment. Therefore high drug consumption is contributing to the continual rise in pharmaceutical residues in the aquatic environment, and address a rising cause for concern. Alternative treatments that can relieve or improve the patient's clinical condition, thereby reducing the consumption of pharmaceuticals, hold great potential for reducing drug residues in the environment. The purpose of this research was to evaluate the reduction in pharmaceutical consumption in a nursing home for the elderly, as a result of treatment with medical cannabis. With time, medical cannabis treatment dramatically improved patients' symptoms and their medical indexes. As a result, the local physicians stopped prescribing drugs that were defined as unnecessary. Overall, 39 dosages of prescription drugs were cancelled for the 19 elderly individuals included in this research, indicating that medical cannabis can be an effective treatment that also reduces the environmental drug load, thereby preventing water pollution.

Keywords: contamination, medical cannabis, pharmaceutical residue, water resource, pain, symptoms improvement, prescribing drug reduction

1 Introduction

In the last two decades, drug manufacture has continuously increased, with the renovation and expansion of pharmaceutical compounds reflecting growing consumption worldwide. The pharmaceutical pain-medicine industry in the United States is worth up to \$635 billion per year and affects more than 100 million Americans^[1,2]. Aside from pharmaceuticals' direct effects on their consumers, this reflects a more global problem of non-fatal diseases and an over-demand for medicines, with the associated drawback of the growing environmental threat hazardous pharmaceutical residues.

Polypharmacy is a situation in which a patient is being treated with more than five drugs, simultaneously. It has been associated with increased risk of unsuitable

medications, medication non-adherence, drug duplication, drug-drug interactions, higher healthcare costs, and adverse drug reactions^[2-5]. At its extreme, it is associated with fatal overdoses^[6], and it has therefore been coined the "opioid epidemic"^[1]. The above situation is quite extreme for the older adult population (over the age of 65), 50% of which are taking at least one superfluous drug. Some of these medicines are given to prevent illnesses, even though there is no proof of their effectiveness^[7].

Active pharmaceutical ingredients (APIs) have been identified in the environment since the 1980s^[8,9], in surface water and groundwater, and ultimately in drinking water and agricultural products^[10-13]. They reach the environment via various routes, including industrial plants, household waste, and landfill leachate; their primary source is effluent from wastewater-treatment plants that is reused in agriculture or to dilute surface water resources^[14]. In the last decade, numerous studies have shown incomplete elimination of many pharmaceuticals in wastewater treatment plants (WWTPs), and therefore the effluent contains APIs^[11, 15-18].

The use of medical cannabis (MC) as an alternative to mainstream and traditional pharmaceutical treatments has already been reported in a number of studies^[19,20]. The main conclusion is generally that substitution of traditional pain medications with MC causes fewer side effects

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and an improvement in medical symptoms^[19,21,22]. Some studies have shown the replacement of other prescription pharmaceuticals by MC as well^[23–25]. However, it is important to emphasize that many of those studies were limited in terms of statistical indexes, database volume, and the perspective of time, calling for further exploration^[26]. Regardless, the reported positive results may play a significant role in the “opioid crisis”, as through promotion of treatment with MC, overdoses of prescription opioid medications will decrease, thereby reducing the staggering statistics of deaths from overdose^[26,27]. Simultaneously, it curbs the amount of hazardous pharmaceutical residues spilling into and threatening water sources and the environment.

The following case study evaluates the reduction in prescription drugs in a nursing home for the elderly as a result of MC treatment. This evaluation was based on patients’ clinical improvement, and the reduction of pharmaceutical residues in the environment.

2 Materials and methods

2.1 Participants

Compassionate treatment care with MC was initiated in July 2010 at Hadarim nursing home in Kibbutz Naan, Israel. This program was run under the supervision of the nursing home manager and the Israel Medical Cannabis Agency, a division of the Israeli Ministry of Health. The research included 27 participants from the nursing home, selected to receive treatment with MC based on their symptoms.

2.2 Cannabis

Four types commercial strains of MC were used in this case study: Erez, Hadarim, Avidkal, and Midnight, which differ in their proportions of the three active cannabinoids: tetrahydrocannabinol (THC), cannabidiol (CBD), and cannabinol (CBN) (Table 1).

Table 1. Cannabis types strains and their cannabinoid composition

Cannabis types (commercial names)	THC (%)	CBD (%)	CBN (%)
Erez	23	0	0.1
Hadarim	8	0	-
Avidkal	0.8	16.5	-
Midnight	12	12	-

The MC was obtained from Tikun Olam Ltd. (Israel), which is the largest authorized and licensed supplier of MC in Israel. The composition of each cannabis type strain was analyzed and quantified in an authorized labo-

ratory at the Hebrew University of Jerusalem.

