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(54) Title: USE OF CANNABINOIDS IN THE TREATMENT OF SEIZURES ASSOCIATED WITH LENNOX-GASTAUT SYNDROME

(57) Abstract: The present invention relates to the use of cannabidiol (CBD) in the treatment of patients with Lemnox-Gastaut syndrome (LGS) who are deemed to be treatment failures on their existing medication. In particular the use of CBD was found to provide a statistically significant reduction in both drop seizures and total seizure frequency in patients who have tried and failed anti-epileptic drugs (AEDs) or those who were currently taking AEDs but have uncontrolled seizures. Preferably the AEDs which have been shown to be treatment failures are one or more of rufinamide, lamotrigine, topiramate and / or felbamate. Preferably the CBD used is in the form of a highly purified extract of cannabis such that the CBD is present at greater than 98% of the total extract (w/w) and the other components of the extract are characterised. In particular the cannabinoid tetrahydrocannabinol (THC) has been substantially removed, to a level of not more than 0.15% (w/w) and the propyl analogue of CBD, cannabidivarin, (CBDV) is present in amounts of up to 1%. Alternatively, the CBD may be a synthetically produced CBD.



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USE OF CANNABINOIDS IN THE TREATMENT OF SEIZURES ASSOCIATED WITH
LENNOX-GASTAUT SYNDROME

FIELD OF THE INVENTION

5 [0001] The present invention relates to the use of cannabidiol (CBD) in the treatment of patients with Lennox-Gastaut syndrome (LGS) who are deemed to be treatment failures on their existing medication. In particular the use of CBD was found to provide a statistically significant reduction in both drop seizures and total seizure frequency in patients who have tried and failed anti-epileptic drugs (AEDs) or those who were currently taking AEDs but have
10 uncontrolled seizures.

[0002] Preferably the AEDs which have been shown to be treatment failures are one or more of rufinamide, lamotrigine, topiramate and / or felbamate.

[0003] Preferably the CBD used is in the form of a highly purified extract of cannabis such that the CBD is present at greater than 98% of the total extract (w/w) and the other components
15 of the extract are characterised. In particular the cannabinoid tetrahydrocannabinol (THC) has been substantially removed, to a level of not more than 0.15% (w/w) and the propyl analogue of CBD, cannabidivarin, (CBDV) is present in amounts of up to 1%. Alternatively, the CBD may be a synthetically produced CBD.

20 BACKGROUND TO THE INVENTION

[0004] Epilepsy occurs in approximately 1% of the population worldwide, (Thurman *et al.*, 2011) of which 70% are able to adequately control their symptoms with the available existing anti-epileptic drugs (AEDs). However, 30% of this patient group, (Eadie *et al.*, 2012), are unable to obtain seizure freedom from the AED that are available and as such are termed as suffering
25 from intractable or "treatment-resistant epilepsy" (TRE).

[0005] Intractable or treatment-resistant epilepsy was defined in 2009 by the International League Against Epilepsy (ILAE) as "*failure of adequate trials of two tolerated and appropriately chosen and used AED schedules (whether as monotherapies or in combination) to achieve sustained seizure freedom*" (Kwan *et al.*, 2009).

30 [0006] Individuals who develop epilepsy during the first few years of life are often difficult to treat and as such are often termed treatment-resistant. Children who undergo frequent seizures in childhood are often left with neurological damage which can cause cognitive, behavioral and motor delays.

[0007] Childhood epilepsy is a relatively common neurological disorder in children and
35 young adults with a prevalence of approximately 700 per 100,000. This is twice the number of epileptic adults per population.

[0008] When a child or young adult presents with a seizure, investigations are normally undertaken in order to investigate the cause. Childhood epilepsy can be caused by many different syndromes and genetic mutations and as such diagnosis for these children may take some time.

5 **[0009]** The main symptom of epilepsy is repeated seizures. In order to determine the type of epilepsy or the epileptic syndrome that a patient is suffering from, an investigation into the type of seizures that the patient is experiencing is undertaken. Clinical observations and electroencephalography (EEG) tests are conducted and the type(s) of seizures are classified according to the ILAE classification described below.

10 **[0010]** The International classification of seizure types proposed by the ILAE was adopted in 1981 and a revised proposal was published by the ILAE in 2010 and has not yet superseded the 1981 classification. The 2010 proposal for revised terminology includes the proposed changes to replace the terminology of partial with focal. In addition, the term “simple partial seizure” has been replaced by the term “focal seizure where awareness / responsiveness is not
15 impaired” and the term “complex partial seizure” has been replaced by the term “focal seizure where awareness / consciousness is impaired”.

[0011] Generalised seizures, where the seizure arises within and rapidly engages bilaterally distributed networks, can be split into six subtypes: Tonic-Clonic (grand mal) seizures; Absence (petit mal) Seizures; Clonic Seizures; Tonic Seizures; Atonic Seizures and
20 Myoclonic Seizures.

