The Use of Social Media to Diagnose and Treat Major Depressive Disorder particularly in teenagers and young adults

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ABSTRACT
Major Depressive Disorder (MDD) is defined as a mental illness and affects an estimated 300 million people worldwide. The disorder affects people in different ways and there is a wide spectrum of symptoms which are very hard to detect, unless a patient comes forward with the issue themselves. In this paper we are going to discuss the ways in which we can use social media to detect MDD in individuals and possibly alleviate the symptoms in the future. We will also discuss the inevitable ethical issues that are associated with these methods.

INTRODUCTION
Major Depressive Disorder (MDD), also known as clinical depression, is “a mental illness which constitutes a serious challenge in personal and public health” and is ranked by the World Health Organisation (WHO) as one of the most burdensome diseases in the world. An individual who suffers from clinical depression would have the typical symptoms of a low mood along with a low self-esteem, a feeling of worthlessness, guilt and helplessness and a loss of interest in activities that the individual would normally find pleasurable (Figure 1). As well as the psychological symptoms, the individual would also face physical symptoms such as disturbed sleep, fatigue, restlessness and a change in appetite which eventually leads to a change in weight; typically weight loss.

Figure 1: Sadness or Hopelessness which prevented usual activities by gender and race/ethnicity, High School students, 2007

Figure 1 shows how many students at an American high school felt that their sadness or hopelessness prevented usual activities in their day to day lives. For females especially, this is a very high percentage of pupils and something must be done to help these students cope with their illness.

Depression is one of the most widely reported mental disorders among adolescents. Depression is associated with several risk behaviours and suicide, the third leading cause of mortality for 15 to 24 year olds.

The illness affects an estimated 300 million people worldwide (WHO, 2001) and although people have become more aware of the disease, many people are not able to recognise whether or not they are suffering from it themselves. Also, the ways in which clinical depression is
detected, supported and treated globally are seen as insufficient because the diagnosis is typically based on the patient’s own experience or reports from relatives or friends of the patient, due to this, there need to be better ways in which we can detect and possibly treat MDD; one of these ways could potentially be through social media.

The most at risk of developing clinical depression are women, who are 70% more likely to develop it than men and 18-24 year olds, who also have the highest prevalence of mental disorders. The 18-29 year olds also happen to have the largest presence on social networking sites; with 84% of Facebook users, 31% of Twitter users and 37% of Instagram users being from this group. So these sites could be used to monitor users with the hope of identifying MDD cases before they develop.

A recent scientific investigation carried out by the Microsoft Research team has suggested a way; they have utilised social networking sites such as Twitter to help to detect and predict MDD in individuals. They have employed “crowdsourcing” to collect data on known sufferers of MDD and monitored their behaviour, language and the emotions they displayed on Twitter. They then used this data to create a statistical classifier which provided estimates for the behaviour of potential sufferers before they were diagnosed.

They also found that the times at which people used these sites had a bearing on whether they had clinical depression or not. For the non-depression class of people, they were less active later in the night and early in the morning, but for the depression class of people peaks of use were shown in the late night and lower activity in the day, as seen in Figure 2. The peaks for posts of the depression class are around the 20th hour and the 1st hour of the day. This finding is supported by the Lustberg & Reynolds report (2000), which showed that 8 in 10 people suffering from MDD have their symptoms worsening in the night. So by monitoring those whose peak usage times fit this pattern, we may be able to find people who may be suffering from depression.

Figure 2: mean number of posts per hour for a non-depression and depression class
There are many self-diagnosis depression tests online where the subject answers a series of questions by selecting options, however the options are not exhaustive, are quite ambiguous and subjective therefore it can lead to people becoming confused. Another method of diagnosis is proposed in a recent study, which had been conducted by the University of Cambridge which involved using the saliva and a survey of teenage boys in order to identify teenage boys with a high risk of developing depression. The investigation aimed to use the levels of cortisol, commonly known as the stress hormone, in the saliva to do so. Higher stress levels tend to be directly proportional to a higher risk of depression so this could be a sensible strategy to test the predictions from Microsoft’s research. The study also incorporated mood questionnaires to help to assess each subject’s risk of developing MDD. 1 in 6 boys in the group of 1,858 teenagers were put in the high-risk category and half of them were diagnosed with clinical depression during the three years of study. As this test does not cater for teenage girls due to their naturally higher cortisol levels, more research is needed to find a suitable test for teenage girls.

