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From 32 Ounces to Zero: A Medical Geographic Study of Dispensing a Cultivated Batch of "Plum" Cannabis Flowers to Medical Marijuana Patients in Washington State

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Abstract — The medicinal use of cannabis is a growing phenomenon in the U.S. predicated on the success of overcoming specific spatial challenges and establishing particular human-environment relationships. This article takes a medical geographic "snapshot" of an urban site in Washington State where qualifying chronically ill and debilitated patients are delivered locally produced botanical cannabis for medical use. Using interview, survey, and observation, this medical geographic research project collected information on the social space of the particular delivery site and tracked the production cost, reach, and health value of a 32-ounce batch of strain-specific medical cannabis named "Plum" dispensed over a four-day period. A convenience sample of 37 qualifying patients delivered this batch of cannabis botanical medicine was recruited and prospectively studied with survey instruments. Results provide insight into patients' self-rated health, human-plant relationships, and travel-to-clinic distances. An overall systematic geographic understanding of the medical cannabis delivery system gives a grounded understanding of the lengths that patients and care providers go, despite multiple hurdles, to receive and deliver treatment with botanical cannabis that relieves diverse symptoms and improves health-related quality-of-life.

Keywords — botanical geography, cannabinoid medicine, complementary and alternative medicine, human-plant relationship, medical cannibas, medical geography, self-rated health

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INTRODUCTION

The present study describes local human relations with a yet-still stigmatized medicinal botanical. *Cannabis sativa L.*, a cannabinoid botanical, is the basis for a complementary and alternative medical system utilized by patients with a variety of chronic and debilitating illnesses. Such a system, which has legally existed in Washington State since 1998 under the banner of a "medical marijuana law," permits cannabis to be used and cultivated for medicinal purposes by patients with certain qualifying diagnoses under the authorization of a health care provider. Medicinal utilization of cannabis in this system often depends on mediators who help to connect duly authorized patients with this still federally contrabanded botanical. Mediators rely on social networks to procure and cultivate cannabis germplasms, thereby ultimately enabling them to deliver resin-rich cannabis flowers to patients seeking access. Using tools and approaches of medical geography, the present study describes in geographically contextualized detail particular ecologically grounded human-plant relations that undergird this system by following the dispensation to patients of a batch of cannabis flowers propagated by cloning. In doing so, the goal is to investigate a potentially sustainable plant-based medicinal system which is being utilized to maintain human health. This article begins with an introduction to medical geography, then moves to a more particular framing of the questions under investigation, and then describes the data collection methods, results, and conclusions.

Medical Geographic Inquiry

Medical geography is a subdiscipline of human geography that can be catalogued alongside other medical social sciences (medical anthropology, medical ethics, etc.). That human-environment relationships are relevant to explaining and understanding patterns of human health and disease—a core belief of Hippocrates (c. 460 BCE-c. 377 BCE)—is a bedrock principle of medical geography. Medical geography has generally concerned itself with elucidating the role of human-environment relationships in explaining and understanding sociospatial patterns of health, disease, health-related behaviors, and medical practices (Meade and Earickson 2000). Its environmentally driven principles are strengthened by the basic precepts of ecology by which medical geographers are able to describe dynamic biophysical linkages between humans, other organisms, and abiotic factors (see, for example, Mayer 1996). Increased knowledge and understanding is frequently generated by health-oriented quantitative and qualitative research that focuses on the spatial interplay between human agents and non-human biological objects (Mayer 2000; Hunter 2003; Oppong & Kalipeni 2005). This interplay is contextualized against the backdrop of an interdependent and interconnected shared environment, broadly construed to include both biophysical (e.g., terrain, climate, biome) and social (e.g., public health regulation, political-economic forces, cultural practices) dimensions at multiple scales, stretching from the local to the global (Meade & Earickson 2000; Jones & Moon 1992).

Several specializations in medical geography have arisen from cross-disciplinary research, such as disease ecology (May 1958), the political ecology of health and disease (Mayer 1996), therapeutic landscapes (Gesler 1992), ethnomedical geography (Good 1980), and spatial perspectives on health care access and delivery systems (Shannon & Dever 1974; Joseph & Phillips 1984). These approaches provide medical geography with the ability to analyze complex health-related spatial phenomena and to better serve pragmatic planning and policymaking aims. In this study, several streams of medical geographic inquiry are blended. The ecological traditions of medical geography are evoked when uncovering how particular plant genetic resources (germplasms) found in the local environment—those of botanical cannabis—are utilized in Washington State's medical care system. Therapeutic landscapes studies are evoked by describing the utilization of a locally available and readily cultivatable dioecious herb in medical practices in Washington State and by describing relevant place-based characteristics at a site of delivery. Ethnomedical geography is utilized by giving geographic consideration to alternative therapies and illness conceptions in medically pluralistic societies. By describing spatial characteristics of a system of delivery for health care resources—in this case, botanical cannabis—health systems delivery geography is invoked and applied at a small-scale (Pyle 1976). Finally, while not directly used, political ecology of health and disease, which has been explored previously by the authors (Aggarwal et al. 2012b), is in the backdrop here as socially contested human-plant relationships are investigated.

Two particular areas of work in medical geography that the present study builds upon are localized studies of controlled medicine access and botanical geographies. Recently published work by Mayer et al. (2008) on the availability of controlled opioid medicines in Washington State outpatient pharmacies charts a novel path, both in its smaller scale and focus on medication delivery rather than a particular type of medical service such as pain management or emergency medicine. With data collected from a comprehensive state-wide pharmacy mail-in survey, the authors presented state-level geographic analysis of opioid availability based on zip-code-sized enumeration units and showed no significant geographic differences in the availability of short-acting and long-acting opioid medicines. Unlike Mayer et al.'s study, the present study is based at a single location and involves locally produced botanical medicines that are "medically authorized," though not formally prescribed.