[0012] Focal (partial) seizures where the seizure originates within networks limited to only one hemisphere, are also split into sub-categories. Here the seizure is characterized according to one or more features of the seizure, including aura, motor, autonomic and awareness / responsiveness. Where a seizure begins as a localized seizure and rapidly evolves to be
25 distributed within bilateral networks this seizure is known as a Bilateral convulsive seizure, which is the proposed terminology to replace Secondary Generalised Seizures (generalized seizures that have evolved from focal seizures and are no longer remain localized).

[0013] Epileptic syndromes often present with many different types of seizure and identifying the types of seizure that a patient is suffering from is important as many of the
30 standard AEDs are targeted to treat or are only effective against a given seizure type / sub-type.

[0014] One such childhood epilepsy syndrome is Lennox-Gastaut syndrome (LGS). LGS is a severe form of epilepsy, where seizures usually begin before the age of 4. Seizure types, which vary among patients, include tonic (stiffening of the body, upward deviation of the eyes, dilation of the pupils, and altered respiratory patterns), atonic (brief loss of muscle tone and
35 consciousness, causing abrupt falls), atypical absence (staring spells), and myoclonic (sudden

muscle jerks). There may be periods of frequent seizures mixed with brief, relatively seizure-free periods.

[0015] Seizures in LGS are often described as “drop seizures”. Such drop seizures are defined as an attack or spell (atonic, tonic or tonic-clonic) involving the entire body, trunk or

5 head that led or could have led to a fall, injury, slumping in a chair or hitting the patient’s head on a surface.

[0016] Most patients with LGS experience some degree of impaired intellectual functioning or information processing, along with developmental delays, and behavioural disturbances.

[0017] LGS can be caused by brain malformations, perinatal asphyxia, severe head injury, 10 central nervous system infection and inherited degenerative or metabolic conditions. In 30-35% of cases, no cause can be found.

[0018] The first line treatment for drop seizures, including the treatment of drop seizures in patients with LGS, usually comprises a broad-spectrum AED, such as sodium valproate often in combination with rufinamide or lamotrigine. Other AEDs that may be considered include

15 felbamate, clobazam and topiramate.

[0019] AEDs such as carbamazepine, gabapentin, oxcarbazepine, pregabalin, tiagabineor and vigabatrin are contra-indicated in drop seizures.

[0020] Common AEDs defined by their mechanisms of action are described in the following tables:

20 **[0021] Table 1. Examples of narrow spectrum AEDs**

Narrow-spectrum AED	Mechanism	Indication
Phenytoin	Sodium channel	Complex partial Tonic-clonic
Phenobarbital	GABA / Calcium channel	Partial seizures Tonic-clonic
Carbamazepine	Sodium channel	Partial seizures Tonic-clonic Mixed seizures
Oxcarbazepine	Sodium channel	Partial seizures Tonic-clonic Mixed seizures
Gabapentin	Calcium channel	Partial seizures Mixed seizures

Pregabalin	Calcium channel	Adjunct therapy for partial seizures with or without secondary generalisation
Lacosamide	Sodium channel	Adjunct therapy for partial seizures
Vigabatrin	GABA	Secondarily generalized tonic-clonic seizures Partial seizures Infantile spasms due to West syndrome

[0022] Table 2. Examples of broad spectrum AEDs

Broad-spectrum AED	Mechanism	Indication
Valproic acid	GABA / Sodium channel	First-line treatment for tonic-clonic seizures, absence seizures and myoclonic seizures Second-line treatment for partial seizures and infantile spasms. Intravenous use in status epilepticus
Lamotrigine	Sodium channel	Partial seizures Tonic-clonic Seizures associated with Lennox-Gastaut syndrome
Ethosuximide	Calcium channel	Absence seizures
Topiramate	GABA / Sodium channel	Seizures associated with Lennox-Gastaut syndrome
Zonisamide	GABA / Calcium /Sodium channel	Adjunctive therapy in adults with partial-onset seizures Infantile spasm

		Mixed seizure Lennox-Gastaut syndrome Myoclonic Generalised tonic-clonic seizure
Levetiracetam	Calcium channel	Partial seizures Adjunctive therapy for partial, myoclonic and tonic-clonic seizures
Clonazepam	GABA	Typical and atypical absences Infantile myoclonic Myoclonic seizures Akinetic seizures
Rufinamide	Sodium channel	Adjunctive treatment of partial seizures associated with Lennox-Gastaut syndrome

[0023] Table 3. Examples of AEDs used specifically in childhood epilepsy

AED	Mechanism	Indication
Clobazam	GABA	Adjunctive therapy in complex partial seizures Status epilepticus Myoclonic Myoclonic-absent Simple partial Complex partial Absence seizures Lennox-Gastaut syndrome
Stiripentol	GABA	Severe myoclonic epilepsy in infancy (Dravet syndrome)

[0024] The present invention describes surprising data from two placebo-controlled studies of CBD as treatment for seizures associated with LGS. The CBD was used as add-on treatment

in patients who were defined as treatment-resistant. Patients had previously tried and stopped using (failed) a median of 6 AEDs, and were being maintained on a median of 3 AEDs.