There were three possible routes of MC administration: smoking, inhalation with a vaporizer, and ingestion by mixing ground cannabis in foods (cakes, cookies or candies).

2.3 Procedures and measures

Detailed documentation was collected during the 12 months research period (2011–2012) for each patient who received MC in this study. Patient health status and measurements (*e.g.*, weight, blood pressure, heart rate, body temperature, and periodic blood tests) were documented weekly by the medical team, and was continuously update. Patient life quality before, during, and after MC treatment was reported by the nursing home staff and the patient’s family members with an interviews, and supported and verified by the local physicians. Technical details regarding the MC type’s strains and admissions format for each patient, as well as a list of drugs that were stopped following MC treatment for each patient, were recorded by the nursing home staff during the year of the study.

2.4 Measured outcome

The potential of MC use as an alternative for a variety of traditional drug treatments was examined. Evaluation was based on the patients’ life quality, expressed as improvement in their clinical parameters, in parallel to a decrease or complete cessation of traditional drug treatments. Life-quality improvement reported by the nursing home staff and physicians was based on continuously measured clinical parameters, close interactions and impressions. Therefore, a decrease or cessation in the use of traditional drugs was the immediate effect and outcome of the study, associated with a reduction in pharmaceutical residues in the environment.

2.5 Ethics statement

It should be noted that a written consent form was obtained from all patients and their relatives before the treatment with MC. The participants’ information was remained confidential.

3 Results

3.1 Characterization of participants

All 27 participants were dependent on nursing home care and poly-pharmaceutical treatment—they were being treated with at least five different drugs before they were selected to use MC. Records regarding prescription pharmaceutical consumption of 8 of the 27 participants were

Table 2. Opiates targeted prior to the start of the study for reduction or cessation, classified by purpose of treatment

Opiates target	Pain	Anxiolytic	Antipsychotic & sedative	Anticonvulsant/ depression	Ataxia/gout	Alzheimer's & Parkinson's	Antidiabetic & laxative
	Acamol	Xanax	Seroquel			Dopicar	Ameryl
	Lyrica	Trazodil	Haldol			Exelon	Laxadin
	Percocet	Clonex	Bondormin			Ebixa	Insulin
Opiates	Tramadex	Recital	Phenergan	Depalept	Colchicine	Levopar	
	Duragesic	Lorivan	Clopixol			Memorit	
	Oxycodin	Vaben					
		Cipralext					

incomplete. Thus, only 19 participants (67%) were eligible for the statistical analysis of drug dose reduction and cessation. Of all of the prescription medicines being taken by the 19 participants before they began the MC treatment, 28 opiates (Table 2) were targeted for reduction.

The symptom criteria for compassionate MC treatment were: pain (67%), anxiety (11%), depression (4%), lack of appetite (33%), spasticity (26%), immobility and limited movement (4%), ataxia (4%), Alzheimer's or Parkinson's (7%), and insomnia/sleep disorders (4%); thus, the most common symptom was chronic pain, mostly caused by spasticity.

For most of the patients, MC administration was oral, as a powder mixed in with porridge (81%). Some of the patients received supplemental MC by inhalation with a vaporizer (13%) or smoking (13%), as needed (Figure 1). Only 4 patients (15%) were administered cannabis by vaporizer only, and 1 patient (4%) by smoking only (Figure 1).

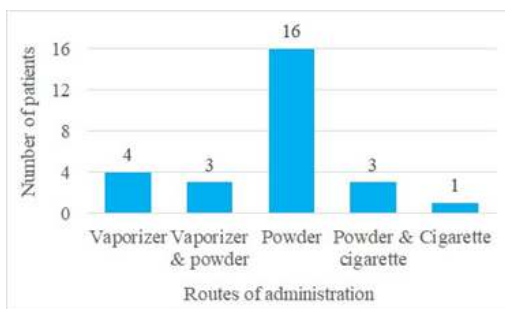


Figure 1. Routes of MC administration to the study patients

With respect to types strains of MC administered, 17 patients (63%) received Hadarim, 8 patients (30%) consumed Erez, and Midnight and Avidekel were consumed by 4 (15%) and 5 (19%) patients, respectively some of the patients received more than one strain of cannabis.

3.2 Outcomes of MC treatment

Improvements due to MC treatment were examined and evaluated for symptom indications before and after

treatment (Figure 2). All patients experienced immediate relief with MC usage.