Although geographies of botanicals have a long history as evidenced by the lengthy entry under "Progress of Botanical Geography" in *The Encyclopaedia of Geography* published in 1837 (237), they have rarely engaged the interest of health and medical geographers. In fact, only one contemporary medical geographic study of botanicals can be found in the published literature. Price's (1960) "Root Digging in the Appalachians: The Geography of Botanical Drugs" chronicles the historical decrescendo of botanical medicines in the American pharmacopoeia and illustrates the anachronistic practices of collecting, producing, distributing, and consuming wild medicinal roots, barks, and herbs then still extant in Southern Appalachia. As plants fell out of the mainstream of modern medicine, field research into the medical geography of botanicals quickly died out as well. Currently, one must turn to the medical anthropological and ethnobotanical literatures to find health-oriented social scientific research studies of human-plant relations.

With rising public interest in complementary and alternative medicine, botanicals have made a small comeback in medical geographic studies of health care delivery (Gordon et al. 1998) concomitant with the trend in emerging medical practices of physicians and patients (re)turning to botanical medicines in their exploration of less toxic and more affordable therapies (Craker et al. 2006; "Guidance for Industry: Botanical Drugs" 2004; CDC 2004). Another trend in health care that warrants attention is local medicinal use of botanicals that run "against the grain" of national and international mandates. Specifically, over the last two decades, the need for adequate treatments for a growing chronically ill patient population (World Health Statistics 2008) has helped to ease long-standing prohibitions on the medical use of historically contrabanded botanicals, as is happening presently with *Cannabis sativa* L. (Figure 1). Possession of cannabis, a cannabinoid-rich plant with psychoactive properties, was federally prohibited in the United States in 1937, removed from the U.S. Pharmacopoeia in 1942 after nearly a century of use, and remains to this day in Schedule I, the most restricted drug classification in federal law, and correspondingly so internationally. As restrictions on its medical use are loosening in numerous locales, new health care delivery systems are forming and unique human-plant medical geographies are emerging. This paper describes this geography from the vantage point of one locale.

Human-Cannabis Relations and the Contested American Geography of Cannabis as Medicine

Cannabis (Kingdom Plantae; Phylum Magnoliophyta; Class Magnoliopsida; Order Rosales; Family Cannabaceae; Genus Cannabis; Species sativa) evolved on earth approximately 36 million years ago (McPartland et al. 2004).

FIGURE 1
***Cannabis sativa* L. Botanical Plate. Composite Plate of Cannabis Sativa by Elmer Smith (Economic Botany Archives, Harvard University, Cambridge, Massachusetts, USA). Available at: http://www2.dpi.qld.gov.au/hemp/16241.html**

It is believed to be one of humanity's oldest cultivated crops, providing a source for fiber, food, oil, medicine, and inebriant since Neolithic times . . . [It] is normally a dioecious, wind-pollinated, annual herb . . . The indigenous range of *Cannabis* is believed to be in Central Asia, the northwest Himalayas, and possibly extending into China . . . *Cannabis* retains the ability to escape from cultivation and return to a weedy growth habitat, and is considered to be only semi-domesticated . . . Methods of *Cannabis* cultivation are described in the ancient literature of China, where it has been utilized continuously for at least six thousand years . . . The genus may have been introduced into Europe ca. 1500 B.C. by nomadic tribes from Central Asia . . . Arab traders may have introduced *Cannabis* into Africa, perhaps one to two thousand years ago . . . The genus is now distributed worldwide from the equator to about 60°N latitude, and throughout much of the southern hemisphere. (Hillig 2005, 161)

Fiber-producing *Cannabis* strains from Europe were first introduced into the Americas by Spanish, French, and British colonists in the sixteenth and seventeenth centuries. Drug-producing *Cannabis* strains, which are genetically very similar and differ mostly at the level of biosynthetic enzymatic expression (van Bakel et al. 2011), were introduced by Angolans brought as slaves to Brazil in the mid-sixteenth century, but the major geographic dispersion of drug-producing *Cannabis* strains in the region occurred three centuries later when nearly half a million indentured workers from India settled in the British West Indies in the late 1830s, bringing drug strains of *Cannabis* with them. *Cannabis* had been used in Indian civilization for well over a millennium, with extant religious texts dating back to ca. 1400 BCE referring to drug strains of *Cannabis* as divine gifts to provide relief from tension and distress (Aldrich 1997). Throughout the nineteenth and early twentieth centuries, successive waves of labor migration from the Caribbean introduced drug *Cannabis* strains into Central America and eventually into the United States when over a million Mexican laborers entered the Southwest in the first three decades of the twentieth century (Courtwright 2001). Recent historical work suggests that drug strains of cannabis may have arisen spontaneously in North America from fiber-producing strains brought by Spaniards in the sixteenth century (Campos 2012).

Cannabis sativa L., while currently unavailable for general prescription use in the US, has been used in approximately three dozen completed controlled clinical trials, and one on-going, now-closed investigational clinical study (Aggarwal et al. 2009a). The few patients enrolled in American cannabis clinical studies are prescribed a cannabis strain or blend cultivated under contract at the taxpayer-funded federal research farm at the University of Mississippi at Oxford and mailed to local pharmacies. The analytical chemist in charge of the farm holds the patent on a rectal suppository formulation of the Schedule III drug dronabinol—an active chemical found in the cannabis plant (Aggarwal et al. 2007). This drug has heretofore been produced by total synthesis, but recently it and other cannabinoid formulations were approved for commercial extraction as natural products directly from the federal supply (USDOJ 2005). Since cultivation began, the federal cannabis herbal product has been inaccessible for general medical use and, since 1970, federal agencies have maintained the position that cannabis, pejoratively termed "marihuana" during the early 1900s, has "no currently accepted medical use in treatment in the United States" (21 USC Sec. 812 01/22/02).