[0025] Despite this intensive treatment regimen, the median number of drop seizures at baseline was in excess of 75 per month in both studies. These were patient populations with a high unmet medical need, who had already tried and failed multiple AEDs. In many cases, the AEDs they were being maintained on included those approved for the treatment of LGS; rufinamide, lamotrigine or topiramate.

[0026] The data collected on patients who were deemed to be treatment failures to one or more of the existing approved drugs for LGS showed that the use of CBD in combination with these medications resulted in a statistically significant reduction in both drop seizures and total seizure frequency.

[0027] In August 2017, Gaston *et al.* described that when CBD was administered to patients with epilepsy in an open label study, it was found that the serum levels of some AEDs increased in the presence of CBD. The study did not find that such an increase resulted in a reduction of seizures in patients that had been deemed to be treatment failures.

BRIEF SUMMARY OF THE DISCLOSURE

[0028] In accordance with a first aspect of the present invention there is provided cannabidiol (CBD) for use in the treatment of seizures associated with Lennox-Gastaut syndrome (LGS) characterised in that the LGS patients are deemed to be a treatment failure on one or more anti-epileptic drugs (AEDs).

[0029] Preferably the one or more AEDs is taken from rufinamide; lamotrigine; topiramate; and / or felbamate.

[0030] Preferably the CBD is in the form of a highly purified extract of cannabis which comprises at least 98% (w/w) CBD. Alternatively, the CBD is present as a synthetic compound.

[0031] Preferably the extract comprises less than 0.15% THC. More preferably the extract further comprises up to 1% CBDV.

[0032] Preferably the dose of CBD is below 50 mg/kg/day, more preferably below 30 mg/kg/day, more preferably still the dose of CBD is 20 mg/kg/day or greater, more preferably still the dose of CBD is 10 mg/kg/day or greater.

[0033] In accordance with a second aspect of the present invention there is provided a method of treating seizures associated with Lennox-Gastaut syndrome (LGS) comprising administering cannabidiol (CBD) to a subject diagnosed with LGS who are deemed to be a treatment failure.

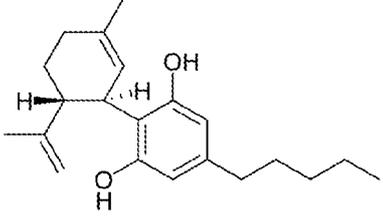
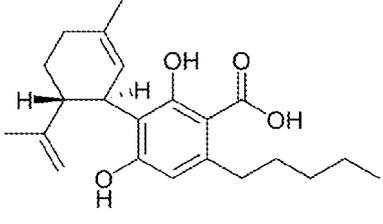
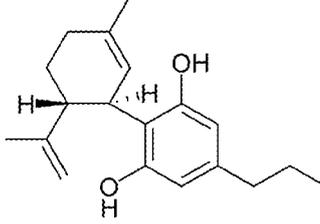
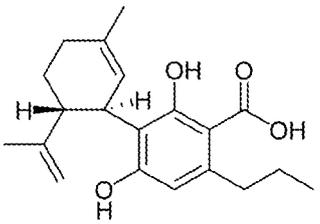
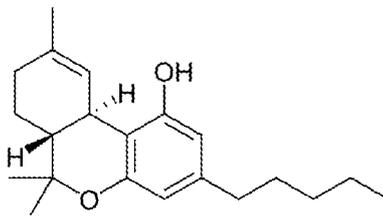
[0034] Preferably the subject is a human.

DEFINITIONS

[0035] Definitions of some of the terms used to describe the invention are detailed below:

- 5 [0036] The cannabinoids described in the present application are listed below along with their standard abbreviations.

Table 4. Cannabinoids and their abbreviations

CBD	Cannabidiol	
CBDA	Cannabidiolic acid	
CBDV	Cannabidivarin	
CBDVA	Cannabidivarinic acid	
THC	Tetrahydrocannabinol	

[0037] The table above is not exhaustive and merely details the cannabinoids which are identified in the present application for reference. So far over 60 different cannabinoids have been identified and these cannabinoids can be split into different groups as follows:

5 Phytocannabinoids; Endocannabinoids and Synthetic cannabinoids (which may be novel cannabinoids or synthetically produced phytocannabinoids or endocannabinoids).

[0038] “Phytocannabinoids” are cannabinoids that originate from nature and can be found in the cannabis plant. The phytocannabinoids can be isolated from plants to produce a highly purified extract or can be reproduced synthetically.

10 **[0039]** “Highly purified cannabinoid extracts” are defined as cannabinoids that have been extracted from the cannabis plant and purified to the extent that other cannabinoids and non-cannabinoid components that are co-extracted with the cannabinoids have been substantially removed, such that the highly purified cannabinoid is greater than or equal to 98% (w/w) pure.

[0040] “Synthetic cannabinoids” are compounds that have a cannabinoid or cannabinoid-like structure and are manufactured using chemical means rather than by the plant.