A promising alternative method for diagnosing clinical depression is to observe the subjects in their natural environment through social media scanning. The use of the Microsoft’s technique of illustrating an individual’s behaviour online and predicting depression before it is developed shows potential for future modelling to start treatment earlier which would be beneficial for medicine. The research team themselves also hope the study can lead to development of scalable methods for automated public health tracking at-scale, so local GPs are able to detect any sign of depression in their patients.

Another experiment devised by Microsoft showed that post-natal depression (PND) could be predicted using Twitter. They used an algorithm which picked up subtle verbal cues which revealed underlying unhappiness or anxiety, a general trend in negativity in posts and a heightened number of profanities were all factors in a new mother suffering PND. They found that they could also extrapolate back to the trend two to three weeks before the birth of the baby and the same “clues” were found in 80% of cases. Horvitz, the co-director of Microsoft Research in Washington believes an app could be developed from this idea that could help new mothers. A similar idea could also be used in identifying MDD in teenagers and young adults, a pattern from known depression cases can be extrapolated back, and once this pattern is detected, the app can be used to convey general information and sometimes personalised help to individuals.

Massimo Poesio and Tommaso Fornaciari, two computational linguists, created a computer system that is highly accurate at detecting deceptive language in written, as well as spoken, statements. The program uses stylometry, which is the study of linguistic style, to count how often certain words appear in order to detect deception. Perhaps, a certain style and rhythm of writing could be linked to MDD and a similar program could be used to detect depression through posts submitted on social networking sites.
Social Bro (Figure 3), a tweet analysing site allows users to see the topics their followers post, their tweeting frequency and their social activity. A program that uses stylometry to detect clinical depression can be used in collaboration with Social Bro to aid clinicians in identifying potential cases of MDD. However, on a site such as Social Bro you can only analyse people who are following you on Twitter, so to be able to analyse several people, you must in turn be followed by several people but the idea of their tweets being monitored may discourage them. So for this project to be successful, individuals would need to follow one of the NHS Twitter profiles such as NHS England and NHS Choices, but as of April 2014 only 1.1% of 15.5 million people actively using Twitter in the UK follow these profiles. NHS will need to find a way to overcome this problem possibly by introducing a social media account which does a similar job to the NHS 111 line but for social media users.

Social Bro can also be used alongside another scheme managed by the Health and Social Care Information Centre (HSCIC). As of March 2014, medical records of everyone in England will be transferred to a central database, at-risk patients could be flagged on this database, and if they are Twitter users, by using Social Bro, their tweets can be analysed for trigger patterns. The main problem with these schemes is the backlash that the NHS would face as it is common knowledge that the NHS faced criticism after announcing that patients’ details will be transferred to the central database, as patients felt that their confidentiality could be undermined.

Combining all of the above schemes and studies would create an efficient technique to diagnose MDD in patients; but one could question the long-term reliability of this. From the Microsoft study, patterns were found in the posts of patients genuinely diagnosed with MDD and from this, Social Bro could be used to identify the patterns (e.g. the topics being discussed by these patients), then the HSCIC scheme could be used to find at-risk patients and compare their pattern of tweeting to try and find people with MDD. However people may not behave the same way on the internet once they discover they are being monitored on social media sites. Users may be cautious not to use words or phrases which may trigger suspicion that they may have clinical depression or some users may even deliberately post tweets to trigger a response from clinicians. However this is an issue that can be eradicated through the use of the Poesio and Fornaciari system to detect deception in the language used by these individuals.
Early detection of MDD in young people would help to develop medicine in the future, perhaps doctors could discover how to prevent further development of the disease which would lead to less suicides worldwide because about two thirds of people who commit suicide are depressed during their time of death and studies indicate that 90% of teens who die by suicide were suffering from a mental disorder that they just weren’t diagnosed with. In fact the risk of attempting suicide with people who have MDD is 20 times more than that of those who do not suffer from clinical depression. Also adolescents with unidentified mental disorders are in poorer physical health and engage in more risky behaviours than their peers. So it is imperative that we are able to diagnose teenagers with any mental diseases they may have in order to prevent suicides.