Thus far, 18 American states and the District of Columbia have passed laws granting physicians the authority to approve or recommend use of botanical cannabis based on medical evaluation to qualifying patients, thereby freeing such patients from state-level prosecution. While not a true prescription, it is a legally recognized doctor-patient clinical discussion viewed as protected speech according to a ruling by the Ninth U.S. Circuit Court of Appeals that the Supreme Court let stand (Conant v. Walters 2002/3); current estimates indicate that thousands of American physicians have made such authorizations for several hundred thousand patients (Aggarwal et al. 2009a; Procon.org).

Sociospatial Challenges of Medicinal Cannabis Use

After receiving medical marijuana authorizations, or *access*, patients procure medical cannabis for their self-administered use under medical supervision from in-state channels and hence *delivery* of the treatment is effectuated—actions which continue to be harshly criminally sanctioned under federal law (DEA 2008; Gonzales v. Raich 2005). In such a bipolar sociopolitical environment, major medicine access and delivery problems certainly remain for patients. Not only is access to knowledgeable physicians and health care providers who feel comfortable recommending medical cannabis a challenge for patients, but also following such recommendations and being delivered a safe and adequate supply, a need that state laws do not comprehensively address, presents significant challenges and hardships.

As the system is presently formulated, three agents have to be brought into contact for medical cannabis use to successfully occur in these locales: patients, health care providers, and plants. When patient and health care provider come together, generally in a clinical setting, this allows for the possibility that a medical decision is made that the use of cannabis may be therapeutically beneficial to the patient. When such medical authorization is obtained and recorded, a patient has to then make close contact with the cannabis plant itself in some useable form in order to implement the medical care plan. All three agents and their respective relationships are subject to unique sociolegal and sociomedical forces.

While the authors have written elsewhere about a clinical site where a doctor and his patients come together to explore medical cannabis therapeutics (Aggarwal et al. 2009b), this article focuses on a dispensing site in which patients and cannabis plant matter are brought into close contact. Medical cannabis systems rely on patients becoming connected with the cannabis plant resources available in their local environment, a challenging task given the fact that cannabis' use as a therapeutic agent is not fully accepted in all social spheres. With starting materials and ability, patients in most medical cannabis states can grow an allowed supply of cannabis at home and thereby become maximally self-reliant. However, for various reasons such as illness or disability, lack of skill, lack of germplasm access, start-up expense, or housing rules, many patients cannot fully self-supply their medicinal cannabis and need or want other alternatives. Centers and sites for dispensing

cannabis for medical purposes, in addition to direct home delivery services, have appeared throughout the United States and have been met with varying degrees of acceptance and scorn at all levels of governance. From a medical geographic standpoint, these sites mediate an individual patient's close contact with the cannabis plant itself, which is usually found at these sites in the form of fully maturated and cultivated organic cannabis flower specimens and other cannabis-infused products.

The medical cannabis being used today in the active state programs is presumed to all be locally cultivated. In order to effect delivery of cannabis, patients, providers, or their contacts in their respective social networks, have to at some point come into direct contact with medicinal-grade cannabis germplasm (plant genetic resources) found in their local environments such as seeds, cuttings, or starter plants. In other words, patients and their cannabis-providing communities of support effectuate their health care by culling and cultivating local cannabis. Viable medical-grade cannabis genetic resources are procured by cultivators through their reliance on spatially diffuse social networks and community supports that have access to the natural resource. Because local, state, and federal law enforcement efforts have never been successful at completely eradicating cannabis from American territory and leaving only the federal farm its sole source, renewable germplasm sources invariably remain locally that patients and care providers count on to tap into and maturate, growth cycle after growth cycle, into usable cannabis botanical medicines of varying strains. Medical cannabis production and delivery at its root level is a human-environment relationship that has complex and interdependent social and natural dimensions. The natural and social history of local medicinal cannabis plant genetic resources, their propagation, preservation, domestication, and the like, are part of an underground human-environment relationship that has never been carefully studied or well-documented.

For those who wish to provide cannabis botanical medicine to patients, the essential geographic challenges are first to make contact with the plant genetic resource, and second, once maturated and prepared, to deliver cannabis across space to meet qualifying patients who have themselves traveled to seek out such care. The first geographic challenge will not be addressed here, as data regarding it is generally shrouded in understandable secrecy. The second geographic challenge will be analyzed here at a specific place, both from the perspective of the patients utilizing care and those expending efforts to deliver the botanical medicine to them. Such places where cultivated botanical cannabis is made medically available to patients who have traveled to receive it are unique places of "socially mediated nature" where a formerly fully contraband, locally cultivated botanical is made available to those with medical authorizations for use. It should be noted that the location of dispensaries is based largely on provider preference, local zoning restrictions, and law enforcement tolerance, rather than proximity to patients. They are not optimally or even obviously sited. Other sites relevant to the geography of medical cannabis dispensing include sites where the cannabis is cultivated, harvested, dried, trimmed, and manicured, sites where the cannabis is tested for quality control and chemical fingerprinting, and sites where it is packaged and prepared for delivery.

