**TITLE PAGE**

## PASS information

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|---|---|
| **Title** | Hydroxychloroquine safety and potential efficacy as an antiviral prophylaxis in light of potential wide-spread use in COVID-19: a multinational, large-scale network cohort and self-controlled case series study |
| **Protocol version identifier** | 1.6 |
| **Date of last version of protocol** | 01/06/2020 |
| **EU PAS register number** | EUPAS34497 |
| **Active substance** | Sulfasalazine, Hydroxychloroquine, Azithromycin, Amoxicillin |
| **Medicinal product** | Sulfasalazine, Hydroxychloroquine, Azithromycin, Amoxicillin |
| **Research question and objectives** | The overarching objective is to evaluate the comparative safety of hydroxychloroquine. Secondly, we will evaluate the association between hydroxychloroquine and the risk of flu and hospitalised pneumonia |
| **Country(-ies) of study** | To be confirmed. For now: United Kingdom, Germany, Spain, Netherlands, Japan, and the United States of America |
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# 1. TABLE OF CONTENTS

*The study protocol should include a table of contents. The following table of contents can be used if this guidance serves as a template (select the table of content and press "F9" to update the page numbers).*

## 2. LIST OF ABBREVIATIONS

| | |
|---|---|
| RA | Rheumatoid Arthritis |
| DMARD | Disease Modifying Anti-rheumatic drug |
| csDMARD | Conventional synthetic DMARD |
| SSZ | Sulfasalazine |
| HCQ | Hydroxychloroquine |
| SCCS | Self-controlled case series |
| SAE | Serious adverse events |
| AZM | Azithromycin |
| AMX | Amoxicillin |
| ARDS | Acute Respiratory Distress Syndrome |

## 3. RESPONSIBLE PARTIES

| **Responsible party/person** | **Institution/Affiliation** |
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## 5. AMENDMENTS AND UPDATES

| Number | Date | Section of study protocol | Amendment or update | Reason |
|---|---|---|---|---|
| 1 | *01/06/2020* | *7, 9.1, 9.3.2, 9.4, Annex 2* | *Amendment* | *To include psychiatric outcomes* |

| | | | | |
|---|---|---|---|---|
| 2 | 01/06/2020 | 9.3.2 | Amendment | Influenza outcome set restricted to influenza outcomes only |

# 7 RATIONALE AND BACKGROUND

Since January 2020 a growing number of infections caused by coronavirus SARS-Cov2 COVID19 has resulted in an unprecedented pressure on healthcare systems worldwide, and a great number of casualties on a global scale. With an approximate 4% mortality based on data from China where the outbreak originated, there is a paucity of data on an international level surrounding the factors associated with disease severity or morbi-mortality.[1] As the number of infected patients continues to increase across the world, useful knowledge can be obtained from previous viral outbreaks including the seasonal flu. Federated access to international data assets mapped to the Observational Medical Outcomes Partnership common data model (OMOP) provides a unique opportunity to make a difference in the current crisis within the Observational Health Data Science and Informatics (OHDSI) community.[2,3]

Several existing medicines have been postulated to be effective against coronavirus, including conventional synthetic disease modifying anti-rheumatic drugs (csDMARDs) usually used as the first line of treatment in autoimmune conditions such as rheumatoid arthritis (RA).[4] Chloroquine and hydroxychloroquine (HCQ) have been proposed as a potential treatment for coronavirus based upon their mechanism of action. Accumulating in the acid vesicles (endosome, golgi vesicles, lysosomes), these agents cause alkalinisation, leading to enzyme dysfunction and preventing endosome mediated viral entry to the cell. [5-8] It is also suggested in vitro that they can prevent glycosylation of virus cell proteins including the ACE2 receptor, inhibiting virus entry and replication.[7,9,10] Chloroquine has been shown in vitro to specifically inhibit SARS-Cov2 COVID-19.[11]

In clinical studies, the addition of HCQ has shown increased early virological response to treatment for chronic hepatitis C, and reduced viral load compared to placebo in patients with HIV infection. [12,13] Treatment with also HCQ saw a lower IL-6 level in HIV patients when compared to Zidovudine treatment.[14] Due to its effects in hepatitis C and HIV, in addition to its known mechanism of action, efforts have focused towards HCQ in the attempt to treat SARS-Cov2 COVID-19. Many trials are currently ongoing using hydroxychloroquine in the treatment of SARS-Cov2 COVID-19.[15-21] Gao *et al*. reported that early results from randomised control trials in China using chloroquine versus placebo have seen reduced disease severity and course without serious adverse effects, although Chen *et al.* have suggested no difference in outcome from conventional treatment.[22,23]

Of those studies that have reported more detailed results, Gautret *et al.* compared HCQ 600mg to those receiving HCQ with azithromycin, suggesting that reduced viral load was seen on day 6 of the study in those undertaking combined treatment.[24] However, a double blind RCT using chloroquine for influenza A and B prevention (including H1N1) in Singapore previously saw no prevention of influenza infection of healthy volunteers when compared to placebo. [25]

All therapies used for RA are associated with both non-serious and serious adverse events (SAEs), although the comparative risk of such events in csDMARDs continues to be conflicting.[26] Patients on methotrexate are frequently counselled regarding an increased risk of infection, however there is little good quality evidence quantifying this risk in the literature with several studies suggesting no increased infection risk with any nonbiologic DMARDs, including HCQ.[27,28]

Methotrexate use has also been associated with a type of rare lymphoma, however RA patients with uncontrolled disease are at risk of such cancers regardless of therapy compared to the general population.[29]

Interrogation of adverse event registers have identified potential associations between HCQ and psychiatric events including psychosis, depression and suicidal ideation.[30] These neuropsychiatric events have been included as potential side effects of both HCQ and AZM, but little is known outside of adverse event registers or individual case reports.[31,32] This protocol has therefore been amended to include these 3 new outcomes in response to concerns raised by regulators and the scientific community.

In the current climate, a set of studies comparing the relative safety of HCQ is pertinent to address this newfound interest in it as a treatment strategy for SARS-Cov2 COVID-19, especially when combined with other medications. The ability to do this across an international network of real world data also confers increased benefit to the global community through greater potential generalisability of results. In addition, studying the association between HCQ use and the risk of flu and hospitalised pneumonia will inform future trials on the use of HCQ as an anti-COVID19 prophylaxis.

# 8. RESEARCH QUESTION AND OBJECTIVES

The aim of this study is to firstly assess the safety of hydroxychloroquine (HCQ) used in RA, in addition to the safety of combination treatment of HCQ and azithromycin (AZM). Secondly, to assess the antiviral efficacy of HCQ and preventative potential of HCQ in assessing the incidence of viral respiratory infection and hospitalised pneumonia in patients taking HCQ.

Specifically, the study has the following objectives:

1. To assess the direct and comparative safety of HCQ
2. To assess the comparative safety of HCQ in combination with AZM compared to a combination of HCQ with AMX
3. To assess the comparative risk of the adverse outcome of hospital-treated pneumonia associated with the use of HCQ compared to SSZ, and HCQ with AZM in combination therapy compared to HCQ with AMX combination therapy

# 9. RESEARCH METHODS

## 9.1. STUDY DESIGN

Two study designs will be used to undertake the four objectives in a multinational, multi-database network:

1. Self-controlled case series (SCCS) estimating the safety of HCQ (Aim 1)

2. New user cohort study estimating the safety, risk of influenza infections and pneumonia in incident users of HCQ compared to SSZ, and users of the combination of HCQ with AZM versus HCQ with AMX (Aims 1, 2, and 3).

Note that AZM will not be studied in the SCCS analyses because of the expected strong time-varying confounding associated with the infection for which AZM is prescribed.

For protocol amendment 1.5 to expedite results in light of safety concerns raised by regulatory bodies and scientific experts, psychiatric outcomes will only be run in study design 2 (new user cohort design).