Figure 2 shows that some of the patients got relief from symptoms that were not included in their first indication list. Effects such as increased appetite, intense improvement of spasticity, much better mood, better sleep, and decreased anxiety and tremors, were seen. Furthermore, all 18 patients that suffered from pain, got relief, while 15 of those patients experienced improvement with at least one more symptom (Figure 2b). Additionally, all 15 patients that their appetite improved, experienced improvements with at least one more symptom (Figure 2b). All 4 patients that their depression got relief, improved their appetite as well (Figure 2b). The dramatic improvement of spasticity enabled the patients to sit upright, use their hands to hold objects, eat by themselves, and suffer much less pain (Figure 3). All of these symptoms improved rapidly (in minutes), in patients who had them before compassionate MC treatment, as well as in patients who were receiving the cannabis to treat other symptoms.

Moreover, patients treated with MC who suffered from post-traumatic stress disorder or inflammation - disorders that were not included in the first indication list - experienced relief of these symptoms as well. After many years of suffering, several of these patients went back to interacting with their family members, talking, communicating, listening to music, playing, and drawing. The effect of MC treatment on those patients was almost "magical".

An immediate ameliorative effect on patients' medical and clinical symptoms was expressed by their no longer needing various prescription drugs. Before treatment and according to the patients' indications, 23 drugs were targeted for dosage reduction or cessation. By the end of the study, the 19 patients had discontinued 39 of the drugs that they had been taking (Figure 4). Most of the drugs that were completely eliminated were opiates, given for pain relief, to relieve anxiety, and as antidepressants. In addition, dosages of a few of the drugs given to treat ataxia and muscle coordination were decreased, due mainly due to the relief and release from spasticity, and

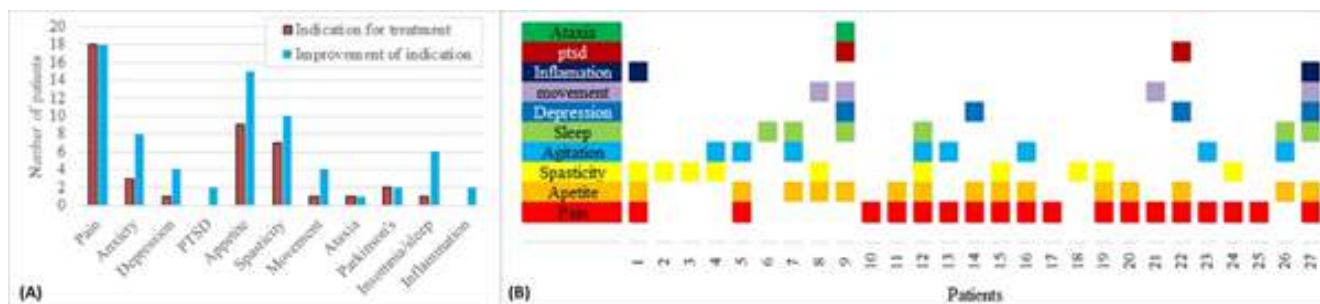


Figure 2. Indication for MC treatment. (A) Indication for MC treatment compared to improvement in that indication after one year of MC treatment; (B) Symptoms improvements for each patient

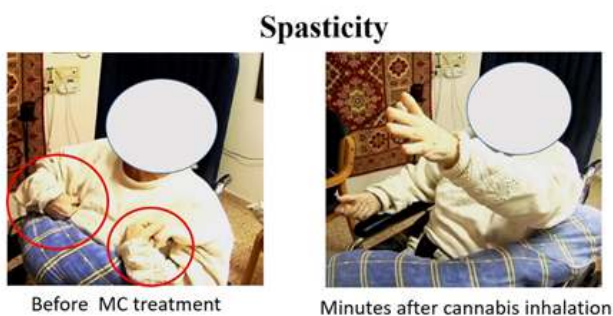


Figure 3. The intense effect of MC treatment on spasticity

routine treatment with drugs for Alzheimer’s, Parkinson’s and other disorders (inflammation, diabetes, and drugs given as laxatives) was discontinued.