While there are some state registries and a number of noteworthy studies and reports that have examined delivery points of medical cannabis in the U.S. using a community-based and patient-centered perspective (Child et al. 1997; Harris et al. 2000; Gieringer 2001; Corral 2001; Chapkis and Webb 2008; ONDCP 2008; Reiman 2006, 2007, 2009), the present research project is significant as the only study using a cannabis germplasm-directed sampling approach. That is, with a particular "monoclonal" or single-strain harvest of cannabis in view, the questions posed are: where did this batch come from; how much does it cost to have it available; how is it presented; who is receiving the batch and for what end?

METHODS

To take a medical geographic "snapshot" of medical cannabis delivery at a particular place, the study used basic methodologies such as questionnaire, interview, and observation to follow the geographic arc of a selected clonal batch of cannabis botanical medicine at a purposefully chosen urban medical cannabis dispensary that delivers locally produced medicine to verified qualifying patients in Washington State. It sought to characterize the costs involved in the batch's delivery to patients, the types of patients treated, the distances travelled by patients and plant suppliers, and the place-based characteristics of the delivery site.

The study was part of a larger study approved by the Human Subjects Division at the University of Washington, and a federal Certificate of Confidentiality was issued by the National Institutes of Health's National Center for Complementary and Alternative Medicine. The Certificate ensures that any sensitive information collected as part of this study will remain shielded from outside parties and that those involved in conducting the study "cannot be compelled in any Federal, State, or local civil, criminal, administrative, legislative, or other proceedings to identify" study participants or otherwise compromise their privacy.

One dispensary director and one group of qualifying cannabis botanical medicine receiving patients were enrolled in this study. The director was recruited into the study upon making initial contact with the dispensary, and

the qualifying patients were recruited into the study when obtaining their physician-authorized cannabis botanical medicine at the dispensary site. The exact location of the urban dispensary where the study was conducted will remain anonymous and undisclosed to protect subjects' privacy. Recently, in Washington State, some municipalities have begun issuing licenses for medical cannabis dispensaries, but at the time that this study was conducted, no licensing schema existed. Prior to beginning the sampling study, contact and working relationships were made with the dispensary director and staff, who assisted in later patient-subject recruitment and data collection. The sampling strategy used in this study was a place-based, germplasm-based one. This means that all patient-subjects recruited for enrollment in this study visited the dispensary site during the time the study was taking place, and all patients chose, out of the several cannabis botanical medicine strains available, to purchase and treat themselves with "Plum,"[1] a strain which had been pre-selected for study unbeknownst to patients. Patients were in no way influenced to choose one strain over another, and those who solely chose other strains were not recruited. The patients in the study therefore constituted a convenience sample that is not representative of all patients utilizing the dispensary or all medical cannabis patients in Washington State generally (estimated at ∼35,000 as of 2009 [Procon.org]). Geographic and germplasm source and maturation information about the batch of "Plum" available in the dispensary during study days was collected through observation and interview with the dispensary director. The study inclusion criteria were: one had to be a qualified medical cannabis patient (pre-verified by the dispensary and asked of subjects as initial survey item) who was delivered part of the "Plum" study batch, aged 18 or older, and proficient in reading and understanding English. The sole study exclusion criterion was anyone who was taking a cannabinoid receptor blocker drug (none mentioned). Patients were given no gifts, payments, or services for participation.

Oral informed consent was obtained prior to conducting a semi-structured interview with the dispensary director. A six-page script was adapted from a previous social work dissertation (Reiman 2006). The interview collected de-identified geographic data on the costs and environmental factors involved in procuring and maturing a cannabis germplasm sample delivered as a batch to qualifying patients. Questions sought to elicit spatially relative, geographic information related to location and movement. Basic service data such as the size of dispensary's patient population and the number of unique health care providers whose authorized patients have received botanical medicine from the dispensary were also collected. Information was captured through note-taking.

The patient sampling study was conducted during dispensing hours over consecutive operational days during 2007–2008. Patients were recruited with the assistance of dispensary staff, who directed potential subjects to the researcher stationed in another part of the dispensary. They were told explicitly that they were under no obligation to participate in the study, that participation was entirely voluntary, and that they were free to discontinue participation at any time. After oral informed consent, willing patients were enrolled, assigned a random number, and asked to fill out in a quiet area an on-site questionnaire that assessed medical marijuana treatment history and health-related quality of life (HRQoL) using standard and tailored instruments. Subjects were given a take-home questionnaire which included travel-to-clinic distances, times, and means. Subjects were also given an addressed and stamped envelope to return materials by mail. They were given the option to drop-off completed materials at the dispensary. All materials associated with a given subject were coded with the original randomly assigned study number and kept securely after return. Over two months after initial patient sampling, a sign was posted by dispensary staff behind the counter for two weeks to increase return rate of study materials.

RESULTS AND DISCUSSION

What are the Dispensary's Characteristics, and How is the Cannabis Batch Presented Therein?

The following information was collected as part of a semi-structured interview with the medical cannabis dispensary director conducted in December 2007.