## 9.2. SETTING

Participants from at least 4 European countries (United Kingdom, Germany, Spain, Netherlands), the United States of America, and Japan are proposed for inclusion. Additional databases will be analysed using the same analytical packages as they join the distributed data network.

Electronic health records and administrative claims from primary care and secondary care will be utilised.

The study will be conducted using data from a large network of real world data sources previously mapped to the Observational Medical Outcomes Partnership (OMOP) Common Data Model (CDM) in collaboration with the Observational Health Data Sciences and Informatics (OHDSI) and European Health Data and Evidence Network (EHDEN) initiatives.

### *9.2.1. STUDY PERIOD*

The study period, when index events and outcomes of interest can be observed, will start from 01/09/2000 and end at the latest available date for all data sources in 2020.

### *9.2.2. STUDY POPULATION: INCLUSION/EXCLUSION CRITERIA*

Participants will be identified using pre-specified concept sets reviewed by a core team of clinicians, epidemiologists, vocabulary experts, and health data scientists with extensive expertise in the use of the OMOP CDM and the OHDSI tools.

**New user exposure cohorts**

Exposure cohorts will be defined where treatment initiation is the index event and includes the following criteria:

- History of RA: Have a condition occurrence or observation indicating RA any time before or on the same day as the index event
- Be aged 18 years or over at index event
- Have at least 365 days of continuous observation time prior to index event.

| Concept ID | Concept name | Domain |
|---|---|---|
| 4035611 | Seropositive rheumatoid arthritis | Condition |

| | | |
|---|---|---|
| 4083556 | Seronegative rheumatoid arthritis | Condition |
| 80809 | Rheumatoid arthritis | Condition |
| 4102493 | Polyneuropathy in rheumatoid arthritis | Condition |
| 4107913 | Myopathy due to rheumatoid arthritis | Condition |
| 46273442 | Deformity of hand due to rheumatoid arthritis | Condition |
| 4334806 | Deformity of foot due to rheumatoid arthritis | Condition |
| 4297650 | Cutaneous atrophy due to rheumatoid arthritis | Condition |
| 2107559 | Rheumatoid arthritis (RA) disease activity, moderate (RA) | Observation |
| 2107558 | Rheumatoid arthritis (RA) disease activity, low (RA) | Observation |
| 2107560 | Rheumatoid arthritis (RA) disease activity, high (RA) | Observation |
| 2108721 | Patient receiving first-time biologic disease modifying anti-rheumatic drug therapy for rheumatoid arthritis (RA) | Observation |
| 4058299 | H/O: rheumatoid arthritis | Observation |
| 2107561 | Disease prognosis for rheumatoid arthritis assessed, poor prognosis documented (RA) | Observation |
| 2107572 | Disease prognosis for rheumatoid arthritis assessed, good prognosis documented (RA) | Observation |

*Hydroxychloroquine study*

*HCQ cohort (Target)*

Index event is defined as the first recorded dispensing/prescription of HCQ in a patient's history; inferred persistent exposure by allowing up to 90 day gaps between dispensing/prescription records.

*SSZ cohort (comparator)*

Index event is defined as the first recorded dispensing/prescription of SSZ in a patient's history; inferred persistent exposure by allowing up to 90 day gaps between dispensing/prescription records.

*Hydroxychloroquine with Azithromycin study*

*HCQ and AZM group (target)*

Index event is defined as the first recorded dispensing/prescription of either HCQ or AZM in a patient's history with the requirement that a dispensing/prescription for the non-index exposure is observed during the 30 days before and including the index date. Assuming that HCQ use is chronic in the management of RA, and AZM is an acute prescription for infection treatment, inferred persistent exposure to AZM is assessed by allowing up to 30 days between dispensing/prescription records.

*HCQ and Amoxicillin group (comparator)*

Index event is defined as the first recorded dispensing/prescription of either HCQ or AMX in a patient's history with the requirement that a dispensing/prescription for the non-index exposure is observed during the 30 days before and including the index date. Assuming that HCQ use is chronic in the management of RA, and AMX is an acute prescription for infection treatment, inferred persistent exposure to AMX is assessed by allowing up to 30 days between dispensing/prescription records.

**SCCS exposure cohorts**

Additional exposure populations, regardless of indication, will be included for the SCCS. For each exposure population, all prevalent users of HCQ will be included and periods of inferred persistent exposure by allowing up to 90 day gaps between dispensing/prescription records will be constructed. Individual SCCS analyses will therefore be executed separately for each of the proposed study outcomes mentioned below (Section 9.3.2), including both safety events and negative control outcomes.

### *9.2.3. FOLLOW UP*

**Cohort studies**

The index date is defined by the first dispensing/prescription as described in the cohort definitions above (Section 9.2.2.) Two periods of follow-up will be considered for two types of analyses for the serious adverse effect outcomes:
In an *intention-to-treat analysis*, the analysis follow-up starts 1 day after the index date and continues up until the first of: outcome of interest, loss to follow-up, or 30 days after the index date to resemble the likely duration of COVID19 treatment regimens. Patients are required to have at least 1 day of follow-up.

In an *on-treatment analysis*, the analysis follow-up starts 1 day after the index date and continues until the first of: discontinuation/switching/combined therapy of index therapy plus a lag time of 14 days, outcome of interest, loss to follow-up, or 1826 days (5 years) after the index date. Patients are required to have at least 1 day of follow-up.

**Self-controlled case series**

Self-controlled case series analyses will be conducted in the general case populations in support of to Aim 1. In these analyses, patient cases are followed for their entire observation time (e.g. from enrolment to disenrollment in an insurance claims database), and incidence rates of each of the study outcomes are calculated and compared in periods of inferred persistent exposure to HCQ and non-exposure periods. We will execute a multivariate SCCS analysis for each exposure population that includes time-varying covariates for other drug exposures.  We will fit a multivariate SCCS model with HCQ therapy as the time-varying exposure.

## 9.3. VARIABLES

### *9.3.1.- EXPOSURES*

Two active comparator analyses will be conducted. First, HCQ (target) will be compared to SSZ (comparator). Second, HCQ used in combination with AZM (target) will be compared to HCQ used in combination with AMX (comparator).

Concept IDs for the four ingredients are below:

| Target drug group | Concept ID | Concept name |
|---|---|---|
| csDMARD | 1777087 | Hydroxychloroquine |

| | | |
|---|---|---|
| csDMARD | 964339 | Sulfasalazine |
| antibiotic | 1734104 | Azithromycin |
| antibiotic | 1713332 | Amoxicillin |

**Exposure assessment**

As described in the cohort definitions (Section 9.2.2), exposure commences on the first dispensing/prescription record with at least 365 days of prior observation period to increase confidence that the exposure is incident. Exposure interval gaps of ≤90 days (HCQ and SSZ) and of ≤30 days (AZM and AMX) between drug dispensing/prescription records will be allowed and inferred as persistent exposure. In the hydroxychloroquine study, drug discontinuation will also be considered if a patient switches from one study drug to another, or when a concomitant second drug is added, with switching defined as an overlap of 30 days or more between two different drugs. Patients who switch from target exposure to comparator exposure, or vice versa, will contribute follow-up time to the exposure cohort that they entered first.

### *9.3.2.- OUTCOMES*

*Outcome identification and validation*

The proposed code lists for the identification of the study population (codes for the identification of RA diagnosis) and for the study outcomes were created by clinicians with experience in the management of RA using ATLAS™, and reviewed by 4 clinicians and 1 epidemiologist. Myocardial infarction and stroke codes were based on a previously published paper.[33]

Face validity for the proposed RA and for each of the outcome cohorts will be reviewed by exploring age- and sex-specific incidence rates compared to previous clinical knowledge and/or existing literature.

