A SOCIAL MEDIA STUDY ON THE EFFECTS OF PSYCHIATRIC MEDICATION USE

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- One in Six Americans take *psychiatric medications*

- Five of the top 50 drugs sold in the U.S. are *psychiatric medications*
EFFECTS OF PSYCHIATRIC MEDICATIONS

• Their mechanism of action poorly understood
• Selection of drug treatments is primarily on trial-and-error basis
• Understanding the effects of psychiatric medication is important
• Clinical trials and reports of adverse events
• Limitations with the existing methodologies
...conducts a large-scale social media study of the effects of 49 FDA approved antidepressants across four major families (SSRIs, SNRIs, TCAs, and TeCAs)

...adopts a patient-centered approach to study the effects of these drugs as reflected and self-reported in longitudinal social media data
PATIENT-CENTERED APPROACH

- Historically, psychiatric care has adopted a “Disease-Centered Model”
  - Neglects the psychoactive effects of drugs
- Consequently, a “Drug-Centered Model” has been advocated
  - Care becomes more collaborative
- “Patient-Centered Model”
Psy. Drug mentions in 2015-16

Self-reports of Intake

Personal Drug Intake Classifier

Stream Data

Account created before 2015?

Compile Treatment & Control Data

Conduct Before and After samples data

Treatment User Data

LIWC
n-grams
Depression
Anxiety
Stress
Psychosis
Suicide

Treatement Covariates

Compute covariates on data before treatment dates

Stratify similar users on propensity scores

Control User Data

Covariates

Control Date

Compute covariates on data before treatment dates

Stratify similar users on propensity scores

Treatement Covariates

User strata

Outcomes

Relative Treatment Effect (RTE) per drug

Compare the outcomes of similar users

P. Affect
N. Affect
Cognition
Depression
Anxiety
Psychosis
Suicide

Control Covariates

Construct Before and After samples data

Before and After samples data
I’m taking my first dose of X tonight.

First day on X. Dose 1 taken, and I already feel weird from it.

My no-med experiment went horribly awry, so I’m starting X today.
TREATMENT AND CONTROL DATASET

- Twitter timelines of 23,191 users who self-reported psychiatric medication intake (2015-2016) [Treatment]

- Random Twitter user timelines (283,374 users) [Control]
STUDY DESIGN

• Conduct Observational Study
• Adopt a Causal Inference Framework based on Matching
• Compare the outcomes of similar (matched) individuals, those exposed to a treatment (psychiatric drug intake), and those who were not.
• Use stratified propensity score analysis
BEFORE AND AFTER SAMPLES

• For Treatment users, the before and after the date of the first intake of medications

• For Control users, we simulate placebo dates by non-parametrically assigning dates from the distribution of Treatment dates.
MEASURING SYMPTOMATIC OUTCOMES

- Affect and Cognition
- Depression, Anxiety, Stress, Psychosis, and Suicidal Ideation
LIWC categories of
- positive and negative affect for affect,
- cognitive mechanics, causation, certainty, inhibition, discrepancies, negation, and tentativeness for cognition
DEPRESSION, ANXIETY, STRESS, PSYCHOSIS, SUICIDAL IDEATION

- Supervised learning classifiers trained on Reddit domain-specific datasets
- Positive class from r/depression, r/anxiety, r/stress, r/psychosis, r/SuicideWatch
- Negative class from 20M Reddit posts gathered from 20 subreddits (eg. r/AskReddit, r/aww, r/movies).
MATCHING FOR CAUSAL INFERENCE

Covariates:
- Social Attributes (#tweets, #followers, #followees, duration on platform, frequency of posting)
- Top 2,000 unigrams
- Normalized psycholinguistic occurrence of LIWC categories
- Baseline mental health status (aggregated use of depression, anxiety, stress, psychosis, and suicidal ideation)
PROPENSITY SCORE ANALYSIS

• Use logistic regression classifier to estimate propensity scores on covariates
• 100 strata of equal width of propensity scores
• Standardized differences to measure balance of covariates
TREATMENT EFFECT

• Relative Treatment Effect (RTE)
  • Ratio of change in outcome of Tr. And Ct. users per stratum

• Individual Treatment Effect (ITE)
  • Regress on psycholinguistic attributes and outcome in Ct. users
  • Predict on attributes of matched Tr. users
  • Ratio of actual (counterfactual) and predicted outcome
RELATIVE TREATMENT EFFECT

P. Affect
N. Affect
Cognition
Depression
Anxiety
Psychosis
Suicidal Idn.

Amitriptyline
Atomoxetine
Bupropion
Buspirone
Citalopram
Clomipramine
Desvenlafaxine
Dosulepin
Doxepin
Duloxetine
Escitalopram
Fluoxetine
Fluvoxamine
Imipramine
Mirtazapine
Nortriptyline
Paroxetine
Sertraline
Venlafaxine
Vortioxetine

SSRI
SSNRI
TeCA
TCA
INDIVIDUAL TREATMENT EFFECT

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- **Blues** indicate greater likelihood of improvement
- **Reds** indicate greater likelihood of worsening
DISCUSSION
TAKEAWAYS

• Social media is an effective sensor to scalably detect behavioral changes in those who initiate treatment via (self-reported) use of psychiatric medications

• Observe that people’s online behaviors change in some unexpected ways following drug intake
POLICY AND ETHICS

• Potential negative consequences of this work
• Ethical complexities
• Self-treatment
CLINICAL IMPLICATIONS

• Patient-Centered Approach to Pharmacological Care
  • Complementary insights into the effects of drugs
  • Pre-treatment signals seem to be predictive of individual drug success

• Drug Repurposing
  • Low cost and high volume assessments of people’s own reports and perceptions related to antidepressants’ use
TECHNOLOGICAL IMPLICATIONS

- Technologies for Regulatory Bodies
- Technologies for Drug Safety Surveillance
- Technologies to support Digital Therapeutics
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Thank You

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