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ABSTRACT

Medical marijuana patients often believe that specific strains are more efficacious at treating their conditions. The goals of this investigation were to determine: (1) how many strains of cannabis are there; (2) which strains are used by medical cannabis (MC) patients; and (3) are there any differences in the strains used by patient condition? Study I involved quantifying the number of strains listed in the online database leafly.com and categorizing these by whether the strain name included a gustatory component. MC patients ($N = 455$) from New England completed an anonymous online survey about their medical history and strain preferences in Study II. There were 1,987 strains listed. Hybrids were significantly more likely than *Cannabis indica* strains to have a gustatory title. Strain preferences were highly state/dispensary specific with one-fifth of MC patients in Maine preferring Mother of Berries (M.O.B., 21.5%). Many respondents mentioned that they had developed a time-dependent pattern with *sativa* use during the day and an *indica* for nighttime use and for improving sleep. There is some general consistency across dispensaries in that hybrid strains and *C. indica* were most common. Further longitudinal and controlled investigations are necessary to identify the strains that are most efficacious for specific conditions.

Medical marijuana has experienced a substantial reemergence in the past two decades. The Medical Cannabis (MC) patient population has changed during this period from primarily HIV and cancer (Corral 2001) to chronic pain (Piper et al. 2017b). Several nations at least partially condone MC, including the Netherlands, Germany, Uruguay, Romania, Chile, the Czech Republic, Colombia, Jamaica, Australia, and Canada (Collier 2016; Davenport and Pardo 2016; Rodriguez 2017) as well as over half of the U.S. (Mead 2017). It is challenging to even estimate the number of MC patients in the U.S. because not all states require registries, but it may be between 440,000 and 650,000 (Fairman 2016). The prevalence in Vermont (3.5/1,000 adults) and Rhode Island (13.6/1,000) is appreciably lower than Colorado (28.7/1,000; Fairman 2016). In addition to prevalence, there are also state-level differences in the qualifying conditions, relationships of dispensaries with health care providers, and where the MC can be procured from (that is, from dispensaries or caregivers). The New England states with MC programs differ somewhat with Maine having the first program, which was passed by voter initiative in 1999 while Vermont's received legal authorization in 2004 and Rhode Island's in 2006. Relative to Maine, Vermont has fewer certifiable conditions and places more limitations on who can authorize a patient to receive MC (NORML 2017). For example, post-traumatic stress disorder (PTSD) is a qualifying condition for MC in Maine and Rhode Island but not in Vermont. Further, medical doctor (MD) and doctor of osteopathic medicine (DO) trained physicians can certify patients and their qualifying conditions in Rhode Island while certified nurse practitioners and physician sssistants may also perform this function in Maine. There are a wide variety of MC products which can be smoked, heated with a vaporizer which contains a heating source, edibles, topicals that can be applied to the skin, tinctures which are liquids administered in a small volume, or as concentrates, which is a more potent preparation.

Medical cannabis is not a single homogenous substance, which is unlike most U.S. Food and Drug Administration approved drugs and has important pharmacotherapeutic implications. The plant *Cannabis sativa* contains at least 70 cannabinoids as well as over 400 other constituents including 120 terpenes (ElSohly and Slade 2005). Terpenes are a family of over 100

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molecules found in cannabis, which are lipophilic compounds that readily cross the blood brain barrier. These phytochemicals are responsible for the distinctive odor and flavor of the strains (Andre, Hausman, and Guerriero 2016). Although tetrahydrocannabinol (THC) is psychoactive and has received the preponderance of empirical attention (Earleywine 2002), several findings indicate that non-THC components (e.g., cannabidiol or cannabigerol [CBG]) are integral for the biological responses to MC (Russo 2011). First, the correlation between plasma levels of THC and the perceived "high" appears only moderate (Agurell et al. 1986). Second, Marinol (synthetic THC) is a Schedule III substance, meaning that it has less abuse potential than Schedule I substances like marijuana (although one could argue that marijuana is currently misclassified). Third, the sales of Marinol (dronabinol) and its generic forms have been relatively modest, while MC, as well as recreational marijuana, is substantially more common (Center for Behavioral Health Statistics and Quality 2015; Johnston et al. 2016). In spite of the stigma associated with MC (Bottorff et al. 2013), many patients prefer MC over synthetic cannabinoids. It is possible that one reason for this inclination is that MC exists in many different forms or strains.

Patients commonly refer to *Cannabis sativa* and *Cannabis indica* as distinct varieties. According to the popular website Leafly (2017), there are numerous distinct strains which are either *C. sativa*, *C. indica*, or hybrids. There is some disagreement among botanists whether *C. sativa* and *C. indica* are distinct species (Hillig 2005; Sawler et al. 2015) or sub-species, but there are outward differences. *C sativa* is taller in height and often has long and narrow leaflets. *C. indica*, from India, is shorter in stature with broader but shorter leaflets. *C. indica* and *C. sativa* samples have been geographically differentiated based on their terpenoid profile (Hillig 2004) and enzymes (Hillig 2005). Among patients, *sativas* have a reputation for producing more cerebral and stimulating effects while *indicas* are more sedative and relaxing (Sawler et al. 2015). Some botanists argue that *Cannabis ruderalis* and *Cannabis afghanica* are additional species (Piomelli and Russo 2016; although see Small 2015), but this terminology is not used by MC patients. Dispensary staff, colloquially known as bud-tenders, often recommend *sativas* for appetite and depression and *indicas* for insomnia, nightmares, anxiety, and chronic pain (Haug et al. 2016). Interestingly, a non-blind, but longitudinal, naturalistic investigation of California MC patients determined that *indicas* produced significantly greater improvements in both energy and appetite than *sativas* (Corral 2001).