**Safety outcomes (Aim 1)**

| Concept ID | Name / Description | Concept ID to be Excluded |
|---|---|---|
| **Episodes of acute respiratory distress** | | |
| 4191650 | Acute respiratory distress | |
| 4195694 | Acute respiratory distress syndrome | |
| 318459 | Respiratory insufficiency | |
| **Persons with chest pain or angina** | | |
| 321318 | Angina pectoris | |
| 77670 | Chest pain | |
| **Venous thromboembolic (pulmonary embolism and deep vein thrombosis) events** | | |
| 435616 | Amniotic fluid embolism | X |
| 435887 | Antepartum deep vein thrombosis | X |
| 196715 | Budd-Chiari syndrome | X |
| 4062269 | Cerebral venous thrombosis in pregnancy | X |
| 442055 | Obstetric air pulmonary embolism | X |
| 433832 | Obstetric blood-clot pulmonary embolism | X |
| 435026 | Obstetric pulmonary embolism | X |
| 440477 | Obstetric pyemic and septic pulmonary embolism | X |

| | | |
|---|---|---|
| 318137 | Phlebitis and thrombophlebitis of intracranial sinuses | X |
| 199837 | Portal vein thrombosis | X |
| 438820 | Postpartum deep phlebothrombosis | X |
| 440417 | Pulmonary embolism | |
| 254662 | Pulmonary infarction | |
| 4235812 | Septic thrombophlebitis | X |
| 195294 | Thrombosed hemorrhoids | X |
| 4187790 | Thrombosis of retinal vein | X |
| 444247 | Venous thrombosis | |
| **Acute renal failure events** | | |
| 262 | Emergency Room and Inpatient Visit | |
| 9203 | Emergency Room Visit | |
| 9201 | Inpatient Visit | |
| 197320 | Acute renal failure syndrome | |
| 432961 | Acute renal papillary necrosis with renal failure | |
| 444044 | Acute tubular necrosis | |
| **Persons with end stage renal disease** | | |
| 443611 | Chronic kidney disease stage 5 | |
| 193782 | End stage renal disease | |
| 4090651 | Dialysis finding | |
| 4032243 | Dialysis procedure | |
| 45889365 | Dialysis Services and Procedures | |
| **Persons with hepatic failure** | | |
| 377604 | Hepatic coma | |
| 4029488 | Hepatic encephalopathy | |
| 4245975 | Hepatic failure | |
| 4337543 | Hepatic necrosis | |
| **Acute pancreatitis events** | | |
| 262 | Emergency Room and Inpatient Visit | |
| 9203 | Emergency Room Visit | |
| 9201 | Inpatient Visit | |
| 199074 | Acute pancreatitis | |
| **Persons with heart failure** | | |
| 315295 | Congestive rheumatic heart failure | X |
| 316139 | Heart failure | |
| **Total cardiovascular disease events (ischemic stroke, hemorrhagic stroke, heart failure, acute myocardial infarction or sudden cardiac death)** | | |
| 262 | Emergency Room and Inpatient Visit | |
| 9203 | Emergency Room Visit | |
| 9201 | Inpatient Visit | |
| 4329847 | Myocardial infarction | |
| 314666 | Old myocardial infarction | X |
| 4048809 | Brainstem death | |
| 321042 | Cardiac arrest | |
| 442289 | Death in less than 24 hours from onset of symptoms | |
| 4317150 | Sudden cardiac death | |
| 4132309 | Sudden death | |
| 437894 | Ventricular fibrillation | X |
| 372924 | Cerebral artery occlusion | |
| 375557 | Cerebral embolism | |
| 443454 | Cerebral infarction | |
| 441874 | Cerebral thrombosis | |

| | | |
|---|---|---|
| 376713 | Cerebral hemorrhage | |
| 439847 | Intracranial hemorrhage | |
| 432923 | Subarachnoid hemorrhage | |
| 315295 | Congestive rheumatic heart failure | X |
| 316139 | Heart failure | |
| **Person with cardiac arrhythmia** | | |
| 44784217 | Cardiac arrhythmia | |
| 38001137 | Cardiac arrhythmia & conduction disorders w CC | |
| 38001138 | Cardiac arrhythmia & conduction disorders w/o CC/MCC | |
| 315078 | Palpitations | |
| 444070 | Tachycardia | |
| 21600248 | ANTIARRHYTHMICS, CLASS I AND III | |
| 43013024 | apixaban | |
| 40228152 | dabigatran etexilate | |
| 40241331 | rivaroxaban | |
| 1310149 | Warfarin | |
| 1309204 | Adenosine | |
| 45892847 | edoxaban | |
| 45890325 | Cardioversion, elective, electrical conversion of arrhythmia | |
| 45890400 | Operative tissue ablation and reconstruction of atria, extensive (eg, maze procedure) | |
| 2107068 | Operative tissue ablation and reconstruction of atria, performed at the time of other cardiac procedure(s), extensive (eg, maze procedure), with cardiopulmonary bypass (List separately in addition to code for primary procedure) | |
| 4051932 | Procedure for arrhythmia | |
| **Persons with bradycardia** | | |
| 4169095 | Bradycardia | |
| 316999 | Conduction disorder of the heart | |
| 4171683 | Sinus bradycardia | |
| 317302 | Sinus node dysfunction | |
| **Gastrointestinal bleeding events** | | |
| 262 | Emergency Room and Inpatient Visit | |
| 9203 | Emergency Room Visit | |
| 9201 | Inpatient Visit | |
| 4138962 | Acute duodenal ulcer without hemorrhage AND without perforation | X |
| 4195231 | Acute gastric ulcer without hemorrhage AND without perforation | X |
| 4147683 | Acute gastrojejunal ulcer without hemorrhage AND without perforation | |
| 4163865 | Acute peptic ulcer without hemorrhage AND without perforation | X |
| 195584 | Acute peptic ulcer without hemorrhage AND without perforation but with obstruction | X |
| 40482685 | Angiodysplasia of duodenum | |
| 28779 | Bleeding esophageal varices | |
| 4222896 | Chronic duodenal ulcer without hemorrhage AND without perforation | X |
| 4296611 | Chronic gastric ulcer without hemorrhage AND without perforation | X |
| 200769 | Chronic gastric ulcer without hemorrhage, without perforation AND without obstruction | X |
| 4177387 | Chronic gastrojejunal ulcer without hemorrhage AND without perforation | X |
| 434400 | Chronic gastrojejunal ulcer without hemorrhage AND without perforation but with obstruction | X |
| 438795 | Chronic gastrojejunal ulcer without hemorrhage, without perforation AND without obstruction | X |

| | | |
|---|---|---|
| 4204555 | Chronic peptic ulcer without hemorrhage AND without perforation | X |
| 24973 | Chronic peptic ulcer without hemorrhage AND without perforation but with obstruction | X |
| 23808 | Chronic peptic ulcer without hemorrhage, without perforation AND without obstruction | X |
| 2002608 | Control of hemorrhage and suture of ulcer of stomach or duodenum | |
| 198798 | Dieulafoy's vascular malformation | |
| 4198381 | Duodenal ulcer disease | |
| 4209746 | Duodenal ulcer without hemorrhage AND without perforation | X |
| 4112183 | Esophageal varices with bleeding, associated with another disorder | |
| 2108900 | Esophagogastroduodenoscopy, flexible, transoral; with control of bleeding, any method | |
| 2108878 | Esophagoscopy, flexible, transoral; with control of bleeding, any method | |
| 4265600 | Gastric ulcer | |
| 4248429 | Gastric ulcer without hemorrhage AND without perforation | X |
| 192671 | Gastrointestinal hemorrhage | |
| 4101104 | Gastrojejunal ulcer without hemorrhage AND without perforation | X |
| 443530 | Hematochezia | X |
| 197925 | Hemorrhage of rectum and anus | X |
| 4027663 | Peptic ulcer | |
| 4291028 | Peptic ulcer without hemorrhage AND without perforation | X |
| **All-cause mortality** | | |
| **Cardiovascular-related mortality** | | |
| 4329847 | Myocardial infarction | |
| 314666 | Old myocardial infarction | X |
| 376713 | Cerebral hemorrhage | |
| 439847 | Intracranial hemorrhage | |
| 432923 | Subarachnoid hemorrhage | |
| 4048809 | Brainstem death | |
| 321042 | Cardiac arrest | |
| 442289 | Death in less than 24 hours from onset of symptoms | |
| 4317150 | Sudden cardiac death | |
| 4132309 | Sudden death | |
| 437894 | Ventricular fibrillation | X |
| 315295 | Congestive rheumatic heart failure | X |
| 316139 | Heart failure | |
| 262 | Emergency Room and Inpatient Visit | |
| 9203 | Emergency Room Visit | |
| 9201 | Inpatient Visit | |
| 372924 | Cerebral artery occlusion | |
| 375557 | Cerebral embolism | |
| 443454 | Cerebral infarction | |
| 441874 | Cerebral thrombosis | |
| **Transient ischemic attack events** | | |
| 262 | Emergency Room and Inpatient Visit | |
| 9203 | Emergency Room Visit | |
| 9201 | Inpatient Visit | |
| 373503 | Transient cerebral ischemia | |
| **Stroke (ischemic or hemorrhagic) events** | | |
| 262 | Emergency Room and Inpatient Visit | |
| 9203 | Emergency Room Visit | |
| 9201 | Inpatient Visit | |