At the time that this study was conducted, the facility had been open for 26 months, and the current director had been operating it for 16 months. The facility's hours of operation were 11am–6pm, Monday–Friday, 12–2pm the first Saturday of each month, and closed on Sundays. In addition to delivering cannabis botanical medicines, the dispensary offered "Starting Growing" classes for $75 taught by a multiple sclerosis patient. It also offered a number of support services for no charge, such as a monthly patient meeting, peer counseling on using and growing medical marijuana, information on Washington's medical marijuana law, medical marijuana usage, patient rights, and medical marijuana scientific research information. Support groups, legal advice, political advocacy trips to the state capital, courtroom support for prosecuted patients, visitation of patients in jail or in the hospital, and illness-specific emotional support in which HIV/AIDS and MS patients talked to other HIV/AIDS and MS patients (or staff) about housing, medical issues, caregiver issues, etc., were all additional services available for no charge. To be verified as a qualifying patient, a patient needed a state-issued ID card and a copy of a Washington-State-licensed physician's authorization for the use of medical

marijuana. Patients were not allowed to use marijuana on site, and they were also not allowed to use tobacco on site. During an average week, ∼250 different patients utilized the dispensary, and since opening, ∼600 different patients had been served. During the four days of patient sampling, the dispensary delivered cannabis botanical medicines each day to 72, 49, 66, and 42 patients, respectively, for a four-day total of 229 patients. Since its opening, ∼100 physicians' patients have been delivered cannabinoid medical treatment from the dispensary, and currently ∼20 physicians' patients are being served by the dispensary.

The dispensary director felt that the facility had the support of local government officials, that it maintained excellent relationship with local police, and had no history of raids by local, state, or federal law enforcement. The dispensary offered a variety of cannabis botanical medicinal products, including cannabis flowers (pistillate inflorescences), edibles prepared with lipophillic extracts (cookies, brownies, etc.), tinctures, salves, butter, hashish, "Mari-pills" (encapsulated ground cannabis flowers activated with coconut oil), tea (market spice tea infused with cannabis "sugar leaf" from the second trimming), and elixir (a cannabis-flower-infused honey). As a service to indigent patients, an apportioned amount of the leafy bits that fell off during handling of the cannabis flowers and accumulated in the bottom of storage bags was made available to patients at no charge as part of a fund named in honor of a patient who had passed away. The director emphasized that all medicinal products offered came from known and reliable local sources and claimed they were produced cleanly and without pesticides. During the time the study was taking place, the complete available stock of cannabis botanical medical products available to patients consisted of the following strains and preparations as displayed with and without prices on a white marker board behind the medicine counter: Ms. Magic 7, Tanner 7, Plum 6, Hawg 7, Tiva 6, Green Hornet 5, Eastern Shag 5, Hash, Elixir, Butter, Mari-pills, Green Cream (a topical salve), and Goo Balls (a sweetened edible). A "0" is added to the end of a number to determine the price in dollars of a quarter ounce of a strain. For example, a quarter ounce of Plum would cost $60. Unlisted prices were given verbally. The dispensary also sold combustion-and-inhalation delivery pipes from $10-20, and offered books, DVDs, and a donation closet for no charge. The size of the facility was approximately 2500 square feet, of which only one-third was being regularly used. The dispensary tried to have "good and easy parking" on the premises and tried to maintain "easy accessibility" for all patients with disabilities (quotations are exact language used).

The dispensary employed three full-time workers and two part-time workers for counter staff services. One full-time worker did medicine intake and outtake out of the back office. S/he interacted with those who brought medical supplies and did the weighing and packaging of medicine that was delivered to patients. Another full-time worker handled the front office. S/he was the patient intake coordinator and served as liaison to physician's offices for patient verification, conducted new patient orientation about the dispensary's policies and procedures, and maintained the dispensary website. The third full-time worker was the dispensary director who also served as the community liaison, did courtroom and jail visitations and other political/legal services. The dispensary also maintained a volunteer staff, and much of their time was used in helping patients set up for producing medical marijuana at home.

The roadblocks the dispensary director saw in meeting patient needs were all related to social structural barriers in patients' community and home environments. These included dealing with: housing issues, such as the fact that some apartment complexes would not allow patients to use or grow medical marijuana; the fact that patients could not use medical marijuana in public; difficulties patients had in maintaining a consistent supply of medical marijuana, and the fact that there were police who continued to raid patients' gardens. The director was less concerned with harsh federal policies than with ensuring local-level policies served patient interests. In terms of general community relations, the director stated that they tried to be good neighbors and good community members in the area where the dispensary was situated. They did not have loud music or parties and tried to foster positive relations, such as by joining the local community council. S/he stated: "The community knows what we are doing."

Where was the Cannabis Batch Coming From, and How Much Did it Cost to Have it Available?

During the interview with the dispensary director, the following data were obtained about the costs involved in delivery. The normal cannabis growing cycle, which can vary from strain-to-train and exact environmental conditions used, takes approximately four months. This includes approximately four weeks each for plant rooting and vegetative growth and eight weeks for blooming and finally harvest, for a total of 16 weeks. The dispensary director reported that the cannabis growing cycle needs to be kept going so that a consistent supply can be maintained. With optimal conditions, at the end of a cycle, a large plant may yield 0.5 lbs (8 oz. or 226.8 grams) of usable botanical medicine. This means that the 32-ounce (907.18-gram) batch of Plum strain cannabis botanical medicine which was dispensed to 71 patients (see next section) may have originated from the yield of as few as four cannabis plant clones. Table 1 displays the estimated delivery costs, including transportation and production/distribution site maintenance, for a four-month cycle, which totaled ∼$47,000.