Strain names are creative and may be based on a variety of factors, including smell/taste (e.g., Sour Lemon O.G.), psychoactive properties (e.g., Amnesia), or be named after individuals (e.g., the cannabis activist Jack Herer, 1939–2010) or figures from popular culture (e.g., Godzilla; Table 1). The strains also have regionally distinct names (e.g., Kush from the Kush Mountains in Central Asia) and availability. The genome of the *sativa*

Table 1. Marijuana strains including themes and example names; strain names are as listed in the database leafly.com.

Theme	Example(s)
Animals	Electric Black Mamba, Catfish, CBD Shark, King Kong, Monkey Paw, Pitbull, Silverback Gorilla, Shark Bite, Walrus Kush
Cannabis activists	Dr. Grinspoon, Chong Star, Ed Rosenthal, Jack Herer, Margaret Cho-G, O.G. Eddy Lepp, Willie Nelson
Cannabidiol (CBD)	3D CBD, Afghani CBD, CBD Critical Cure, CBD Kush, CBD Mango Haze, CBD Shark, Nebula II CBD, TJ's CBD
Contemporary figures	Charlie Sheen, Deadhead O.G., Michael Phelps O.G., Obama Kush, Phishhead Kush, Snoop Dog O.G., Stevie Wonder, Tiger Woods
Colors	Blue Alien, Blue Diesel, Blue Kiss, Blue Knight, Blue Mystic, Blue O.G., Blue Treat, Stella Blue, Green Candy, Green Dragon, Green Dream, Green Kush, Green Poison, Green Python, Green Ribbon, Purple Candy, Purple Chemdawg, Purple Elephant, Purple Hashplant, Purple Martian Kush, Purple Panty Dropper, Red Haze, Red Dragon, Red Eye O.G., Berry White, White Fire 43, White Kush, The White, White Knight, White Widow
Expletive	Alaska Thunder Fuck, Ape Shit, Bubba's Bitch, Cat Piss, Devil's Tit, Dog Shit, Fucking Incredible, Karma Bitch, Purple Monkey Balls
Food & tastes	Blueberry, Candy Cane, Cannalope Kush, Champagne Kush, Cherry Pie, Girl Scout Cookies, Key Lime Pie, Lemon Skunk, Mango Dream, Pineapple Chunk, Pineapple Express, Sweet Deep Grapefruit, Super Sweet, Thin Mint Girl Scout Cookies
Historical figures	B.B. King, Elvis, Jack the Ripper, Jimi Hendrix, King Louis XIII, Kobain Kush
Locations	Afghan Kush, Black Russian, California Orange, Durban Poison, Dutch Treat, East Coast Sour Diesel, Hawaiian Cookies, Humboldt Dream, Manitoba Poison, Mexican, Montana Silvertip, NYC Diesel, Seattle Cough, North American Indica, North Indian, South American, South Central LA, South Indian Indica, UK Cheese
Military	Agent Orange, AK-47, Cluster-Bomb, Four Star General, MK-ULTRA
Movies	Alice in Wonderland, Charlotte's Web, Cinderella 99, Chucky's Bride, Green Lantern, Green Hornet, LA Confidential, Snow White, Training Day
Movie characters	Bruce Banner, Darth Vader O.G., Death Star, Master Yoda, Skywalker, Yoda's Brain, Romulan, Walter White, Willy Wonka, Wonder Woman
Natural phenomenon	Aurora Borealis, El Niño, Northern Lights, Sunset Sherbet
Products & brands	Big Mac®, Bugatti® O.G., Cracker Jack®, Crown Royale®, Goldwing®, Gucci® O.G., Jumba Juice®, Lamborghini®, Rollex® O.G. Kush, Sierra Mist®
Religious	3 Kings, Church O.G., Devil Fruit, Diablo, Exodus Cheese, God's Gift, God's Treat, Grand Hindu, Green Goddess, Jesus O.G., Hindu Kush, Hindu Skunk, Holy Grail Kush, Kosher Kush, Little Devil, Reclining Buddha, Purple Hindu Kush, Sweet Black Angel
Royalty	King's Bread, King's Cake, King's Kush; Dream Queen, Green Queen, Ice Queen, Queen's Panties, Space Queen, White Queen; Blue Knight
Other drugs	Belladonna, Dopium, Green Crack, LSD, Opium
Star	Alpine Star, Dark Star, Dream Star, Morning Star, Sapphire Star, Sensi Star, Star Killer, Star Tonic

Purple Kush was sequenced (Van Bakel et al. 2011). The crossing of two strains—for example, Blue Dream with White Widow—results in a hybrid (Blue Widow). Natural product chemists have identified terpene differences between the Northern Lights and the Hawaiin Indica strains (Rothschild et al. 2005). However, the biological importance of the labels has been questioned by Sawler and colleagues (2015), who determined that a subset of medical and recreational cannabis had a genetic profile (i.e., *indica* versus *sativa*) that was inconsistent with the sample's label. The diversity of strains may allow for more personalized approach than is available with a one-size fits all substance like Marinol. Further, many patients regularly switch strains due to the development of tolerance. Patients with some conditions (e.g., epilepsy) may prefer low-THC; i.e., relatively non-psychoactive or high CBD varieties.