| | | |
|---|---|---|
| 372924 | Cerebral artery occlusion | |
| 375557 | Cerebral embolism | |
| 376713 | Cerebral hemorrhage | |
| 443454 | Cerebral infarction | |
| 441874 | Cerebral thrombosis | |
| 439847 | Intracranial hemorrhage | |
| 432923 | Subarachnoid hemorrhage | |
| **Acute myocardial infarction events** | | |
| 262 | Emergency Room and Inpatient Visit | |
| 9203 | Emergency Room Visit | |
| 9201 | Inpatient Visit | |
| 4329847 | Myocardial infarction | |
| 314666 | Old myocardial infarction | X |

## Psychiatric outcomes added in protocol amendment 1.5

| Concept ID | Name / Description | Concept ID to be Excluded |
|---|---|---|
| **Hospitalisation for Psychosis** | | |
| 262 | Emergency Room and Inpatient Visit | |
| 9201 | Inpatient Visit | |
| 375229 | Organic delusional disorder | X |
| 380986 | Senile dementia with delusion | X |
| 432590 | Delusional disorder | |
| 433031 | Hallucinations | |
| 434900 | Drug-Induced Psychosis | X |
| 434911 | Recurrent major depressive episodes, severe, with psychosis | |
| 435783 | Schizophrenia | |
| 436073 | Psychotic disorder | |
| 437532 | Recurrent manic episodes, severe, with psychosis | |
| 439246 | Mixed bipolar affective disorder, severe, with psychosis | |
| 439256 | Bipolar affective disorder, currently manic, severe, with psychosis | |
| 439259 | Single major depressive episode, severe, with psychosis | |
| 439262 | Single manic episode, severe, with psychosis | |
| 441540 | Reactive confusion | X |
| 4333667 | Presbyophrenic psychosis | X |
| **Incident Depression** | | |
| 21604490 | Antipsychotics | |
| 372608 | Amnesic disorder | |
| 372610 | Postconcussion syndrome | X |
| 373179 | Senile degeneration of brain | |
| 375239 | Degenerative brain disorder | |
| 376095 | Drug-induced dementia | X |
| 377788 | General paresis- neurosyphilis | X |
| 378726 | Dementia associated with alcoholism | X |
| 435088 | Senility | |
| 436092 | Pick's disease | |
| 4043378 | Frontotemporal dementia | |
| 4182210 | Dementia | |
| 435520 | Reactive depressive psychosis | X |
| 436665 | Bipolar disorder | X |
| 438727 | Atypical depressive disorder | X |

| | | |
|---|---|---|
| 440383 | Depressive disorder | |
| 4224940 | Schizoaffective disorder, depressive type | X |
| 40481798 | Chronic depressive personality disorder | X |
| 436665 | Bipolar disorder | |
| 437249 | Recurrent manic episodes | |
| 4333677 | Mania | |
| 703470 | Tranylcypromine | |
| 733896 | Phenelzine | |
| 766209 | Selegiline | |
| 781705 | Isocarboxazid | |
| 19127550 | Nialamide | |
| 703547 | Trazodone | |
| 714684 | nefazodone | |
| 725131 | Mirtazapine | |
| 750982 | Bupropion | |
| 794147 | Maprotiline | |
| 1398039 | St. Johns Wort Extract | |
| 19006186 | Tryptophan | |
| 19007737 | Mianserin | |
| 19008261 | Viloxazine | |
| 19041910 | tianeptine | |
| 19084693 | reboxetine | |
| 36427294 | Oxitriptan | |
| 36878783 | Agomelatine | |
| 40234834 | vilazodone | |
| 44507700 | vortioxetine | |
| 375229 | Organic delusional disorder | X |
| 380986 | Senile dementia with delusion | X |
| 432590 | Delusional disorder | |
| 434900 | Drug-induced psychosis | X |
| 435783 | Schizophrenia | |
| 436073 | Psychotic disorder | |
| 441540 | Reactive confusion | X |
| 4333667 | Presbyophrenic psychosis | X |
| 715259 | duloxetine | |
| 717607 | Desvenlafaxine | |
| 743670 | venlafaxine | |
| 19080226 | milnacipran | |
| 715939 | Escitalopram | |
| 722031 | Paroxetine | |
| 739138 | Sertraline | |
| 751412 | Fluvoxamine | |
| 755695 | Fluoxetine | |
| 797617 | Citalopram | |
| 705755 | Trimipramine | |
| 710062 | Amitriptyline | |
| 713109 | Amoxapine | |
| 716968 | Desipramine | |
| 721724 | Nortriptyline | |
| 738156 | Doxepin | |
| 754270 | Protriptyline | |
| 778268 | Imipramine | |

| | | |
|---|---|---|
| 798834 | Clomipramine | |
| 19023846 | dibenzepin | |
| 19032424 | amineptin | |
| 19037989 | Dothiepin | |
| 19039883 | butriptyline | |
| 19091830 | Lofepramine | |
| 19098514 | quinupramine | |
| 19110751 | Melitracen | |
| 19122204 | Iprindole | |
| 19129635 | Opipramol | |
| **Suicide and suicidal ideation** | | |
| 39235 | Self inflicted injury | |
| 440925 | Suicide | |
| 444362 | Suicidal deliberate poisoning | |
| 4181216 | Self-administered poisoning | |
| 4273391 | Suicidal thoughts | |
| 4303690 | Intentionally harming self | |

**Influenza infection (aim 2)**

| | | |
|---|---|---|
| **Episodes of influenza** | | |
| 4266367 | Influenza | |
| 4319159 | Influenza-like illness | |
| 4153160 | Influenza-like symptoms | |
| 4099911 | Parainfluenza virus bronchitis | |
| 439857 | Parainfluenza virus pneumonia | |

**Hospitalisation for pneumonia (Aim 3)**

| Concept ID | Name / Description | Concept id to be Excluded |
|---|---|---|
| **Hospitalizations with pneumonia** | | |
| 255848 | Pneumonia | |
| 262 | Emergency Room and Inpatient Visit | |
| 9201 | Inpatient Visit | |

**Negative control outcomes**

A list of negative control outcomes will also be assessed for which there is no causal relationship with choice of medication after a diagnosis of rheumatoid arthritis. These outcomes were identified using a semi-automatic process based on data extracted from literature, product labels and spontaneous reports followed by manual review by 2 clinicians.[34] The list is available in Annex 2.