15 **[0041]** Phytocannabinoids can be obtained as either the neutral (decarboxylated form) or the carboxylic acid form depending on the method used to extract the cannabinoids. For example, it is known that heating the carboxylic acid form will cause most of the carboxylic acid form to decarboxylate into the neutral form.

20 **[0042]** “Treatment-resistant epilepsy” (TRE) or “intractable epilepsy” is defined as per the ILAE guidance of 2009 as epilepsy that is not adequately controlled by trials of one or more AED.

[0043] “Childhood epilepsy” refers to the many different syndromes and genetic mutations that can occur to cause epilepsy in childhood. Examples of some of these are as follows: Dravet Syndrome; Myoclonic-Absence Epilepsy; Lennox-Gastaut syndrome; Generalized
25 Epilepsy of unknown origin; CDKL5 mutation; Aicardi syndrome; tuberous sclerosis complex; bilateral polymicrogyria; Dup15q; SNAP25; and febrile infection related epilepsy syndrome (FIRES); benign rolandic epilepsy; juvenile myoclonic epilepsy; infantile spasm (West syndrome); and Landau-Kleffner syndrome. The list above is non-exhaustive as many different childhood epilepsies exist.

30 **[0044]** “Drop seizures” are defined as a seizure involving the entire body, trunk or head that led or could have led to a fall, injury, slumping in a chair or hitting the patient’s head on a surface. Seizure types classed as resulting in a drop seizure are atonic, tonic or tonic-clonic seizures.

[0045] “Treatment failure” is defined as patients who were currently taking an AED but continued to have uncontrolled seizures, or had previously taken and stopped treatment with an AED due to lack of efficacy in controlling seizures.

5 **DETAILED DESCRIPTION**

PREPARATION OF HIGHLY PURIFIED CBD EXTRACT

[0046] The following describes the production of the highly-purified (>98% w/w) cannabidiol extract which has a known and constant composition was used in the Examples below.

[0047] In summary the drug substance used is a liquid carbon dioxide extract of high-CBD containing chemotypes of *Cannabis sativa* L. which had been further purified by a solvent crystallization method to yield CBD. The crystallisation process specifically removes other cannabinoids and plant components to yield greater than 98% CBD. Although the CBD is highly purified because it is produced from a cannabis plant rather than synthetically there is a small number of other cannabinoids which are co-produced and co-extracted with the CBD. Details of these cannabinoids and the quantities in which they are present in the medication are as described in Table 5 below.

[0048] **Table 5: Composition of highly purified CBD extract**

Cannabinoid	Concentration
CBD	> 98% w/w
CBDA	NMT 0.15% w/w
CBDV	NMT 1.0% w/w
Δ^9 THC	NMT 0.15% w/w
CBD-C4	NMT 0.5% w/w

> – greater than

NMT – not more than

20 **EXAMPLE 1: EFFICACY OF CANNABIDIOL IN THE TREATMENT OF LENNOX-GASTAUT SYNDROME (LGS) IN PATIENTS DEEMED TO BE ANTI-EPILEPTIC DRUG (AED) TREATMENT FAILURES**

25 [0049] Currently only four products have been authorised in the EU for the treatment of LGS. These medications are rufinamide, lamotrigine, topiramate and felbamate. Details of these can be found in Table 6 below.

[0050] **Table 6: Summary of Approved Treatment Options for Lennox-Gastaut Syndrome**

Treatment	Authorisation in the EU	Licensed use in LGS (www.medicines.org.uk or EMA Website)
Rufinamide	Approved via the centralised procedure on 16/01/2007	Adjunctive therapy in the treatment of seizures associated with Lennox-Gastaut syndrome in patients 4 years of age and older.
Lamotrigine	First approval August 1997	Seizures associated with Lennox-Gastaut syndrome.
Topiramate	Nationally approved; Date of first authorisation in UK: 18/07/1995	Adjunctive therapy in children aged 2 years and above, adolescents and adults with partial onset seizures with or without secondary generalisation or primary generalised tonic-clonic seizures and for the treatment of seizures associated with Lennox-Gastaut syndrome.
Felbamate	Nationally approved: Date of first authorisation in France: 16/05/1994	Adjunctive therapy in the treatment of partial and generalised seizures associated with Lennox-Gastaut syndrome in children. For use only in those patients who respond inadequately to alternative treatments and whose epilepsy is so severe that a substantial risk of aplastic anaemia and/or liver failure is deemed acceptable

[0051] The UK's National Institute for Clinical Excellence (NICE) have produced a recommended pathway for the treatment of LGS (NICE, 2016). NICE have suggested that first line treatment is sodium valproate. If this is not effective or tolerated then lamotrigine should be prescribed as adjunctive treatment. Other AEDs that may be used are rufinamide, topiramate and felbamate. Usually, it takes a combination of more than one AED to gain any seizure control.

[0052] All four compounds authorised in the EU specifically for the treatment of LGS all seems to act via sodium channel blockade (see Table 7). Since CBD has a different mode of

action to these treatments, it offers prescribers and patients a viable alternative for the treatment of this disease, which is notoriously unresponsive to conventional anti-epileptic treatments.