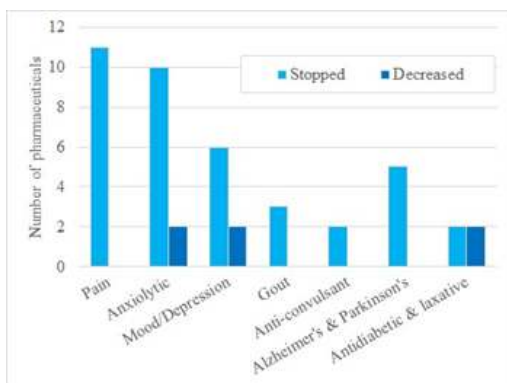


Figure 4. Distribution of the 39 drugs that were no longer taken, or were reduced, following treatment with MC, according to symptoms

4 Discussion

We evaluated the potential of MC treatment to improve patients’ clinical and medical parameters and general condition, resulting in a reduction in prescription drug dosages and as a result, a decrease in the environmental risk of pharmaceutical residues contaminating water sources and the environment. The research group was composed of hospitalized elderly patients in a nursing

home, i.e., dependent patients, 65 years or older. This population group tends to suffer from a variety of symptoms, and are usually highly likely to be associated with polypharmacy. For these people, MC might offer a way of managing symptoms with fewer side effects, in a situation with a good possibility of decreasing administered drug usage^[3,7,28,29]. Moreover, although some recent studies have shown increasing use of cannabis by the elderly, only a few such populations have been analyzed^[23,30,31] and to the best of our knowledge, no one has analyzed the use of MC in a nursing home.

Symptom relief as a result of MC treatment was prominent and distinctly noticeable for most of the patients. Relief of symptoms such as pain, anxiety, moodiness, and spasticity was evident, agreeing well with many previous studies^[22,24,25,32–34]. Relief was obtained not only for the specific indications serving as criteria for each patient, but also for additional symptoms and side effects (e.g., sleep disorders, ataxia, depression, and lack of appetite), as shown previously by Boehnke *et al.* (2016).

Spasticity, which restricts patients’ movements and complicates their treatment, improved dramatically with MC treatment. Consequently, patients’ movements (ataxia) improved significantly, along with their communication with family members. This also contributed considerably to their independence, enabling them to eat unassisted and to use their hands (Figure 3). The improvement in the patients’ appetite and eating abilities, accompanied by the elimination of feeding tubes, rendered the daily and unpleasant enema unnecessary. According to the physicians, MC treatment improved most of the patients’ clinical parameters, eliminating the anxious atmosphere and frequent shouting that characterized the nursing home before MC treatment; the treatment especially increased their general self-confidence.

Gradually, with symptom relief and improvement, pharmaceutical dosages were reduced and sometimes eliminated, under the physician’s advice. In total, the consumption of 39 drug dosages was stopped and that of 5 others

reduced. Termination of pharmaceutical consumption associated with MC treatment has also been shown in other studies. Abuhaira *et al.* (2018) showed that after 12 months of treatment with cannabis, most patients stopped or reduced their intake of chronic medications. Vigil *et al.* (2017) also presented cessation and reduction of drugs concomitant with MC treatment.

We present a novel aspect of MC treatment, in that it integrates other implications of this alternative treatment, focusing on its possible benefits to the environment. For better assessment and quantification of these implications, further research needs to be done. It is also important to emphasize that the participant group was limited, making statistical analysis limited.

Our results showed that even pharmaceuticals that were not included on the main target list for cessation or reduction were stopped (23 pharmaceuticals defined as targets, and 39 pharmaceutical dosages actually eliminated). These results might explain the findings of Nielsen *et al.* (2017)^[35], who showed that when cannabinoids are co-administered with opioids, they might allow reduction of opioid doses without loss of analgesic treatment efficacy. The positive effects of MC on diverse conditions might explain the cessation of additional drugs (*e.g.*, constipation and enema treatment, drugs for sleep disorders, etc.). Despite the study's limitations, the fact that MC treatment led to a total reduction of prescription drugs remains salient.

It is possible that with the recent increase in MC treatment in many western countries, the synergistic effects of the many cannabinoids present in the cannabis (not only THC and CBD) will have an overall positive effect on human health. This will be expressed in the improvement of various health symptoms, the reduced need for prescription drugs and finally, in the long term, a reduction of pharmaceutical residues in the environment, water resources and food.

5 Summary and conclusions

The focus of this study was the reduction in pharmaceutical usage as a result of MC treatment. We found an overall improvement in the patients, including of their symptoms and medical conditions, cessation or reduction of traditional drug usage, and a general improvement in life quality. The alternative treatment with MC provided an actual solution for pain symptoms, lack of appetite, and other side effects of traditional drugs. Quality of life improved for all patients not only personally, but also in terms of the nursing home atmosphere, since shouting and agitation diminished. The sharp decrease in prescription drug usage was clear, with the 19 patients ceasing

39 different drugs and decreasing the dosage of another 5. As an added benefit, the environmental threat posed by hazardous APIs from consumed drugs may sharply decrease, demonstrating the potential of MC to keep our freshwater resources free of pharmaceutical residues.

Conflict of interest

The authors declare no conflict of interest.

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