### 9.3.3.- Covariates

**Cohort studies**

The following consistently extracted set of baseline patient characteristics will be constructed for inclusion as potentially confounding covariates in the regularized, logistic regression PS model.[35] From this large set of typically tens of thousands of covariates, key predictors of

exposure classification will be selected for the propensity score (See Section 9.7.). Note that not all data sources necessarily include data for all covariates. Covariates to be included:

- Demographics (age in 5-year bands, sex, race, ethnicity, index year, index month)
- All conditions occurrence records aggregated to SNOMED clinical finding level during the following lookback windows:
    - in 365 days prior to and including index date
    - in 30 days prior to and including index date
- All drug exposure records aggregated to RxNorm ingredient level and ATC classes during the following lookback windows:
    - in 365 days prior to and including index date
    - in 30 days prior to and including index date
    - persistent exposure that overlaps index date
- All procedure occurrence records during the following lookback windows:
    - in 365 days prior to and including index date
    - in 30 days prior to and including index date
- Measurements (including laboratories) within, above, and below normal range during the following lookback window:
    - in 365 days prior to and including index date
- Device exposure records during the following lookback windows:
    - in 365 days prior to and including index date
    - in 30 days prior to and including index date
- Comorbidity or risk scores including:
    - Charlson
    - DCSI
    - CHADS2
    - CHADS2VASc

**SCCS**

The effects of age and season will be assumed constant within each calendar month, and will each be modelled using bicubic splines with 5 knots. For more detail, see the SelfControlledCaseSeries package. (http://ohdsi.github.io/SelfControlledCaseSeries)

## 9.4. DATA SOURCES

This study will aim to be conducted using routinely collected data from different data sources that participate in the OHDSI and/or EHDEN initiatives.

These databases will provide representative clinical information as collected in actual practice conditions in different European healthcare settings, US, Australia and Japan routine practice. Further databases will be added as they are made available to this initiative.

The proposed databases have been proposed based upon their participation in the OHDSI and EHDEN initiatives after mapping to the OMOP common data model. Where possible, data will be accessed remotely by participants from data partner institutions in EHDEN (SIDIAP, IPCI, CPRD), from study investigators from Janssen Pharmaceuticals (CCAE, OptumEHR, MDCR, MDCD, JMDC, Optum de-identified Clinformatics® Data Mart) and from IQVIA (IMRD, IQVIA US Ambulatory EMR, IQVIA Disease Analyser Germany EMR, and IQVIA Hospital US Charge Master, US LRxDx Open Claims) and from the Department of Veterans Affairs.

Data available to Janssen have been described elsewhere and include US claims and EMR, and Japanese claims.[33] Other participating databases are detailed in the table below, and include electronic medical records and claims from Europe and the US.

All analyses will be conducted in a federated manner using tools previously validated and tested in a number of studies conducted by the OHDSI community.

**Table 9.4: Overview of the considered databases**

| Database name | Abbreviation | Population | Patients (millions) | Data History | Data capture process and short database description |
|---|---|---|---|---|---|
| Department of Veterans Affairs | VA | USA (Veteran population) | ~12M | 2000 – | VA OMOP data reflects the national Department of Veterans Affairs health care system, which is the largest integrated provider of medical and mental health services in the United States. Care is provided at 170 VA Medical Centers and 1,063 outpatient sites serving more than 9 million enrolled Veterans each year. |
| IQVIA Disease Analyzer Germany | DAGermany | Germany (General population) | 37M | 1992 – | Anonymized patient records collected from Patient Management software used by general practitioners and selected specialists to document patients' medical records within their office-based practice during a visit. |
| IQVIA UK Integrated Medical Record Data | IMRD | UK (General population) | 15M | 1989 – | Pseudonymized Electronic Medical Records collected from patient management software used within UK Primary Care |
| IQVIA US Ambulatory EMR | AmbEMR | USA (General population) | 49M | 2006 – | General practice EHR, Outpatient specialist EHR - Dataset consists of longitudinal, de-identified ambulatory electronic health records data |
| IQVIA US LRxDx Open Claims | OpenClaims | USA (General population) | 654M | 2010 – | Pre-adjudicated claims at the anonymized patient level collected from office-based physicians and specialists via office management software and clearinghouse switch sources for the purpose of reimbursement. |
| Clinical Practice Research Datalink | CPRD | UK (General population) | 13M | 1995 – | De-identified patient data from a network of clinical practitioners' practices across the UK. Primary care data are linked to a range of other health related data to provide a longitudinal, representative UK population health dataset. |
| IBM MarketScan Commercial Claims | CCAE | USA (Patients with commercial insurance aged <65 years) | 142M | 2000 – | Data from individuals enrolled in US employer-sponsored insurance health plans. The data includes adjudicated health insurance claims (e.g. inpatient, outpatient, and outpatient pharmacy) as well as enrollment data from large employers and health plans who provide private healthcare coverage to employees, their spouses,and dependents. Additionally, it captures laboratory tests for a subset of the covered lives. |
| IBM MarketScan Multi-State Medicaid Database | MDCD | USA | 26M | 2006 – | Adjudicated US health insurance claims for Medicaid enrollees from multiple states and includes hospital discharge diagnoses, outpatient diagnoses and procedures, and outpatient pharmacy claims as well as ethnicity and Medicare eligibility. |
| IBM MarketScan Medicare Supplemental Database | MDCR | USA (Patients with commercial insurance aged 65+ years) | 10M | 2000 – | Represents health services of retirees (aged 65 or older) in the United States with primary or Medicare supplemental coverage through privately insured fee-for-service, point-of-service, or capitated health plans. These data include adjudicated health insurance claims (e.g. inpatient, outpatient, and outpatient pharmacy). Additionally, it captures laboratory tests for a subset of the covered lives. |
| Integrated Primary Care Information | IPCI | Netherlands (General Population) | 2.5M | 1996- | Complete medical records collected from 450 general practitioners with geographical representation of the country. |
| Japan Medical Data Center | JMDC | Japan (insured general population) | 5.5M | 2005 – | Data from 60 Society-Managed Health Insurance plans covering workers aged 18 to 65 and their dependents (children younger than 18 years old and elderly people older than 65 years old). JMDC data includes membership status of the insured people and claims data provided byinsurers under contract (e.g. patient-level demographic information, inpatient and outpatient data inclusive of diagnosis and procedures, and prescriptions as dispensed claims information) |

| | | | | | |
|---|---|---|---|---|---|
| Optum de-identified Clinformatics® Data Mart Database | Clinformatics | USA (Patients with commercial insurance or commercial Medicare insurance) | 85M | 2000 - | Inpatient and outpatient healthcare insurance claims |
| Optum® de-identified Electronic Health Record Dataset | OptumEHR | USA (General population) | 93M | 2006 – | Optum's de-identified electronic health record data medical records database. The medical record data includes clinical information, inclusive of prescriptions as prescribed and administered, lab results, vital signs, body measurements, diagnoses, procedures, and information derived from clinical notes using Natural Language Processing (NLP). |
| The Information System for Research in Primary Care | SIDIAP | Spain-Catalonia (80% of general population) | 7.7M | 2006 – | Electronic health records from primary care partially linked to inpatient data. SIDIAP is also linked to a pharmacy dispensations and primary care laboratories. Healthcare is universal and taxpayer funded in the region, and primary care physicians are gatekeepers for all care and responsible for repeat prescriptions. |

## 9.5. STUDY SIZE

Since this study will be undertaken using routinely collected data, all patients meeting the eligibility criteria above will be included. No *a priori* sample calculation was performed; instead, a minimum detectable relative risk (MDRR) will be calculated for each target-comparator-outcome analysis in each of the available databases. Analyses are required to have >0 events observed during follow-up in both target or comparator cohorts in order to produce an estimate and standard error. Given at least 1 event is observed, a large MDRR in a single data source could contribute an underpowered estimate to a meta-analytic estimate provided adequate study diagnostics criteria are met (See Section 9.7.)