[0053] Table 7: Modes of action of antiepileptic drugs authorised in the EU

5 specifically to treat Lennox-Gastaut Syndrome

Drug	Mode of action
Rufinamide	Uncertain, but thought to modulate the activity of sodium channels, prolonging their inactive state
Lamotrigine	Is a use- and voltage-dependent blocker of voltage-gated sodium channels. It inhibits sustained repetitive firing of neurons and inhibits release of glutamate (the neurotransmitter which plays a key role in the generation of epileptic seizures).
Topiramate	Full mode of action unknown but thought to contribute to the anti-seizure effects via: state-dependent sodium channel blocking action potentiation of the activity of GABA
Felbamate	A sodium channel inactivator.

[0054] In two placebo-controlled studies of CBD as a treatment for seizures associated with LGS, cannabidiol was used as add-on treatment in patients who were defined as treatment-resistant. Patients had previously tried and stopped using a median of 6 AEDs, and were being maintained on a median of 3 AEDs.

[0055] The first study was a 1:1 randomised, double-blind, 14-week comparison of cannabidiol oral solution (CBD-OS) versus placebo. The treatment period consisted of a two-week titration period followed by a 12-week maintenance period. The treatment period was followed by a 10-day taper period and a four-week follow-up period. The study aimed to determine the efficacy, safety and tolerability of 20 mg/kg/day cannabidiol compared with placebo.

[0056] The second study was a 1:1:1 randomised, double-blind, 14-week comparison of two dose levels of cannabidiol (10 mg/kg/day and 20 mg/kg/day) versus placebo. The treatment period consisted of a two-week titration period followed by a 12-week maintenance period. The treatment period was followed by a 10-day taper period and a four-week follow-up period. The study aimed to determine the efficacy, safety and tolerability of two dose levels of CBD-OS compared with placebo. Patients in the placebo group were split into two equivalent cohorts; half receiving 10 mg/kg/day dosing volumes and half receiving 20 mg/kg/day dosing volumes.

[0057] In order to ensure that caregivers were able to interpret a seizure correctly, all caregivers underwent pre-study training, and their description and classification of a seizure was independently verified by a committee appointed by the Epilepsy Study Consortium

[0058] Despite the number of medications, the patients were already taking, the median number of drop seizures at baseline was in excess of 75 per month in both studies. These were patient populations with a high unmet medical need, who had already tried and failed multiple AEDs. In many cases, the AEDs they were being maintained on included those approved for the treatment of LGS; rufinamide, lamotrigine or topiramate.

[0059] An analysis of the change in seizure frequency for CBD vs placebo in patients who were currently taking, or had previously taken and stopped, each of rufinamide, lamotrigine or topiramate; felbamate was undertaken. Such patients can be reasonably defined as AED treatment failures.

[0060] Rufinamide

[0061] Tables 8 to 10 below show the results in patients who have tried and failed rufinamide, or those who are currently taking it but have uncontrolled seizures. There was a significantly greater reduction in drop and total seizure frequency and a significantly greater proportion of patients with a $\geq 50\%$ reduction in drop seizure frequency at the 20 mg/kg/day dose of cannabidiol compared with placebo.

20

[0062] **Table 1: Percentage Change from Baseline in Drop Seizure Frequency in Patients who are Rufinamide Treatment Failures**

Variable	Cannabidiol 20 mg/kg/day (N=95)	Cannabidiol 10 mg/kg/day (N=47)	Placebo (N=95)
Drop Seizure Frequency (per 28 Days)			
Baseline Period Median (Q1, Q3)	88.00 (35.78, 156.00)	87.61 (44.00, 224.00)	77.47 (47.31, 125.52)
Treatment Period Median (Q1, Q3)	42.30 (16.57, 136.29)	56.00 (23.76, 128.57)	64.84 (34.22, 116.62)
Median % Change During Treatment (Q1, Q3)	-38.78 (-68.53, 1.93)	-32.95 (-60.59, 1.42)	-17.09 (-36.22, 1.06)
Treatment Difference vs. Placebo	-19.34	-9.80	-

(95% CI) ^a	(-30.75, -7.24)	(-23.07, 3.05)	
P-value ^b	0.0022	0.1314	-

^a Estimated median difference and 95% CI calculated using the Hodges–Lehmann approach.

^b p-value calculated from a Wilcoxon rank–sum test.

[0063] Table 2: Patients who are Rufinamide Treatment Failures Who Achieved At Least a 50% Reduction in Drop Seizure Frequency from Baseline

Variable	Cannabidiol 20 mg/kg/day (N=95)	Cannabidiol 10 mg/kg/day (N=47)	Placebo (N=95)
≥ 50% Reduction in Drop Seizure Frequency (per 28 Days) from Baseline			
Number of Responders (%)	37 (38.9)	13 (27.7)	16 (16.8)
P-value ^a	0.0011	0.1836	-

^a p-value calculated from a Fisher's exact test.