Much of the clinical research conducted on cannabinoids in the U.S. either involves pure THC or a research strain that contains a lower level of THC than is commonly employed. Because the strains that are used by MC patients have received limited empirical attention (Corral 2001; Elzinga et al. 2015; National Academy of Sciences 2017; Pearce, Mitsouras, and Irizarry 2014), the goals of this report were to: (1) determine how many strains, and their characteristics, are listed in a database commonly employed by MC patients; (2) describe which strains are employed by MC patients; and (3) identify any differences in the profile of patients using different strains.

Methods

This report includes examination and analysis of a publically available cannabis strain database (Study I) and an online survey of MC patients (Study II).

Study I

Procedures

The educational and commercial site leafly.com (headquartered in Seattle, Washington) was selected after discussion with dispensary staff and MC patients. This site reported receiving six million visits per month in 2015 (Tarantola 2015) and was used in an earlier investigation (Elzinga et al. 2015). Although this database is widely used in patient decisions, it is not clear the extent that genetic (Sawler et al. 2015; Van Bakel et al. 2011) or analytical chemistry (i.e., THC or CBD levels; ElSohly and Slade 2005) are incorporated into how strains are categorized or enumerated. Strains were listed as *C. sativa, C. indica*, or hybrid. While this terminology is employed clinically, botanists might

argue that there are very few pure *indica* or *sativa* strains. Strain names were entered into a spreadsheet. Items (N = 137) that were available as only a single preparation (i.e., vaporizer, dabs, or concentrates; for example, Liquid Gold Vape Pen Pink Lemonade or Golden XTRX CO_2 Dabbables) were removed. Strain names were further categorized based on whether one or more terms in their moniker had a gustatory or olfactory component (e.g., Sweet, Sour). "Blue" was interpreted as short for the popular strain Blueberry. For simplicity, the olfactory/gustatory theme will also be referred to as "taste." Similarly, strain names were coded for a geographical component to their label (e.g., Afghan/Aghani, African).

Data analysis

Strain characteristics to further quantitatively examine were identified by entering strain names into Wordle (http://www.wordle.net/), which represents word frequency by size. Non-parametric analyses were completed with two-tailed chi-square tests: http://graphpad.com/quickcalcs/contingency1.cfm .

Study II

Participants

The participants (N = 1,535) were members of dispensaries in the New England area, primarily from the Wellness Connection of Maine (1009 or 65.7%), but also the Champlain Valley Dispensary in Vermont (377 or 24.6%) and the Summit Medical Compassion Center in Rhode Island (149 or 9.7%). Dispensaries in Connecticut and Massachusetts elected not to participate because another online study was ongoing and dispensaries in New Hampshire were not yet operational. Additional information about this voluntary sample, including the response rate, is available elsewhere (Piper et al. 2017a, 2017b).

Procedures

An online survey (available from first author) consisting of forced choice and open-ended items was constructed based on discussions with dispensary staff, patients, and the peer-reviewed literature and entered into SurveyMonkey. Because the state laws that determine who is eligible for MC differ, slightly different versions of the survey were constructed for Maine, Vermont, and Rhode Island. The survey contained items about demographics, medical history, and MC preferences. Data collection was completed from August 2015 to April 2016, which was prior to the November 2016 recreational marijuana ballot initiatives in Maine and Massachusetts. All procedures were approved by the IRB of Husson University School of Pharmacy.

Data analysis

Strains were categorized as *indica, sativa,* or hybrids based upon the cannabis strain database Leafly (leafly.com) as of December 2016. Analyses were restricted to the subset of participants (N = 569), who listed at least one specific strain in response to two open-ended questions: "For the condition you were certified for, which strain(s) works best for you?" and "Please describe other strains you use and why." In the event that multiple strains were listed, only the top two strain preferences (primary and secondary) were included for analysis. If only one participant listed a preference for a specific strain, this was listed as an "other" in figures for simplicity. Open-ended comments were further examined to determine if there were any patterns regarding specific diseases (e.g., chronic pain, anxiety disorders, sleep disorders) with strains. Qualitative data were reported verbatim, including any typos or grammatical errors. Feedback was categorized as associated with a specific strain or a more general (non-strain) grouping. Open-ended responses to "How long did it take for you to find the correct route/dose/frequency/strain of medical cannabis?" were converted to days. Parametric statistics were completed with Systat, version 13.1. Non-parametric statistics were completed using chi-square without Yates correction or, if the N/cell was less than 5, Fischer's exact test with https://www.graphpad.com/quickcalcs/contingency1/.