## 9.6. DATA MANAGEMENT

All data extraction and curation will be conducted using the ATLAS tool, an open source software platform by the OHDSI community, as well as the OHDSI Methods Library, a set of R packages developed and maintained by the OHDSI community. (https://ohdsi.github.io/MethodsLibrary)

The process will follow the steps described here:

1. Define concept set expressions that consist of the source codes used to record clinical observations in disparate data sources
2. Define the target and comparator exposure cohorts used as input to subsequent analytic routines
3. Ascertain outcome populations
4. Review of cohort diagnostics for study feasibility and clinical face validity (e.g. cohort sizes, age and sex-specific incidence rates, index event source code prevalence, clinical characteristics)

## 9.7. DATA ANALYSIS

### *SAFETY ANALYSES (AIMS 1 AND 2)*

### Comparative Cohort analysis in RA

The comparative safety of HCQ study in subjects with RA will be assessed through a comparative cohort analysis, compared against SSZ as an active comparator. The comparative safety of HCQ + AZM combination therapy will be compared against HCQ + AMX therapy in subjects with RA. Individuals with a history of the outcome occurring within the 30 days before index will be excluded from the analyses.

Analyses will use the CohortMethod package (https://ohdsi.github.io/CohortMethod/). This analytic package uses a large-scale propensity score constructed through the Cyclops package (https://ohdsi.github.io/Cyclops), based on many baseline covariates derived from the data, including all drugs, condition, and procedures observed prior to the treatment initiation, as well as summary scores such as the Charlson Comorbidity Index.[36]

Propensity score (PS) stratification will be used as the analytic strategy to adjust for imbalance between exposure cohorts in a comparison. The PS will be estimated using a large-scale regularized logistic regression fitted with a Laplace prior (LASSO) and with the optimal hyperparameter determined through 10-fold cross validation. The predictor variables included will be based on all observed patient characteristics and covariates available at each data source and extracted as described above (See Section 9.3.3.). We will exclude all covariates that occur in fewer than 0.1% of patients within the target and comparator cohorts prior to PS model fitting for computational efficiency. Patients in the target and comparator cohorts will be stratified into 5 PS quintiles. We will compute and plot the propensity score distribution and assess covariate balance expressed as the standardized difference of the mean for every covariate before and after propensity score adjustment. We will consider any standardized difference > 0.1 to indicate non-negligible imbalance between exposure cohorts.[37]

We compare the target cohort with the comparator cohort for the hazards of outcome during the follow-up periods by applying a univariate Cox proportional hazards model conditioned on the PS strata with treatment allocation as the sole explanatory variable.

### SCCS

Safety of HCQ therapy will also be assessed separately, regardless of indication, using SCCS analysis, comparing exposed and unexposed time periods within the same individuals. The method is self-controlled in that it makes within-person comparisons of event rates during periods of hypothesized increase risk with other periods of baseline risk, with eliminates all time-invariant confounding. Because we do not compare between persons, the SCCS is robust to between-person differences, even including unmeasured differences (like genetics). However, the method is vulnerable to time-varying confounders: the time of exposure may be incomparable to the time when not exposed. To adjust for this, we will include many time-varying co-variates in the models, including age, season, and other drug exposures (and by proxy underlying conditions treated by drug exposures).

The effect estimate is the IRR, which is derived from a Poisson regression that is conditioned on an outcome event having been observed. Hence, it is a case-only design where the population for which the inference is made is the intersection of the exposed population and case population. The method is considered a series because it uses longitudinal time-stamped

exposure and event information between fixed study start and end points. The validity of the SCCS effect measure relies on the main assumptions that events do not influence subsequent exposures, events do not influence the length of a patient's observation period with no time trend in outcome, and events arise in a non-homogenous Poisson process.[38,39] The event rate is modeled as

$$\lambda_{ij} = \exp(\phi_i + \beta_j)$$

where $\lambda_{ij}$ is the event rate for the ith person with the jth level exposure, $\phi_i$ is the individual effect for the ith person, and $\beta_j$ is the jth level exposure effect that acts multiplicatively relative to $\beta_0$=0. The case series likelihood function used to estimate $\beta_j$ takes a ratio form in which the individual effect $\phi_i$ cancels out as a nuisance parameter, rendering the effect $\beta_j$ implicitly controlled for individual effects. The estimate $\log(\beta_j)$ is the IRR and is interpreted as the effect of the jth level of the exposure on the outcome relative to the baseline risk.[40] We will adjust for age and season to reduce the risk of underlying confounding. In a separate sensitivity analysis, we will additionally adjust for time-dependent observation.[41]

The SCCS is run using the freely available package (https://ohdsi.github.io/SelfControlledCaseSeries/). This package allows the modelling of age and season as splines, and supports the multiple SCCS model (MSCCS), where all other drug exposures are included as time-varying covariates.[42] A large-scale regularized conditional Poisson regression fits the outcome model using the Cyclops package, with a hyperparameter selected through 10-fold cross-validation.

### Risk of systemic viral infections and of hospital-treated pneumonia (Aim 3)

The comparative and direct risk of systemic viral infections (flu) associated with the use of HCQ and HCQ + AZM will be assessed using both a comparative cohort study (comparison versus SSZ for HCQ, and HCQ + AMX for HCQ + AZM) and a SCCS (within-subject comparisons for each target exposure population separately), with the same methodology described for Aim 1.

The comparative and direct risk of hospital-treated pneumonia associated with the use of HCQ and HCQ + AZM will be assessed using both a comparative cohort study (comparison versus SSZ for HCQ, and HCQ + AMX for HCQ + AZM) and a SCCS (within-subject comparisons for each target exposure separately) with the same methodology described for Aim 1.

### Evidence Evaluation

In addition to the design-specific diagnostics, such as the covariate balance computed for the comparator cohort design, we will estimate overall residual bias in all designs using negative controls. An assessment of negative control outcomes (Annex 3) will be used to assess whether there is residual confounding after propensity score adjustment. An empirical null distribution will be fitted to the effect size estimates of the negative controls, allowing for quantification of residual bias and calibration of hazard ratios, confidence intervals, and p-values. If there is evidence of residual confounding and there is a sufficient number of control events, estimates will be calibrated.

Study diagnostics (power, propensity score distribution, covariate balance, empirical null distribution) will be evaluated by clinicians and epidemiologists to determine which database-target-comparator-outcome-analysis variants will produce unbiased estimates. Database-target-comparator-analysis variants with 0 outcomes in the time-at-risk window or contained

analyses with baseline covariate with standardized mean difference>0.1 after stratification will be excluded from analysis. Study diagnostics for all database-target-comparator-outcome-analysis will be provided as part of study, regardless of which effect estimation results are unblinded. The main models will be adjusted for unbalanced PS-variables at baseline.

All analysis code will be completed and version controlled at https://github.com/ohdsi-studies/Covid19DrugRepurposing prior to unblinding estimation results. All study diagnostics are available for exploration at https://data.ohdsi.org/Covid19EstimationHydroxychloroquine/.

All the proposed analyses will be conducted for each database separately, with estimates combined in fixed effects meta-analysis methods where I2 is <=40%. No meta-analysis will be conducted where I2 for a given drug-outcome pair is >40%.

### 9.8. LIMITATIONS OF THE RESEARCH METHODS

**Selection bias**

Selection bias might arise as the consequence of including subjects with a specific period of time available in the data. Attrition tables will be provided to report on the impact of such exclusion criteria.

**Information bias**

Information bias may occur due to the incorrect identification of exposure, outcomes or co-variates. With regards to exposure, misclassification may occur due to the patient not fulfilling the prescription (primary non-adherence) or in relation with non-compliance. Hence an overestimate of utilization of the study drugs can happen, expectedly leading to non-differential misclassification.

In addition, lack or incomplete recording of safety events may lead to misclassification of the proposed safety endpoints.

**Confounding**

As confounding by indication may produce differences in baseline characteristics between the comparator and target cohorts, we will use several methods to deal with confounding:

1. Restriction: comparative studies will be conducted only in subjects previously diagnosed with RA and using any of the drugs of interest as a first line treatment. In addition, we will trim the <5% and >95% percentiles of the preference score to maximise equipoise in the study population.
2. Propensity score stratification: we will stratify by PS quintiles to reduce confounding by indication.
3. Matching: for the comparative studies we will use propensity score matching (1:1) to minimise confounding related to all observed confounders.
4. Negative control outcome analyses will be used to identify any residual unobserved confounding in the propensity score analyses. If this analysis suggests the presence of relevant unresolved confounding then further analyses will not be completed.