We must also ask ourselves if social media holds the key to alleviating the symptoms of depression and could possibly cure it? A recent study by a Neuro-economist Paul J. Zak has scientifically proven that using social media triggers the release of the Oxytocin, a hormone that acts as a neurotransmitter in the brain and plays a huge role in pair bonding. Stress is a major component of depression and leads to the release of the hormone cortisol by the adrenal glands. Research has proven that elevated cortisol levels have been associated with reduced hippocampal volumes. The hippocampus (Figure 5) is part of the limbic system and its role is within long-term memory and those that have lost “major portions of the limbic system, but still have the hippocampus, only have long term memory and cannot record any new memories or functions”. This could possibly be due to the cortisol which attacks the neurons and causes the hippocampus to reduce in size. “Cortisol also stimulates the amygdala while it impairs the hippocampus, forcing our attention onto the emotions we feel, while restricting our ability to take in new information” which could explain why people with depression and stress may find it hard to concentrate.

An idea into how to solve this problem lies within social media. A smaller hippocampus also means there are fewer serotonin receptors so less serotonin is secreted. According to Bristol University, Serotonin is involved in many bodily functions seen in figure 4.

Higher Serotonin levels can alleviate symptoms of depression. “Serotonin and Oxytocin co-release in the brain so increasing serotonin levels is likely to increase oxytocin”. In the same way increasing Oxytocin levels could increase serotonin levels. As previously explained Oxytocin is released while using social media which makes us feel good. We think that if we monitor Oxytocin levels with response to stimuli online then using the results collected, the stimulus which increases the Oxytocin level the most could be used to help increase serotonin levels. The reason this would have to be done is because serotonin “cannot cross the blood-brain barrier. Therefore serotonin that is used inside the brain must be produced within it” which is why serotonin levels cannot be increased artificially for example through injecting the hormone.
The study would start with measuring the levels of Oxytocin and Serotonin in the brain of the subjects. Plasma Oxytocin can be measured with radioimmunoassay after plasma extraction to see the level of Oxytocin present and Serotonin levels through taking blood from a vein and testing it. The subjects will then use social media for a set period of time. During this time, the oxytocin levels will be monitored. The stimuli which increases the oxytocin level should be noted specifically i.e. describe the picture or message, its theme, content etc. These results should be analysed clearly showing what increases the oxytocin levels and by how much. As the levels of oxytocin in the brain may still be high directly after social media use, there will be a break between this part of the study and the next whether it is weeks or months. Using the same subjects, measure the serotonin levels in the blood plasma before exposing them to the stimuli which best increased the oxytocin levels in the first part of the study. Again the subjects should be exposed this stimuli for a set period of time but the same as before. Directly after this, another test should be taken to see if the serotonin levels in the brain have increased.

If the study is successful then the levels of cortisol and possibly the volume of the hippocampus would be increased. A larger hippocampus could mean more serotonin so less symptoms of depression and possibly reduced depression. But this would only be the case if the production of serotonin was the cause of the depressive symptoms. In some cases, people with depression do not have low serotonin levels so this test may not have an effect on them. In these cases more personalised measures suited to the cause of the depression will have to be taken to alleviate these symptoms.