Results

Study I

There were a total of 1,987 strains, of which over half (1,029 or 51.8%) were hybrids, one-quarter (576 or 29.0%) were *C. indicas,* and the remainder were *C. sativas* (382 or 19.2%). Of the potential themes in Table 1, examination of word frequency revealed that geographical (Kush, Hawaiian, Afghan) and taste (Sour, Skunk, various fruits) warranted further exploration. Ten strains contained the term "Poison" and eight contained "CBD." Labels for hybrid strains were more likely to include a taste component (36.2%) than *C. indica* strains (27.3%, $\chi^2(1)$ = 13.50, $p < .0003$). The difference between hybrids and *C. sativas* (31.2%) was not significant ($\chi^2(1)$ = 3.19, p = .07). Geographical labels were less frequent among hybrids (16.2%) relative to *sativas* (23.6%, $\chi^2(1)$ = 10.05, $p < .002$) or *indicas* (23.8%, $\chi^2(1)$ = 13.73, $p < .0003$).

Study II

Participant characteristics are shown in Table 2. Twice as many MC patients listed at least one strain in response to the question "For the condition you were certified for, which strain(s) works best for you?" from Maine (45.1%) compared to either Vermont (21.5%, $\chi^2(1)$ = 64.50, $p < .0001$) or Rhode Island (22.1%, $\chi^2(1)$ = 28.04, $p < .0001$). The subset of participants with a strain preference were middle-aged (mean = 44.9, SD = 13.5) and White (91.7%). Respondents that had not reported a strain preference were a half-decade older (mean = 49.9, SD = 14.0, $t(1,342)$ = 6.46, $p < .0005$) and were less likely to be White (84.1%, $\chi^2(1)$ = 18.21, $p < .0001$). Vermont respondents were, on average, a half-decade older than those from Maine ($t(485)$ = 2.88, $p < .005$). Less than half of Rhode Island participants resided in an area with a population of less than 50,000, which was below the three-quarters in Maine ($\chi^2(1)$ = 9.19, $p < .005$) or Vermont ($\chi^2(1)$ = 12.64, $p < .0005$). The majority of MC certifications were completed by physicians (i.e., MDs or DOs). However, non-physicians (i.e., nurse

Table 2. Demographic and characteristics of New England dispensary patients with a medical cannabis (MC) strain preference.

	Maine	Vermont	Rhode Island
N with a strain preference, N total completing study	455/1,009	81/377[M]	33/149[M]
% female	54.9%	56.8%	43.8%
Age (± SD)	44.1 (± 13.5)	49.0 (± 12.7)[M]	45.7 (± 14.0)
% non-White	8.8%	3.7%	12.1%
Reside in area with population <50,000	73.2%	81.5%	48.5%[M,V]
MC certificate issued by MD or DO	77.3%	86.4%	100.0%[M,V]
Duration certified to use MC (years, ± SEM)	1.5 (0.1)	1.4 (0.2)	3.1 (0.8)[M,V]
Preferred delivery method:			
Joint, pipe, or bong	58.5%	38.3%[M]	54.5%
Vaporizer	26.6%	23.5%	27.3%
Edibles	9.9%	14.8%	6.1%
Tincture	3.5%	19.8%[M]	0.0%[V]
Concentrates	1.5%	3.7%	12.1%
Amount spent on MC each week (± SEM)	$66.38 (2.79)	$79.04 (15.64)	$73.11 (13.01)
MC tolerance development (% yes)	42.3%	34.2%	35.5%
Side-effects of MC (% yes)	14.4%	21.0%	9.4%
Median duration (days) to find correct strain of MC (± SEM)	60.0 (50.1)	60.0 (47.2)	47.5 (43.7)

DO: Doctor of Osteopathic Medicine; MC: Medical Cannabis; MD: Medical Doctor; SD: Standard Deviation; SEM: Standard Error of the Mean. [M]$p < .05$ versus Maine; [V]$p < .05$ versus Vermont.

practitioners or physician assistants) were more likely to provide the certification in Vermont and Maine. Intractable or chronic pain was the primary condition that MC patients were certified for in Maine (63.2%) and Rhode Island (87.8%). Note that pain was added as an approved condition to join the Vermont marijuana registry after this study was completed. Three-fifths of respondents reported that they had back or neck pain (60.3%), almost one-third reported neuropathic pain (29.2%), while pain following trauma (18.6%) or surgery (16.5%), and abdominal pain (13.5%) were less frequent, and cancer pain was uncommon (1.9%). Post-traumatic stress disorder was a certifying condition for over-quarter (26.4%) of Maine participants, but none from other states.

There were a wide variety of responses to "How long did it take for you to find the correct route/dose/frequency/strain of medical cannabis?" One-third (34.4%) were non-quantitative or could not readily be converted into numeric information (e.g., "fairly quickly"), although most expressed some degree of frustration (e.g., "still learning," "I'm not there," or "six months and the search continues"). One respondent noted:

Still working on it. The problem is, there are no medical personnel who have any experience yet as to what one should take for their particular illness. I'm going through that right now and am overwhelmed because there are

so many varieties and types it could take me forever to come up with a plan.