TABLE 1
Estimate of Cannabis Botanical Medicine Delivery Costs Over One Four-Month Indoor Germplasm Maturation Cycle

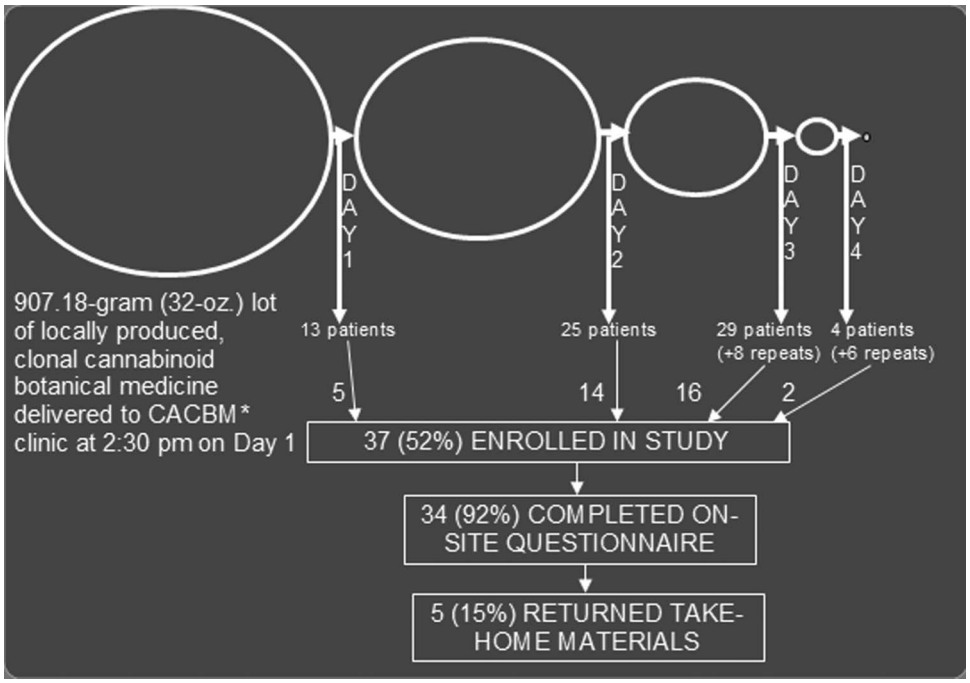
Stocking/Maturation Costs per Cycle	
$2000-house rent/month	$8000
$500-electricity/month	$2000
$250-water/sewage/month	$1000
$100-cable/phone/internet ("need it to be an actual seeming home with someone there")/month	$400
$2400-6 lights (pressurized Na lamps) = ballast, hood, light bulb ($400/unit and $100 for replacement bulbs per year)	$2400*
$200-fluorescent lights	$200*
$100-cultivation buckets (one for each plant)	$100
$100-soil/perlite	$100
$500-nutrients (fertilizer) (two-month supply)	$1000
$0-clones for free (sometimes $15-$20), but mostly people freely sharing excess clones ("collectivist ethic since beginning") OR $600 for four seeds (♀)	$0
$20-$30-dumping costs for soil (every two months)	$50
$100-misc. packaging, garbage, transportation materials	$100
Labor Costs per Cycle (wage: $10-$15/hr or $13/hr)	
3-5 hours of work/day x 112 days (16 wks)	$5824
Harvest/trim: 10 people working for seven hours	$910
Dry trim: 10 people working for seven hours	$910
Need 36 hours of labor on immediate reserve—Insurance—for landlord issues (housing law; e.g., have to move the entire operation due to a landlord site visit)	$468*
Transportation Costs per Cycle	
2.5 hr distance = 5 hr roundtrip x $13/hr = $65 + $30	$95
Available and Deliverable at Staffed Facility, Costs over a Cycle	
$2500-facility rent/month	$10000
$385-phone/fax/internet/month	$1540
$350-electricity/heat/water/sewage/month	$1400
$400-office supplies (labels, paperwork, packaging supplies)/month	$1600
$100-security alarm system/month	$400
$150-cellphone for 24 hr. emergency contact/month	$600
$2775-$75/day-wages for two employees during operating hrs – 37 hours/month	$11100
Installing camera system	$10000*
Installing iron bars on windows	$10000*
Totals	
One-time costs (lights, reserve labor, camera system, iron bars)	$23068*
Total Stocking Costs	$12750
Total Labor and Transportation Costs	$7739
Total Available and Deliverable at Staffed Facility Costs	$26660
Total Costs per four-month cycle (excluding one-time costs)	$47149

Quotes from interview with dispensary director have been included.
*One-time costs.

How Did the Cannabis Batch Arrive, and How Was it Dispensed?

At 2:30pm on Day 1 of the study, the subject recruitment portion of the study began when a 907.18-gram (32-ounce) batch of dried and manicured Plum strain cannabis flowers was delivered by car after an approximately 2.5 hr journey to the dispensary in a plastic container, and processed and prepared for distribution

FIGURE 2
Cannabis Batch Delivery-Based Patient Sampling Strategy. Circle sizes are Proportional to Size of Batch at the Beginning of Each Day Over the Course of its Complete Delivery. *Complementary and Alternative Cannabis Botanical Medicine



by staff. Recruitment concluded when the batch was completely depleted by Day 4. One point nine grams (1.9 g) of the batch was placed in a sample container, which patients were able to inspect prior to making their strain choices. Over the course of the four consecutive operating days during which the study took place, 71 different patients—13 on day 1, 25 on day 2, 29 (+8 from previous days) on day 3, 4 (+6 from previous days) on day 4—were delivered physician-recommended cannabis botanical medicine from the 32-ounce clonal Plum strain batch of dried, resinous cannabis flowers—233.9g on day 1, 287.0g on day 2, 283.5g on day 3, and 85.0g day 4—until it was completely used up. Over the course of the observed days, 15.6g of leafy bits that fell off during handling of the batch of Plum strain cannabis flowers and accumulated at the bottom of storage bags was delivered to 37 patients at no charge—14 on day 1, 8 on day 2, 12 on day 3, 3 on day 4—which included an unknown number of repeat patients. These patients were not recruited into the study.