This method will not work presently as the only way of monitoring the hormone levels is through blood tests which take a while to produce the results and it would be unethical to constantly take that much blood from a subject. In order to test this theory, more advanced technology which could possibly measure hormone levels from outside the body would be needed. The study would also require a control group in order to prove that it is the increased oxytocin levels that are increasing the levels of serotonin. This would include these subjects not using social media or partaking in oxytocin inducing activity. Finally, the study could work but in the short run. Research into how long term use of social media increases the oxytocin levels in the brain will need to be conducted.

If successful, the use of subtle positive messages on these sites could subliminally decrease people’s depression, this is an idea already in play on sites such as Tumblr where users have
taken it upon themselves to try and alleviate clinical depression. Furthermore, Barbara Sahakian at University of Cambridge states that teenagers, especially males, do not respond to talking therapies, such as cognitive behavioural therapy (CBT), instead they respond better to visual techniques. Thereby, social media sites can be used to alleviate the effects of clinical depression by using soothing colours such as orange and water-based imagery so individuals subconsciously become more relaxed and soothed. However to be certain of this, studies need to be administered to test the accuracy of the psychological effect of colour.

However, studies done by several individuals such as Sloan et al. and Berenbaum and Oltmanns show that when faced with positive stimuli, the depressed subjects reacted negatively rather than positively (feeling “less pleasant, less emotionally aroused”). They also reacted negatively to negative stimuli, so perhaps the solution would be for the social networking sites to block all negative images – but this is an ambiguous request as what is seen as negative is subjective.

Given the conflicting feelings of the boundaries that doctors can cross, more research must obviously be done to prove the importance of accessing the accounts of patients and using their posts on social networking sites, and to prove that it does work.

Should social media be proven to successfully detect depression in individuals accurately then we believe that sufferers of the mental illness will be informed faster and will be able to receive treatment quicker.
CONCLUSION

Social media is a promising tool for public health, not only can we use it to predict possible sufferers, but we can also use it to help ease the suffering that they go through.

Earlier detection will not only lead to less suffering for the patient; there would be less emotional and financial burden. It also prevents relapse once treatment begins, this is important for long term recovery and could prevent suicides in young people.

However there are problems with our ideas, as it is unlikely many teenagers and young adults would want people to know if they have a mental health issue as it could affect their chances of getting some jobs. So it is important to raise awareness of mental illnesses so people feel more comfortable in coming forward and accepting treatment, otherwise it may be uncomfortable for them to talk about their feelings.

The Teen Depression Awareness Project discussed “barriers” that teens could encounter such as worrying about their family’s perceptions about them having this illness; this may be grounds for adolescents to refuse to acknowledge their illness and to refuse treatment. Through the use of apps however the problem becomes more confidential and teenagers may find this more welcoming as they can discuss their illness with a doctor and come to terms with it before telling their family. The project also found that patients’ parents were more willing to accept the care that would be provided than the patients themselves (Figure 6), so once again more awareness is needed so teenagers are more comfortable to receive care.

Another problem is that not the entire population of teenagers and young adults are present on these sites, so there needs to be a way to make them aware of some of the symptoms of MDD through other means such as advertisements on popular sites such as Google and Hotmail.

There is also the difficulty in establishing boundaries, when do doctors and researchers know how far they can go? Many people may feel that to analyse tweets without permission first would be wrong, but others argue that once it is on the internet it is free for public use. A way around this is to establish an agreement with the researchers so that the use of this information can remain confidential.

As the world today is driven by technology and there is a greater presence online, we believe that social media should play a greater part in helping to detect depression in people in the UK.
and around the world, however beforehand more studies need to be conducted to ensure the accuracy of the research carried out by Microsoft. Given the number of people with MDD in the world and the success of the initiatives already discussed, introducing these measures into mainstream medicine would significantly increase the number of people receiving early diagnosis of the disease and therefore receiving early treatment.
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Images

• Figure 1

• Figure 2

• Figure 3
  http://www.socialbro.com/

• Figure 4
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• Figure 5
  http://www.memorylossonline.com/glossary/images/hippocampus.jpg

• Figure 6