## 10. PROTECTION OF HUMAN SUBJECTS

For this study, participants from numerous healthcare databases will be studied. The use of the OMOP common data model and OHDSI tools will enable the federated analysis of these different databases without changing access rights to patient-level data.

# 11. Management and reporting of adverse events/adverse reactions

According to the new guidelines for good pharmacovigilance practice (EMA/873138/2011) there is no requirement for expedited reporting of adverse drug reactions from studies with secondary use of data (such as electronic health care databases). All the identified adverse events/reactions will be summarized in the resulting manuscript/s and/or interactive web-based report of all conducted analyses.

# 12. Plans for disseminating and communicating study results

Dissemination activities will be of a scientific nature (articles in scientific journals, presentations at conferences, etc.). Our aim is for these studies to be made available as soon as possible in order to support treatment decisions in the global Covid-19 pandemic.

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# ANNEX 1. ENCEPP CHECKLIST FOR STUDY PROTOCOLS

**Study title:** Hydroxychloroquine safety and potential efficacy as an antiviral prophylaxis in light of potential wide-spread use in COVID-19: a multinational, large-scale network cohort and self-controlled case series study

**EU PAS Register® number:**
**Study reference number (if applicable):**

| **Section 1: Milestones** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 1.1 Does the protocol specify timelines for | | | | |
| 1.1.1 Start of data collection[1] | ☒ | ☐ | ☐ | 9.2.1 |
| 1.1.2 End of data collection[2] | ☒ | ☐ | ☐ | |
| 1.1.3 Progress report(s) | ☐ | ☐ | ☒ | |
| 1.1.4 Interim report(s) | ☐ | ☐ | ☒ | |
| 1.1.5 Registration in the EU PAS Register® | ☐ | ☐ | ☒ | |
| 1.1.6 Final report of study results. | ☐ | ☐ | ☒ | |

Comments:

| |
|---|
| |

| **Section 2: Research question** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 2.1 Does the formulation of the research question and objectives clearly explain: | ☒ | ☐ | ☐ | 7 |

[1] Date from which information on the first study is first recorded in the study dataset or, in the case of secondary use of data, the date from which data extraction starts.
[2] Date from which the analytical dataset is completely available.

| **Section 2: Research question** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 2.1.1 Why the study is conducted? (e.g. to address an important public health concern, a risk identified in the risk management plan, an emerging safety issue) | ☒ | ☐ | ☐ | |
| 2.1.2 The objective(s) of the study? | ☒ | ☐ | ☐ | 8 |
| 2.1.3 The target population? (i.e. population or subgroup to whom the study results are intended to be generalised) | ☒ | ☐ | ☐ | 9.2.2 |
| 2.1.4 Which hypothesis(-es) is (are) to be tested? | ☒ | ☐ | ☐ | 8 |
| 2.1.5 If applicable, that there is no *a priori* hypothesis? | ☐ | ☐ | ☒ | |

Comments:

| |
|---|
| |

| **Section 3: Study design** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 3.1 Is the study design described? (e.g. cohort, case-control, cross-sectional, other design) | ☒ | ☐ | ☐ | 9.1 |
| 3.2 Does the protocol specify whether the study is based on primary, secondary or combined data collection? | ☒ | ☐ | ☐ | 9.1 |
| 3.3 Does the protocol specify measures of occurrence? (e.g., rate, risk, prevalence) | ☒ | ☐ | ☐ | 9.7 |
| 3.4 Does the protocol specify measure(s) of association? (e.g. risk, odds ratio, excess risk, rate ratio, hazard ratio, risk/rate difference, number needed to harm (NNH)) | ☒ | ☐ | ☐ | 9.7 |
| 3.5 Does the protocol describe the approach for the collection and reporting of adverse events/adverse reactions? (e.g. adverse events that will not be collected in case of primary data collection) | ☐ | ☐ | ☒ | |

Comments:

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| **Section 4: Source and study populations** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 4.1 Is the source population described? | ☒ | ☐ | ☐ | 9.2.2 |
| 4.2 Is the planned study population defined in terms of: | | | | |
| 4.2.1 Study time period | ☒ | ☐ | ☐ | 9.2 |
| 4.2.2 Age and sex | ☒ | ☐ | ☐ | |
| 4.2.3 Country of origin | ☒ | ☐ | ☐ | |
| 4.2.4 Disease/indication | ☒ | ☐ | ☐ | |

| **Section 4: Source and study populations** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 4.2.5 Duration of follow-up | ☒ | ☐ | ☐ | |
| 4.3 Does the protocol define how the study population will be sampled from the source population? (e.g. event or inclusion/exclusion criteria) | ☒ | ☐ | ☐ | |

Comments:

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| **Section 5: Exposure definition and measurement** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 5.1 Does the protocol describe how the study exposure is defined and measured? (e.g. operational details for defining and categorising exposure, measurement of dose and duration of drug exposure) | ☒ | ☐ | ☐ | 9.2.2 & 9.3.1 |
| 5.2 Does the protocol address the validity of the exposure measurement? (e.g. precision, accuracy, use of validation sub-study) | ☒ | ☐ | ☐ | 9.2.2 |
| 5.3 Is exposure categorised according to time windows? | ☒ | ☐ | ☐ | 9.2.2 |
| 5.4 Is intensity of exposure addressed? (e.g. dose, duration) | ☒ | ☐ | ☐ | 9.2.2 |
| 5.5 Is exposure categorised based on biological mechanism of action and taking into account the pharmacokinetics and pharmacodynamics of the drug? | ☐ | ☐ | ☒ | |
| 5.6 Is (are) (an) appropriate comparator(s) identified? | ☒ | ☐ | ☐ | 9.2.2 & 9.3.1 |

Comments:

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| **Section 6: Outcome definition and measurement** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 6.1 Does the protocol specify the primary and secondary (if applicable) outcome(s) to be investigated? | ☒ | ☐ | ☐ | 9.3.2 |
| 6.2 Does the protocol describe how the outcomes are defined and measured? | ☒ | ☐ | ☐ | 9.3.2 |
| 6.3 Does the protocol address the validity of outcome measurement? (e.g. precision, accuracy, sensitivity, specificity, positive predictive value, use of validation sub-study) | ☒ | ☐ | ☐ | 9.3.2 |

| **Section 6: Outcome definition and measurement** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 6.4 Does the protocol describe specific outcomes relevant for Health Technology Assessment? (e.g. HRQoL, QALYs, DALYS, health care services utilisation, burden of disease or treatment, compliance, disease management) | ☐ | ☐ | ☒ | |

Comments:

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| **Section 7: Bias** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 7.1 Does the protocol address ways to measure confounding? (e.g. confounding by indication) | ☒ | ☐ | ☐ | 9.7 |
| 7.2 Does the protocol address selection bias? (e.g. healthy user/adherer bias) | ☒ | ☐ | ☐ | 9.8 |
| 7.3 Does the protocol address information bias? (e.g. misclassification of exposure and outcomes, time-related bias) | ☒ | ☐ | ☐ | 9.8 |

Comments:

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| **Section 8: Effect measure modification** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 8.1 Does the protocol address effect modifiers? (e.g. collection of data on known effect modifiers, sub-group analyses, anticipated direction of effect) | ☐ | ☐ | ☒ | |

Comments:

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| **Section 9: Data sources** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 9.1 Does the protocol describe the data source(s) used in the study for the ascertainment of: | | | | |
| 9.1.1 Exposure? (e.g. pharmacy dispensing, general practice prescribing, claims data, self-report, face-to-face interview) | ☒ | ☐ | ☐ | 9.4 |
| 9.1.2 Outcomes? (e.g. clinical records, laboratory markers or values, claims data, self-report, patient interview including scales and questionnaires, vital statistics) | ☒ | ☐ | ☐ | 9.4 |
| 9.1.3 Covariates and other characteristics? | ☒ | ☐ | ☐ | 9.4 |
| 9.2 Does the protocol describe the information available from the data source(s) on: | | | | |

| **Section 9: Data sources** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 9.2.1 Exposure? (e.g. date of dispensing, drug quantity, dose, number of days of supply prescription, daily dosage, prescriber) | ☒ | ☐ | ☐ | 9.3 |
| 9.2.2 Outcomes? (e.g. date of occurrence, multiple event, severity measures related to event) | ☒ | ☐ | ☐ | 9.3 |
| 9.2.3 Covariates and other characteristics? (e.g. age, sex, clinical and drug use history, co-morbidity, co-medications, lifestyle) | ☒ | ☐ | ☐ | 9.3 |
| 9.3 Is a coding system described for: | | | | |
| 9.3.1 Exposure? (e.g. WHO Drug Dictionary, Anatomical Therapeutic Chemical (ATC) Classification System) | ☒ | ☐ | ☐ | 9.3 |
| 9.3.2 Outcomes? (e.g. International Classification of Diseases (ICD), Medical Dictionary for Regulatory Activities (MedDRA)) | ☒ | ☐ | ☐ | 9.3 |
| 9.3.3 Covariates and other characteristics? | ☒ | ☐ | ☐ | 9.3 |
| 9.4 Is a linkage method between data sources described? (e.g. based on a unique identifier or other) | ☒ | ☐ | ☐ | 9.3 |

Comments:

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| **Section 10: Analysis plan** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 10.1 Are the statistical methods and the reason for their choice described? | ☒ | ☐ | ☐ | 9.3 & 9.7 |
| 10.2 Is study size and/or statistical precision estimated? | ☐ | ☐ | ☒ | 9.3 |
| 10.3 Are descriptive analyses included? | ☐ | ☐ | ☒ | |
| 10.4 Are stratified analyses included? | ☐ | ☐ | ☒ | |
| 10.5 Does the plan describe methods for analytic control of confounding? | ☒ | ☐ | ☐ | 9.7 |
| 10.6 Does the plan describe methods for analytic control of outcome misclassification? | ☒ | ☐ | ☐ | 9.8 |
| 10.7 Does the plan describe methods for handling missing data? | ☐ | ☐ | ☒ | |
| 10.8 Are relevant sensitivity analyses described? | ☒ | ☐ | ☐ | 9.7 |

Comments:

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| **Section 11: Data management and quality control** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 11.1 Does the protocol provide information on data storage? (e.g. software and IT environment, database maintenance and anti-fraud protection, archiving) | ☐ | ☐ | ☒ | |
| 11.2 Are methods of quality assurance described? | ☒ | ☐ | ☐ | 9.7 |
| 11.3 Is there a system in place for independent review of study results? | ☒ | ☐ | ☐ | 9.7 |

Comments:

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| **Section 12: Limitations** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 12.1 Does the protocol discuss the impact on the study results of: | | | | |
| 12.1.1 Selection bias? | ☒ | ☐ | ☐ | |
| 12.1.2 Information bias? | ☒ | ☐ | ☐ | 9.8 |
| 12.1.3 Residual/unmeasured confounding? (e.g. anticipated direction and magnitude of such biases, validation sub-study, use of validation and external data, analytical methods). | ☒ | ☐ | ☐ | |
| 12.2 Does the protocol discuss study feasibility? (e.g. study size, anticipated exposure uptake, duration of follow-up in a cohort study, patient recruitment, precision of the estimates) | ☒ | ☐ | ☐ | 9.6 |

Comments:

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| **Section 13: Ethical/data protection issues** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 13.1 Have requirements of Ethics Committee/ Institutional Review Board been described? | ☐ | ☐ | ☒ | |
| 13.2 Has any outcome of an ethical review procedure been addressed? | ☐ | ☐ | ☒ | |
| 13.3 Have data protection requirements been described? | ☐ | ☐ | ☒ | |

Comments:

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| **Section 14: Amendments and deviations** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 14.1 Does the protocol include a section to document amendments and deviations? | ☒ | ☐ | ☐ | 5 |

Comments:

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| Updated for protocol version 1.5 to note amendments made |

| **Section 15: Plans for communication of study results** | **Yes** | **No** | **N/A** | **Section Number** |
|---|---|---|---|---|
| 15.1 Are plans described for communicating study results (e.g. to regulatory authorities)? | ☒ | ☐ | ☐ | 12 |
| 15.2 Are plans described for disseminating study results externally, including publication? | ☒ | ☐ | ☐ | 12 |

Comments:

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Name of the main author of the protocol: Daniel Prieto-Alhambra

Date: 02/04/2020

Signature: _____

# ANNEX 2: NEGATIVE CONTROL OUTCOME LIST

*note outcomes highlighted with an asterisk will not be excluded for protocol amendment 1.5

assessment of psychiatric safety outcomes

| Concept ID | Concept Name |
|---|---|
| 378256 | Abnormal reflex |
| 4092879 | Absent kidney |
| 433753 | Alcohol abuse |
| 321689 | Apnea |
| 78200 | Benign mammary dysplasia |
| 4195873 | Breath smells unpleasant |
| 443792 | Calculus of bile duct |
| 434327 | Cannabis abuse* |
| 197318 | Cholesterolosis of gallbladder |
| 432303 | Cocaine abuse* |
| 439125 | Complete trisomy 21 syndrome |
| 433270 | Cord entanglement without compression |
| 4311591 | Cramp in limb |
| 441267 | Cystic fibrosis |
| 436233 | Delayed milestone |
| 40486120 | Delay in physiological development |
| 439791 | Emotional upset* |
| 374801 | Foreign body in ear |
| 259995 | Foreign body in orifice |
| 196456 | Gallstone |
| 4166231 | Genetic predisposition |
| 434164 | Glycosuria |
| 4163735 | Hemochromatosis |

| | |
|---|---|
| 439871 | Hemospermia |
| 4058388 | Hypertrophic scar |
| 435522 | Hypervitaminosis D |
| 443236 | Hypnotic or anxiolytic dependence |
| 4098604 | Hypomagnesemia |
| 435371 | Hypothermia |
| 443447 | Iatrogenic hypotension |
| 374375 | Impacted cerumen |
| 4344500 | Impingement syndrome of shoulder region |
| 440382 | Learning difficulties |
| 435516 | Lipoprotein deficiency disorder |
| 438808 | Mammary duct ectasia |
| 441553 | Myoclonus |
| 4119307 | Neurogenic claudication |
| 4209423 | Nicotine dependence |
| 438130 | Opioid abuse* |
| 313601 | Oxygen supply absent |
| 44782778 | Pain disorder with psychological factor* |
| 4091513 | Passing flatus |
| 4022076 | Patient dependence on care provider |
| 439971 | Poisoning by anticoagulant |
| 46286594 | Problem related to lifestyle |
| 199876 | Prolapse of female genital organs |
| 4049367 | Psychologic conversion disorder |
| 440068 | Psychosexual dysfunction* |
| 436246 | Reduced libido* |
| 73754 | Restless legs |
| 4168212 | Restlessness and agitation* |
| 138821 | Seborrhea |
| 4198492 | Shoulder joint unstable |
| 25518 | Sickle cell trait |
| 4176908 | Snapping thumb syndrome |
| 4248728 | Snoring |
| 138278 | Sprains and strains of joints and adjacent muscles |
| 4008710 | Stenosis due to any device, implant AND/OR graft |
| 40479573 | Stimulant abuse* |
| 40483172 | Stimulant dependence* |
| 440233 | Strain of supraspinatus muscle AND/OR tendon |
| 4194160 | Thyroid function tests abnormal |
| 4216708 | Urgent desire for stool |
| 4275889 | Visual hallucinations* |
| 4193634 | Worried* |