[0064] Table 3: Percentage Change from Baseline in Total Seizure Frequency in Patients who are Rufinamide Treatment Failures

Variable	Cannabidiol 20 mg/kg/day (N=95)	Cannabidiol 10 mg/kg/day (N=47)	Placebo (N=95)
Total Seizure Frequency (per 28 Days)			
Baseline Period Median (Q1, Q3)	197.87 (91.72, 408.41)	169.00 (85.00, 517.52)	139.07 (70.48, 446.19)
Treatment Period Median (Q1, Q3)	102.20 (39.32, 289.74)	95.51 (39.26, 223.69)	110.53 (61.14, 326.67)
Median % Change During Treatment (Q1, Q3)	-34.90 (-63.93, -1.44)	-31.25 (-60.71, -10.70)	-12.74 (-37.98, 0.71)
Treatment Difference vs. Placebo (95% CI) ^a	-19.43 (-30.37, -8.55)	-17.54 (-28.27, - 5.26)	-
P-value ^b	0.0008	0.0062	-

^a Estimated median difference and 95% CI calculated using the Hodges–Lehmann approach.

^b p-value calculated from a Wilcoxon rank–sum test.

[0065] Lamotrigine

[0066] Tables 11 to 13 below show the results in patients who have tried and failed lamotrigine, and those who are currently taking it but have uncontrolled seizures. There is a significantly greater reduction in both drop and total seizure frequency and a significantly greater proportion of patients with a $\geq 50\%$ reduction in drop seizure frequency at both doses of cannabidiol compared with placebo.

[0067] Table 4: Percentage Change from Baseline in Drop Seizure Frequency in Patients who are Lamotrigine Treatment Failures

Variable	Cannabidiol 20 mg/kg/day (N=114)	Cannabidiol 10 mg/kg/day (N=49)	Placebo (N=116)
Drop Seizure Frequency (per 28 Days)			
Baseline Period Median (Q1, Q3)	79.59 (32.00, 156.80)	66.71 (31.00, 152.00)	72.84 (43.68, 128.69)
Treatment Period Median (Q1, Q3)	36.30 (15.43, 116.31)	40.29 (13.58, 86.80)	57.99 (33.20, 125.01)
Median % Change During Treatment (Q1, Q3)	-40.74 (-69.62, 3.16)	-37.16 (-62.01, -7.14)	-18.19 (-38.87, 1.01)
Treatment Difference vs. Placebo (95% CI) ^a	-19.24 (-30.07, -7.18)	-18.79 (-30.57, -6.03)	-
P-value ^b	0.0023	0.0040	-

^a Estimated median difference and 95% CI calculated using the Hodges–Lehmann approach.

^b p-value calculated from a Wilcoxon rank–sum test.

[0068] Table 5: Proportion of Patients who are Lamotrigine Treatment Failures Who Achieved At Least a 50% Reduction in Drop Seizure Frequency from Baseline

Variable	Cannabidiol 20 mg/kg/day (N=114)	Cannabidiol 10 mg/kg/day (N=49)	Placebo (N=116)
$\geq 50\%$ Reduction in Drop Seizure Frequency (per 28 Days) from Baseline			
Number of Responders (%)	47 (41.2)	17 (34.7)	19 (16.4)
P-value ^a	<0.0001	0.0131	-

^a p-value calculated from a Fisher’s exact test.

[0069] Table 6: Percentage Change from Baseline in Total Seizure Frequency in Patients who are Lamotrigine Treatment Failures

Variable	Cannabidiol 20 mg/kg/day (N=114)	Cannabidiol 10 mg/kg/day (N=49)	Placebo (N=116)
Total Seizure Frequency (per 28 Days)			
Baseline Period Median (Q1, Q3)	166.13 (73.00, 404.00)	151.20 (66.71, 314.00)	142.03 (69.56, 427.60)
Treatment Period Median (Q1, Q3)	98.64 (30.89, 266.43)	68.41 (34.42, 179.08)	122.57 (61.89, 366.84)
Median % Change During Treatment (Q1, Q3)	-34.44 (-60.93, -1.44)	-32.87 (-64.77, -3.30)	-14.51 (-39.00, 0.70)
Treatment Difference vs. Placebo (95% CI) ^a	-17.35 (-27.82, -7.42)	-19.63 (-32.11, -6.19)	-
P-value ^b	0.0008	0.0044	-

5 ^a Estimated median difference and 95% CI calculated using the Hodges–Lehmann approach.

^b p-value from calculated from a Wilcoxon rank–sum test.

[0070] Topiramate

10 **[0071]** Tables 14 to 16 below show the results in patients who have tried and failed topiramate, and those who are currently taking it but have uncontrolled seizures. There is a significantly greater reduction in both drop and total seizure frequency at both doses of cannabidiol compared with placebo, and a greater proportion of patients with a ≥ 50% reduction in drop seizure frequency at both doses of cannabidiol compared with placebo (reaching
15 statistical significance for the 20 mg/kg/day dose but only marginal statistical significance for the 10 mg/kg/day dose).