However, there was also sporadic feedback expressing appreciation to the staff of their dispensaries for educating them on this process. In Vermont, there were frequent comments about the limited availability of strains. A minority (11.1%) of respondents skipped this item entirely. Table 2 compares each state on this measure. Overall, 15.9% took less than one week but 9.8% took one year or longer. Over one-third of participants in each state reported that they had developed a tolerance to the benefits of MC.

Two-thirds of Rhode Island MC patients listed a hybrid strain as their primary preference, which was greater than either Maine ($\chi^2(1) = 5.61$, $p < .05$) or Vermont ($\chi^2(1) = 5.43$, $p < .05$). Figure 1 depicts the first-choice strain preference and shows that each state's dispensary had their own offerings which were preferred by patients. There was no overlap between the top 10 strains in Vermont with either Maine or Rhode Island. However, Blue Dream was the second most preferred strain in Maine (14.9%) and Rhode Island (9.1%). Headband was ranked fourth in Maine (9.7%) and sixth in Rhode Island (6.1%).

Open-ended feedback was examined to determine if there were any strains that were most beneficial for a particular disease or if there were any other patient
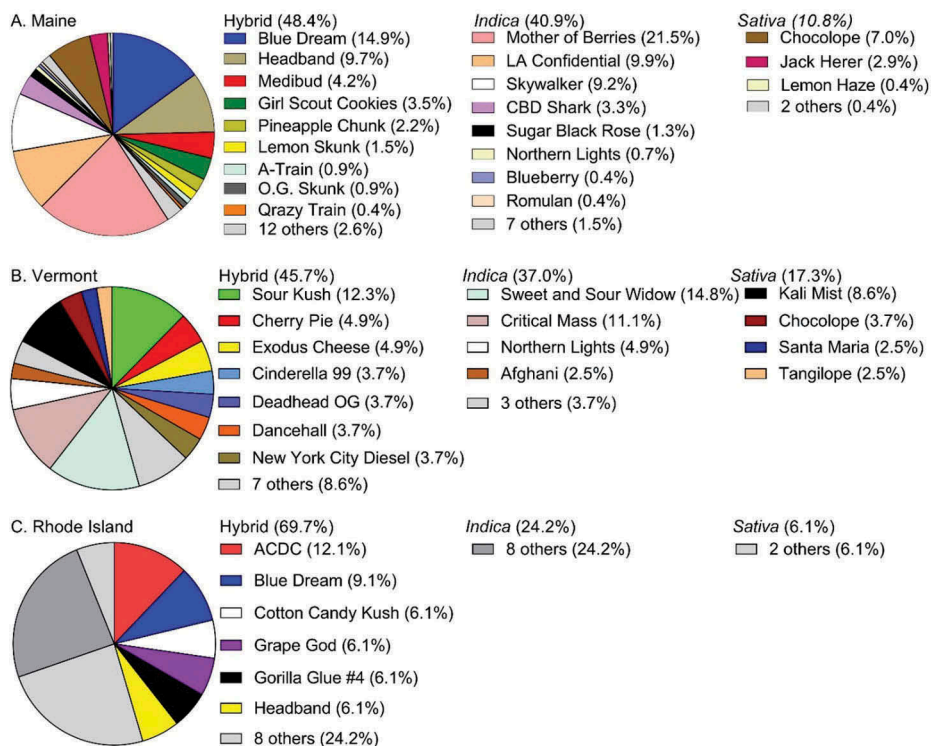
Figure 1. First-choice strain preference among medical cannabis patients in Maine (A, $N = 455$), Vermont (B, $N = 81$), and Rhode Island (C, $N = 33$).

insights. Many respondents mentioned that they had developed a time-dependent pattern with a *sativa* strain use during the day and an *indica* strain for nighttime use and for enhancing sleep. For example:

> The strain Blueberry and Blue Dream both work well for me, one is a primarily Indica (Blueberry) and the other is a primarily Sativa (Blue Dream) and both work well in different ways for the pain. The Indica dominant strain is better for later at night when I may need to try get relief before going to sleep. The Sativa is better for pain management during the day when I need to maintain a clearer head.

There was not a single strain that MC patients uniformly found useful for a disease or condition. However, there were some indications (Table 3) where certain strains were more frequently mentioned (e.g., Blue Dream and Mother of Berries (MOB) for pain; Medibud and Blue Dream for PTSD, MOB for sleep).

Discussion

The first objective of this report—to quantify the number of cannabis strains—revealed that there are almost 2,000 strains. Nationally, there are a tremendous abundance of options available for recreational and medical purposes and more strains are added on a weekly basis. In comparison, over 200 strains are available from licensed producers (Maida and Daeninck 2016). Given the legal prohibitions for marijuana (i.e., strain names are not linked to single producer), inclusion of geographic information has been a common element of the labels. However, taste was an even more frequent theme. The perception of "taste" results from a combination of gustatory and olfactory senses. There are many strains whose labels include core gustatory components of sweet (e.g., Sweet Tooth, Sweet Berry, Sugar Cookie) and sour (Sour Apple, Sour Kush, Sour Lemon O.G.), whereas saltiness, bitter, and umami were less well-represented. The terpenoid nerolidol has an orange aroma (Russo 2011) and there are 18 strains with the orange moniker. Other terpenoids whose scents correspond with strain labels include limonene (lime: nine strains) and α-pinene (pine: six strains). Although the preponderance of neurobiological research on the active components of cannabis has focused on the cannabinoids, particularly THC and CBD, the olfactory components feature prominently in the strain labels and the cannabis user's experience. Of note, a subset of strains contained the term "poison," which may suggest bitterness and be of interest to sensory neuroscientists (Reed and Knaapila 2010). Medical chemists interested in developing an alternative to botanical products might find that inclusion of a terpenoid would enhance the user's experience and might be more successful than dronabinol.