Who was Receiving the Cannabis Batch and for What End, and How Far Had They Travelled?

Of the 71 unique patients served by the batch, 37 (52%) enrolled in the study (5, 14 16, and 2 on days 1–4, respectively), 34 (92%) completed the on-site questionnaire (three could not due to time constraints), and five returned the take-home materials (15% response rate). Figure 2 summarizes the study sampling strategy implementation and graphically depicts the gradual depletion of the batch of cannabis through delivery to patients.

The on-site survey data collected from the 37 patient-subjects revealed the following health and demographic characteristics. The average number of years of being qualifying medical marijuana patients was 3.8. They were 35% female and 65% male. The average age was 39 years old, ranging from 21–61 years old, with the female median age being 12 years higher than the male median age. Sixty-seven point six percent (67.6%) of the patients in the sample identified as Caucasian, 13.5% as African American, 8.1% as Native American, 5.4% as Hispanic, and 8.1% as Other. Median annual income was $20,000-34,499. Surprisingly, 88.6% of the patients in the sample had some form of health insurance, and of these, 64.5% held health insurance from the public sector (e.g., Medicare, Medicaid, Early Intervention Program, VA).

Table 2 shows the qualifying conditions for the medical use of marijuana in Washington State with which subjects identified as their diagnosis, including original

TABLE 2

Diagnosed Qualifying Conditions for the Medical Use of Marijuana in Washington State at Time of Study Reported in Patient Sample

→Diagnosed Qualifying Conditions for medical use of marijuana in WA state ↓ Patient	Cancer	HIV	Multiple Sclerosis	Epilepsy, oth. Seizure Dis.[1]	Spasticity disorder	Intractable pain[1]	Glaucoma[2]	Crohn's Disease[3]	Hepatitis C[4]	Nausea/vom./wasting/appetite loss/cramping/seizures/musc. spasms/spasticity[5]	Comment
1						X[a]					[a]"chronic stomach/nausea"
2		X									
3						X				X[b]	[b] "chronic migraines"
4		X									
5						X[c]				X[d]	[c]"chronic migraines"; [d]"appetite loss due to migraines"
6								X		X[e]	[e]"Irritable Bowel Syndrome IBS"
7						X[f]				X[g]	[f]"Back-Spine Injuries, Surgeries & Acute Pain. (Nerves & Muscles) Arthritis"; [g]"cramping, muscle spasms, pain (instead of "hard" narcotics)"
8	X[h]					X[i]					[h]"Colon Cancer"; [i]"Migraine headache"
9						X[j]			X		[j]"Hep C"
10						X[k]			X		[k]"Hep C"
11				X							
12				X[l]	X						[l]"TBI"*
13	X[m]										[m]"Breast Cancer Stage 4"
14						X[n]					[n]"Chronic Nerve Pain/Muscle Spasms"

15			X					
16					X[o]		X[p]	[o]"Arthritis of Neck" "Chronic Headaches"; [p]"Alternative medicine for severe muscle spasms"
17			X		X[q]			[q]"leg spasticity rel. to MS"
18	X[r]					X	X[s]	[r]"Kidney R Removed"; [s]"Diverticulitis"
19						X[t]		[t]"Migraines"
20			X					
21			X					
22		X						
23					X[u]	X[v]	X[w]	[u]"spastic colon"; [v]"osteoporisis"; [w]"chronic diarrhea, migraines"
24	X[x]							[x]"Breast"
25					X[y]		X[z]	[y]"lower back Behind Pelvis"; [z]"muscle spasms lower back"
26					X[aa]	X	X[bb]	[aa]"severe Osteo. Art."; [bb]"muscle spasm/very bad cramps"
27				X[cc]	X[dd]	X[ee]	X[ff]	[cc]"parathesia disorder"; [dd]"spinal cord injury, C5-C6, incomplete feeling below level of injury"; [ee]"burning parathesias","stomach cramping pain→sharp & dull pain"; [ff]"spinal cord injury→ appetite stimulation"

(*continued*)

TABLE 2
(Continued)

→Diagnosed Qualifying Conditions for medical use of marijuana in WA state ↓ Patient	Cancer	HIV	Multiple Sclerosis	Epilepsy, oth. Seizure Dis.[1]	Spasticity disorder	Intractable pain[1]	Glaucoma[2]	Crohn's Disease[3]	Hepatitis C[4]	Nausea/vom./wasting/appetite loss/cramping/seizures/musc. spasms/spasticity[5]	Comment
28		X									
29		X									
30										X[gg]	[gg]"I throw up 3 to 5 times a day"
31					X[hh]	X[ii]	X		X	X	[hh]"gastro intestional disorder", [ii]"diabetic neuropathy"
32			X						X		
33			X								
34										X[jj]	[jj]"Charcot-Marie-Tooth"
35						X	X			X	
36						X					
37		X[kk]									[kk]"Full Blown AIDS under 50 T cells"
Totals	4	6	6	3	8	16	2	1	4	14	

[1]epilepsy or other seizure disorder;
[2]limited to mean pain unrelieved by standard medical treatments and medications;
[3]either acute or chronic, limited to mean increased intraocular pressure unrelieved by standard treatments and medications;
[4]with debilitating symptoms unrelieved by standard treatments or medications;
[5]with debilitating nausea and/or intractable pain unrelieved by standard treatments or medication;
[6]any disease, including anorexia, which results in nausea, vomiting, wasting, appetite loss, cramping, seizures, muscle spasms, and/or spasticity, when these symptoms are unrelieved by standard treatments or medications.
*Traumatic Brain Injury.