[0072] Table 7: Percentage Change from Baseline in Drop Seizure Frequency in Patients who are Topiramate Treatment Failures

Variable	Cannabidiol	Cannabidiol	Placebo
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	20 mg/kg/day (N=111)	10 mg/kg/day (N=56)	(N=122)
Drop Seizure Frequency (per 28 Days)			
Baseline Period Median (Q1, Q3)	88.00 (37.33, 211.75)	87.95 (42.28, 239.21)	76.87 (46.00, 142.90)
Treatment Period Median (Q1, Q3)	44.00 (17.21, 151.51)	57.02 (23.11, 141.85)	64.95 (33.09, 132.13)
Median % Change During Treatment (Q1, Q3)	-34.13 (-67.28, 4.31)	-36.08 (-60.53, -2.35)	-16.61 (-36.61, 1.06)
Treatment Difference vs. Placebo (95% CI) ^a	-16.83 (-28.28, -4.46)	-16.92 (-28.26, -4.54)	-
P-value ^b	0.0069	0.0074	-

^a Estimated median difference and 95% CI calculated using the Hodges–Lehmann approach.

^b p-value calculated from a Wilcoxon rank–sum test.

[0073] Table 8: Proportion of Patients who are Topiramate Treatment Failures Who Achieved At Least a 50% Reduction in Drop Seizure Frequency from Baseline

Variable	Cannabidiol 20 mg/kg/day (N=111)	Cannabidiol 10 mg/kg/day (N=56)	Placebo (N=122)
≥ 50% Reduction in Drop Seizure Frequency (per 28 Days) from Baseline			
Number of Responders (%)	40 (36.0)	17 (30.4)	21 (17.2)
P-value ^a	0.0016	0.0517	-

^a p-value calculated from a Fisher's exact test.

[0074] Table 9: Percentage Change from Baseline in Total Seizure Frequency in Patients who are Topiramate Treatment Failures

Variable	Cannabidiol 20 mg/kg/day (N=111)	Cannabidiol 10 mg/kg/day (N=56)	Placebo (N=122)
Total Seizure Frequency (per 28 Days)			

Baseline Period Median (Q1, Q3)	184.41 (93.00, 470.40)	180.13 (82.65, 494.26)	161.72 (74.06, 402.00)
Treatment Period Median (Q1, Q3)	101.71 (37.53, 322.86)	88.31 (41.06, 206.45)	125.15 (65.05, 349.42)
Median % Change During Treatment (Q1, Q3)	-33.76 (-60.93, -0.09)	-31.57 (-61.30, -6.20)	-14.70 (-39.07, 0.71)
Treatment Difference vs. Placebo (95% CI) ^a	-15.87 (-26.10, -5.32)	-17.04 (-27.40, -5.42)	-
P-value ^b	0.0034	0.0047	-

^a Estimated median difference and 95% CI calculated using the Hodges–Lehmann approach.

^b p-value calculated from a Wilcoxon rank–sum test.

[0075] Felbamate

- 5 [0076] Tables 17 to 19 below show the results in patients who have tried and failed felbamate, and those who are currently taking it but have uncontrolled seizures. There is a marginally statistically significantly greater reduction in drop seizure frequency and a statistically significantly greater proportion of patients with a $\geq 50\%$ reduction in drop seizure frequency at the 20 mg/kg dose of cannabidiol compared with placebo.

10

[0077] Table 10: Percentage Change from Baseline in Drop Seizure Frequency in Patients who are Felbamate Treatment Failures

Variable	Cannabidiol 20 mg/kg/day (N=38)	Cannabidiol 10 mg/kg/day (N=22)	Placebo (N=51)
Drop Seizure Frequency (per 28 Days)			
Baseline Period Median (Q1, Q3)	81.19 (40.65, 245.00)	130.17 (66.71, 227.86)	76.28 (32.52, 140.00)
Treatment Period Median (Q1, Q3)	47.32 (17.21, 136.29)	68.26 (23.76, 171.39)	58.26 (32.29, 113.79)
Median % Change During Treatment	-31.62 (-74.69, 1.93)	-30.50 (-51.11, 3.03)	-13.64 (-36.06,

(Q1, Q3)			2.77)
Treatment Difference vs. Placebo (95% CI) ^a	-17.76 (-36.90, 2.32)	-11.57 (-31.16, 9.21)	-
P-value ^b	0.0930	0.2984	-

^a Estimated median difference and 95% CI calculated using the Hodges–Lehmann approach.

^b p-value calculated from a Wilcoxon rank–sum test.

[0078] Table 11: Proportion of Patients who are Felbamate Treatment Failures Who Achieved At Least a 50% Reduction in Drop Seizure Frequency from Baseline

Variable	Cannabidiol 20 mg/kg/day (N=38)	Cannabidiol 10 mg/kg/day (N=22)	Placebo (N=51)
	≥ 50% Reduction in Drop Seizure Frequency (per 28 Days) from Baseline		
Number of Responders (%)	15 (39.5)	6 (27.3)	7 (13.7)
P-value ^a	0.0068	0.1921	-

^a p-value calculated from a Fisher's exact test.