Some of the currently employed strain labels may have an extensive history but, as medical and recreational use continues to become more condoned, there is room for reorganization in conjunction with standardization of cannabinoid and terpenoid levels. Although explicit or unsavory (e.g., Agent Orange) labels may make memorable descriptors, less inflammatory terms could have more widespread appeal among the general public as well as health care providers who are interested in further cannabis information. The legal teams of large corporations might not be enthusiastic if dispensaries were distributing a product that shares their trademarked label (e.g., "Big Mac," "Jolly Rancher," or "Cracker Jack") (Deggins 1947). These challenges may have prompted Connecticut to abandon the current nomenclature and develop their own (Rahn 2015). Substantial changes like these may be necessary because reliance on the external plant appearance may be a non-optimal strategy for cannabis categorization. Principle component analysis of the cannabinoids and terpenoids of almost 500 MC samples even challenges a clear demarcation between sativa and indica strains (Elzinga et al. 2015).

The second objective of this study was to describe which strains are employed by MC patients. The 500 participants that listed strains were selected from among a larger pool ($N \approx 1,500$) and may be representative of more experienced and knowledgeable MC patients. A general pattern of approximately half of MC patients preferring hybrids, two-fifths choosing *indicas*, and the remaining 10% selecting *sativas* was identified, although some state differences were noted. State level statistical comparisons should be interpreted with caution as only one dispensary, or dispensary system, participated in this project in each state. Given that there are thousands of strains currently available (Study I), enough that it would take a motivated patient trying one strain each day over five years, and that each dispensary, particularly in rural areas with a finite customer base, can only grow and distribute a limited number, our finding that the strains preferred in one state (e.g., Sweet and Sour Widow in Vermont) showed limited overlap with those in other areas (e.g., M.O.B. in Maine) may be expected. However, the volume of strains, the ease and potential to develop new ones, and the alternative labels for the same strains (e.g., Blue Widow is also known by as White Berry, Blue Venom or Berry White) have created some frustration among a subset of patients in that it may take them an extended period to either find an

Table 3. Open-ended comments among medical cannabis patients that mentioned specific diseases or disorders.