specifiers and comments on their qualifying conditions. All 10 qualifying condition categories at that time were represented: four (10.8%) had cancer, six (16.2%) had HIV, six (16.2%) had multiple sclerosis, three (8.1%) had epilepsy or other seizure disorder, eight (21.6%) had spasticity disorder, 16 (43.2%) had intractable pain, two (5.4%) had glaucoma, one (2.7%) had Crohn's disease, four (10.8%) had hepatitis C, and 14 (37.8%) had any other disease, including anorexia, resulting in nausea, vomiting wasting, appetite loss, cramping, seizures, muscle spasms, and/or spasticity. Half of the patients identified more than one qualifying condition. Additional sample health data such as symptom relief, health-related quality of life, psychological distress levels and coping strategies are published elsewhere (Aggarwal et al. 2012a; Aggarwal et al. 2013).

Of the 34 patients who had been dispensed cannabis from the Plum study batch that were given take-home surveys, five returned the survey materials for a response rate of 15%. They were: a 41-year-old Caucasian male with HIV who received 1/8 ounce (Pt#2), a 49-year-old Caucasian male with multiple sclerosis who received 5/8 ounce (Pt#15), a 37-year-old African-American male with neck muscle spasms and chronic headaches who received 2 ounces (Pt#16), a 52-year-old Native American/Caucasian female with multiple sclerosis who received 1/8 ounce (Pt#20), and a 39-year-old Hispanic/Caucasian male with AIDS-stage HIV who received 1/8 ounce (Pt#37). All reported that medical marijuana treatment is a major component of their health/disease management. Four of the five subjects (all except #37) endorsed using medical cannabis as a preventive medicine. Three of the five subjects endorsed cultivating their own medical cannabis (excluding #16 and #37). In response to the question: "How have you incorporated medical marijuana into your life? Do you have a relationship with this botanical medicine?" one subject (#15) responded, presumably referencing gardening: "when I have plants I feel a relationship of love & respect & awe in the plant." Another (#20) commented: "We are both created of the same source/maker: Inhaling, ingestion or other application of nautral [sic] medicine brings one closer, than w/ synthetics or man-mades." Elsewhere three subjects, when queried, endorsed spiritual/religious views regarding cannabis (Pt# 2, 16, 20), explicitly noting the plant's natural origins as distinguished from synthetic drugs.

These five patients all resided within relative close proximity to the dispensary (mean distance, 6.1 mi, range 4-10 mi), required no more than 45 minutes of travel time, with three traveling south from home and two traveling northeast from home to reach the dispensary. Most reported taking public transit. Distance-traveled geographic information was anonymously gleaned by asking patients to estimate their travel-to-clinic distance by logging into the website Google Maps (http://maps.google.com), inputting their home address and the dispensary address, and reporting the estimated distance given by the computer program. Using this technique, no personally identifying residential geographic information had to be collected.

CONCLUSION

Health-related data collected from a convenience sample of medical cannabis patients in Washington State, all drawing from one common strain-specific batch of cannabis, when combined with the data collected on delivery site characteristics, makes considerable progress toward shedding light on human-environment and human-plant relationships. Geographic strategies in this cannabis delivery system are employed by both providers and patients, with providers locally planting, harvesting, and packaging cannabis medicine at various sites and delivering it to patients who have traveled to a delivery site to which they have been granted access by a physician's recommendation. It should be noted that Washington State voters adopted by voter referendum a new law on November 6, 2012, which will allow for legal possession of up to 1 ounce of dried cannabis, 72 ounces of cannabis-infused liquids, and 16 ounces of cannabis-infused solid food—all without need for medical authorization. This will invariably change geographic parameters in the medical cannabis system.

In this study, an attempt has been made to map the medical geography of cannabis botanical medicines delivery at the single-dispensary local delivery scale, keeping in mind the underlying human-environment relationships, from germplasm maturation to patient utilization. This includes discovering the health characteristics of patients clustering in sites associated with delivery of these botanicals, estimating the costs involved in maturating a single-strain batch of cannabis botanical medicine, enumerating a batch's reach in terms of number of patients served, and describing relevant human-plant ecological relationships. Following one batch of botanical medicine allows an appreciation of the sociomedical value of a community health care delivery system that has access to cannabis germplasm, allows for the development a rational geographic patient sampling strategy, and enables collection of health outcomes data from patients who are using a chemotypically identical strain of cannabis botanical medicine. The limitations of this study are that the subjects constituted a convenience sample. The study was further limited by the small return rate of prospective study materials, which may have been related to the lengthiness of survey materials, need to access the internet, and prolonged two-month interval between survey provision and posting of reminder sign. Other limitations included recall bias, lack of corroborating medical records,

and inability to trace complete human-plant geographic relations due to present legal barriers. Future directions for research regarding medical cannabis dispensing could seek to collect more sophisticated statistics correlating amounts dispensed with purchasing frequency, travel distance, gender, and medical condition. A long project of shedding light on the human-cannabis relationship through the collection of oral histories, plant breeding histories, and plant genetic fingerprints remains to be done in order to better elucidate American cannabis medical ethnobotany.

NOTE

1. Reported THC content, 17% by weight, and CBD, 0.8% by weight, with no data available on terpenoid profile. Measurements done by HPLC. This data was presented at the 2012 International Cannabinoid Research Society Meeting in Freiburg, Germany, in July 2012 by cannabinoid researcher Michelle Sexton, N.D., and was based on average results from three samples of Plum cannabis flowers collected in greater Seattle, Washington, in 2011–2012.

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