[0079] Table 12: Percentage Change from Baseline in Total Seizure Frequency in Patients who are Felbamate Treatment Failures

Variable	Cannabidiol 20 mg/kg/day (N=38)	Cannabidiol 10 mg/kg/day (N=22)	Placebo (N=51)
	Total Seizure Frequency (per 28 Days)		
Baseline Period Median (Q1, Q3)	135.07 (63.47, 452.00)	156.89 (89.79, 520.41)	135.00 (68.00, 279.03)
Treatment Period Median (Q1, Q3)	102.20 (31.11, 394.83)	103.09 (38.50, 188.36)	99.14 (60.38, 319.38)
Median % Change During Treatment (Q1, Q3)	-27.56 (-64.07, 7.27)	-34.36 (-64.46, -1.39)	-12.53 (-29.89, -1.61)
Treatment Difference vs. Placebo (95% CI) ^a	-14.58 (-32.78, 4.06)	-21.77 (-40.77, -1.96)	-
P-value ^b	0.1179	0.0282	-

^a Estimated median difference and 95% CI calculated using the Hodges–Lehmann approach.

^b p-value calculated from a Wilcoxon rank–sum test.

Conclusions

5 [0080] Pooled data from two well-controlled, multi-centre, multi-national randomised studies show that patients who are taking without seizure control, or who have previously taken and have since stopped, the AEDs authorised for use in LGS in the EU, go on to achieve significant benefit from CBD. This effect is most significant at the daily dose of 20 mg/kg/day.

10 [0081] These data show that add-on treatment with CBD is able to provide a clinically relevant advantage over and above that obtained by lamotrigine, rufinamide, felbamate and topiramate. This clinically relevant advantage is consistent with the different mode of action of cannabidiol to those of these AEDs.

15 [0082] Surprisingly the combined use of CBD with one or more of the medications approved to treat LGS, namely rufinamide, lamotrigine, topiramate or felbamate enables a statistically significant reduction in drop and total seizure frequency in patients deemed to be treatment failures on their existing medication.

CLAIMS

1. Cannabidiol (CBD) for use in the treatment of seizures associated with Lennox-Gastaut syndrome (LGS) characterised in that the LGS patients are deemed to be a treatment failure on one or more anti-epileptic drugs (AEDs).
5
2. Cannabidiol (CBD) for use according to claim 1, wherein the one or more AEDs are taken from rufinamide; lamotrigine; topiramate; and / or felbamate.
- 10 3. Cannabidiol (CBD) for use according to claim 1 or 2, wherein the CBD is in the form of a highly purified extract of cannabis which comprises at least 98% (w/w) CBD.
4. Cannabidiol (CBD) for use according to claim 1 or 2, wherein the CBD is present as a synthetic compound.
15
5. Cannabidiol (CBD) for use according to claim 3, wherein the highly purified extract comprises less than 0.15% THC.
6. Cannabidiol (CBD) for use according to claim 3, wherein the extract further comprises up to 1% CBDV.
20
7. Cannabidiol (CBD) for use according to any of the preceding claims, wherein the dose of CBD is below 50 mg/kg/day.
- 25 8. Cannabidiol (CBD) for use according to any of the preceding claims, wherein the dose of CBD is greater than 20 mg/kg/day.
9. A method of treating seizures associated with Lennox-Gastaut syndrome (LGS) comprising administering cannabidiol (CBD) to a subject diagnosed with LGS who are deemed to be a treatment failure.
30

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2018/053315

A. CLASSIFICATION OF SUBJECT MATTER
 INV. A61K45/06 A61K31/352 A61P25/08
 ADD.
 According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
 Minimum documentation searched (classification system followed by classification symbols)
 A61K A61P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 EPO-Internal, BIOSIS, CHEM ABS Data, EMBASE, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	GB 2 531 282 A (GW PHARMA LTD [GB]) 20 April 2016 (2016-04-20) the whole document	1-9
X	US 2017/224634 A1 (VANGARA KIRAN KUMAR [US] ET AL) 10 August 2017 (2017-08-10) paragraph [[0159][0160][0302][0304]]; claims 3, 17; example 16 ----- -/--	1,3,4, 7-9

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p>
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Date of the actual completion of the international search 7 February 2019	Date of mailing of the international search report 01/03/2019
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Ansaldo, M
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INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2018/053315

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>O Devinsky ET AL: "Efficacy and safety of Epidiolex (cannabidiol) in children and young adults with treatment-resistant epilepsy: Initial data from expanded access program",</p> <p>1 January 2015 (2015-01-01), XP055553292, Retrieved from the Internet: URL:https://www.aesnet.org/meetings_events/annual_meeting_abstracts/view/2414222 [retrieved on 2019-02-07] the whole document</p>	1,3,5-9
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International application No

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