Crohn's Disease	
General:	"Indica strains in general work better to ease my Crohn's disease & IBS symptoms." "Indicas help to mellow me out and calm down, ease the chronic pain, and give me an appetite too as weight loss with Crohns is a huge issue for me."
Fibromyalgia	
General:	"Sativa dominant strains help a lot with inflammation, which is a part of the chronic knee and lower back pain that are symptoms of osteoarthritis and fibromyalgia."
Strains:	"Some of the most efficacious strains I have found for managing my Fibromyalgia are: White Widow, Blueberry, Kush (Bubba, O.G., Fruity hybrids), Dutch Treat, New York City Diesel, Headband," "O.G. Skunk is one of my favorite"
Multiple Sclerosis	"Indica heavy strains work best for chronic pain, weak muscles, sleep issues." (M.O.B. & Pineapple Chunk) Hybrids with some sativa work best for cognitive issues and fighting fatigue. (headband)"
Pain	
General:	"Have found most strains work for nerve pain... some last longer... high indica not as effective," "I haven't any one strain that is better than another for the pain. I switch around to check all the available strains." "For stomach pain edibals work the best but smoking is more affordable and dulls pain," "Sativa, for during the day, when my back is stiff and uncomfortable."
A-train[h]:	"A-Train for strong pain relief with enough sativa to allow for daytime use."
Blue Dream[h]:	"Blue Dream MOB Indica edibles for greatest pain relief," "Blue dream seems to work well for my pain," "The Blue Dream, though sativa dominant, is what I most often consume for chronic pain. It may not relieve pain as well as some indica-dominant strains, but Blue Dream gave me my life back. It dulls the pain, plus the saliva in it makes me feel, 'pain? Who cares about pain?'" "Blue Dream pain during the day," "Blue Dream is my go to because I feel as if I can still function while high and not be useless and it helps my anxiety and not just my pain." "I prefer to use Blue Dream for pain," "Blue Dream helps for the migraines."
CBD Shark[i]	"CBD shark shock for pain relief with a clearer head than others." "cbd shark for pain."
Charlotte's Web[s]	"Charlotte's Web, Shark Shock, Headband all help with pain."
Chocolope[s]	"I like chocolope when I need a little extra energy to get things done when I am in pain." "Chocolope (as well as medibud) for its uplifting and energetic effects. It helps dull pain without 'zombifying' me," "Chocolope, it relieves pain and relaxes me after work without making me drowsy," "Chocolope for pain relief and adrenaline boost for daytime use."
Critical Mass[i]	"Critical Mass (indica) tincture for pain"
Headband[h]	"I like headband, and it is a daytime medication. It works for my pain, but doesn't make me want to lay down and take a nap." "Headband gives pain relief and after about 2 hrs it helps me sleep." "Headband allows me relief without making me tired or stoned"
Kali Mist[s]	"The Kali Mist tincture is by far the best daytime pain relief," "Kali Mist relives daytime pain."
Kosher Kush[i]	"Kosher Kush has been the best at relieving pain."
LA Confidential[i]	"LA Confidential for sleep and really bad pain," "LA Confidential for pain," "LA Confidential for pain relief and relaxation for bedtime use."
Medibud[h]	"Medi Bud for overall day pain management," "Medibud provides great pain relief," "Medi bud is excellent. It has an almost numbing effect for me and enables immediate relief to a more tolerable level of pain." "Medibud... it's good, it's mild, can still function and work, but it helps relax the pain in my back"
M.O.B.[i]	"M.O.B. has been wonderful for insomnia and pain," "M.O.B. Mother of Berries is working good for me at night with my PTSD," "MOB best for pain," "M.O.B. for intense pain and sleep," "Mother of berry works best in the evening, helps very much with pain and makes me sleepy." "I really like MOB and Blue Dream for pain." "The only strain that works for my nerve pain is the only purp strain available through my dispensary which is MOB," "MOB is the only strain my dispensary has that works on the nerve pain for my body. I have tried them all. It has been very specific."
Pineapple Chunk[h]	"For migraine and neck pain I prefer pineapple chunk," "Pineapple Chunk works wonders when I need to settle myself in for sleep. I find it relaxes my muscles enough to allow me to sleep."
Skywalker Kush[i]	"For the best pain relief I use a strain called Skywalker Kush, but any indica small flower works great"
Sugar Black Rose[i]	"It works well for my pain. Doesn't make me look high and it doesn't make me act funny." "I also find that indica works for my pain, favorite strain 'sugar black rose'"
Super Skunk[i]	"Super Skunk... Pain relief without tiredness"
Super Sour Skunk[h]	"A great hybrid for pain is Super Sour Skunk... it works well for me for daytime pain."
Trainwreck[h]	"Trainwreck takes pain away."
Sensi Star[i]	"I used sensi star at night to sleep through with no knee pain."
Sweet & Sour Widow[i]	"Sweet and sour widow, and oil vape pens, and cartridges for chronic pain.", "Sweet and Sour Widow...effective at painmanagement."
White Widow[h]	"I find white widow to be a great painkiller."
PTSD	
General:	"Indica dominant hybrids help my anxiety, PTSD and sleep issues," "indica is much better than sativa for PTSD anxiety, as sativa can causing a racing heartbeat about an hour after ingestion, which can increase anxiety."
A-Train[h]	"Another strain that is quite helpful for both (pain and PTSD) is A-Train," "A train for ptsd."
Blue Dream[h]	"Blue dream works best," "Blue Dream for PTSD," "I am also using Blue Dream to help with my PTSD, Anxiety and Depression during the day."
Girl Scout Cookies[h]	"Any kush or girl scout cookies really work for my anxiety and PTSD."
Lemon Skunk[h]	"Lemon Skunk definitely felt it helped with anxiety and depression," "The most helpful strains for my PTSD so far have been: Lemon skunk Pineapple chunk Sugar black rose M.O.B Headband."
Medibud[h]	"During the day I like Medibud if I am going to be out in public places where there will be other people, I find it allows me to stay calm and I dont feel so anxious," "High CBD strains like Medibud and Grape Ox are two favorites. They... ease my PTSD so I can sleep well," "I've found Medibud to be rather effective."
M.O.B.[i]	"M.O.B. works well for ptsd and anxiety," "Currently M.O.B. Mother of Berries is working good for me at night with my PTSD." "Ptsd mother of berry, Skywalker kush, LA confidential."
Sleep	
General:	"For the sleep apnea, the indica strains are definitively superior." "Indica works great for being able to sleep and almost completely eliminates my restless leg syndrome." "Indica it helps me sleep and prevents bad dreams," "I don't believe there is any real difference between the various strains in regards to treating medical symptoms. The real difference is between Sativa and Indica. Sativa seems to work best on depression and lethargy. Indica seems to work best on relieving pain, helping to sleep, and nausea."

Table 3. (Continued).

Crohn's Disease	
LA Confidential[i]	"LA Confidential works best for my insomnia." "L.A. confidential helps me go to sleep."
M.O.B.[i]	"M.O.B. has been wonderful for insomnia and pain," "When I'm in some serious pain and can't sleep, I like the MOB. It helps my body relax." "For sleep and pain, I have found that M.O.B works best as a strain for vaporizing (indica) and an indica salve works best for pain," "M.O.B. at night in order to sleep." "MOB—mainly for sleep, as the medication I take disrupts my sleep."
Northern Lights[i]	"Northern lights and Cherry Pie is good for relaxation and helps promote sleep."
Sugar Black Rose[i]	"Sugar Black Rose initially to aid sleep. Then A-Train and now Blue Dream to help get moving." "Sugar rose will help with sleep."

For diseases with multiple mentions, comments were divided into a general (i.e., not listing a specific strain) and strain specific categories. [i]*Cannabis indica*, [s]*Cannabis sativa* or [h]hybrid strain according to leafly.com.

M.O.B.: Mother of Berries; O.G.: Original Gangster; PTSD: Post-Traumatic Stress Disorder.

optimal strain or, if tolerance develops, to identify a secondary option.

The third objective of this report was to determine if particular strains are perceived as more effective for particular conditions. The findings that emerged (Blue Dream for chronic pain, Medibud for PTSD, and M.O.B. for sleep) should be viewed as extremely tentative and verified with larger samples, ideally using electronic medical records to complement the self-reported diagnoses and retrospective design of this report. The records of dispensaries may also provide a data source for future longitudinal research.

The multitudes of currently available strains are a double-edged sword. There is tremendous potential for precision medicine with the strain(s) and route(s) of administration being tailored to a specific patient with multiple health conditions. For example, a veteran with chronic pain following a combat injury and PTSD with sleep difficulties could receive different strains than a chemotherapy patient whose goal is to improve appetite. On the other hand, the volume of strains could result in an extended search period (months or years) and significant expense not covered by insurance. As additional U.S. states (e.g., Florida, Ohio, and Pennsylvania) and countries (e.g., Australia and Jamaica) implement their own MC programs, there is a continuum of options available. On one extreme, the Netherlands makes only five strains available by prescription from pharmacies. The strains have known concentrations of THC (< 1% to ≈22%) and CBD (< 1% to 9%) and are provided by a single company (Office of Medical Cannabis 2017). Importantly, one-third of the concentrates submitted to a California testing facility by MC patients had detectible levels of pesticides (Raber, Elzinga, and Kaplan 2015), which reinforces the importance of pharmaceutical standards for MC production. The Dutch model may avoid the volumes of strain options available in other areas (e.g., Canada; Maida and Daeninck 2016), which characterizes the other extreme of the spectrum. However, a lack of choices may result in MC patients returning to the black market for marijuana if

tolerance develops. Further, an emphasis on standardization based on THC and CBD may neglect the understudied role of terpenoids like limonene and β-pinene (Andre, Hausman, and Guerriero 2016; Rothschild, Bergstrom, and Wangberg 2005) in the therapeutic profile of MC strains.

Study limitations include that the strains reported are based on the options currently available to U.S. consumers. A limitation of Study I is that it is based on the information contained in a widely used database. The validity of this database relies on expert opinion regarding this quasi-legal plant, but additional study using more empirically grounded resources is needed. Further, there is some subjectivity inherent in the theme analysis (e.g., does the term "screwdriver" refer to the tool or to the colloquial term for a citrus containing beverage). The cannabis subculture may use terms in ways that were unfamiliar to the author. Quantification of the number of strains available is likely an underestimate, as this is continually expanding and further research on different cannabis formations, particularly edibles, is necessary. Some argue that the *indica/sativa* dichotomy is not informative and that a more useful approach would be to quantify the cannabinoids and terpenes (Casano et al. 2011; Piomelli and Russo 2016). Examination of the samples submitted by MC patients in California revealed that some strains (e.g., Velvet Kush) had a high degree of consistency in their THC content while others (e.g., O. G. Kush) differed by five-fold (Elzinga et al. 2015). Data like this raise the possibility that, based on the medical and recreational cannabis products available in the U.S., the indica/sativa dichotomy is meaningless. Plant morphology provides little, if any, information about the quantity of THC, CBD, or terpenes. Further, the technology exists to employ genetic clones to ensure that each generation of MC for each "strain" is genetically identical, but it is unclear whether this is a uniform practice across New England. Strain preference is the result of a variety of factors which are not

limited to efficacy but may also include any potential recreational experiences, and information provided by other patients, online sources (Pearce, Mitsouras, and Irizarry 2014), or dispensary staff (Haug et al. 2016). Strain availability may be influenced by the dispensary, as there are limited number of dispensaries operating in rural areas. Financial considerations are also crucial, as MC patients may suffer from conditions like chronic pain or psychiatric disorders which may adversely impact their employment options. There are anecdotal reports from the western U.S. that the veracity of strain labels may be suspect as dispensaries have manipulated labels for marketing purposes. Future research conducted after genetic or biochemical verification of the strains becomes a standard practice is necessary to extend, or challenge, the reported results as the foundation of these studies (i.e., the patient's knowledge of the strain in their possession) may be questionable (Sawler et al. 2015). There are no agreed-upon standards or enforced regulations for what constitutes a MC strain or its label (Hazekamp, Tejkolova, and Papadimitriou 2016). The vernacular employed by patients is only loosely connected to that used by botanists and this study is only an incremental step towards overcoming this siloing. The clandestine history of marijuana in conjunction with dozens of states implementing unique and disconnected programs has created barriers to achieving the full therapeutic potential of MC, which will require greater standardization of the strains that patients find most efficacious.

The investigations reported here may be of value to patients and providers attempting to optimize treatments for a variety of common conditions, including chronic pain. Future efforts by natural product chemists and geneticists, coupled with the input of dispensary staff and controlled trials with experienced users, could improve standardization of strains, and strain databases, as well as the optimization of those which are most likely to be beneficial for patients.

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Conflict of interest

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