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A Network Perspective on Suicidal Behaviour

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Abstract

Although suicide is a major public health issue worldwide, we understand little of the onset and development of suicidal behavior. Suicidal behavior is argued to be the end result of the complex interaction between psychological, social and biological factors. Traditional epidemiological techniques are not able to deal with this complexity. A new technique called network analysis can help us better understand suicidal behavior as it allows to visualize and quantify complex association between many symptoms. It moves away from the idea that symptoms are caused by an underlying common cause such as depression or suicidality. Instead, symptoms are thought to cause each other. A network perspective has been successfully applied to the field of depression and psychosis, but not yet to the field of suicidology. In this perspective article, I will argue that a network perspective on suicidal behavior can help us to 1) better understand suicidal behavior, 2) develop more sensitive diagnostic tools for subgroups of patients, and 3) help the personalized treatment of suicidal behavior. I will provide examples based on real data, and offer directions for future studies.

Keywords: suicide; network analysis; symptoms; personalized treatment

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1. Introduction

Suicide is a major public health issue worldwide[1]. It is the tenth leading cause of death, and in many countries, numbers have been increasing since the economic crisis in 2007[2]. In the past years, many epidemiology studies have been done, and many datasets containing information on suicidal behavior are available. Still, we understand little of the aetiology and development of suicidal behavior, only that it is highly complex interplay between psychological, social and biological factors[3,4]. Traditional epidemiological analysis has resulted mostly in static, general risk factors such as age and gender. This is interesting from a public health care perspective, but not of much use for the individual patient, or his therapist. The notion that older males are at higher risk for suicide then younger females is not specific enough to be of clinical relevance. I propose to re-analyze the existing databases from a network perspective to improve our understanding of suicidal behavior, to develop more specific diagnostic criteria and improve personalized treatment.

Traditional psychiatric thinking states that there is one latent underlying disorder (depression, or in our case suicidality) that can cause different symptoms (Fig 1)[5,6].

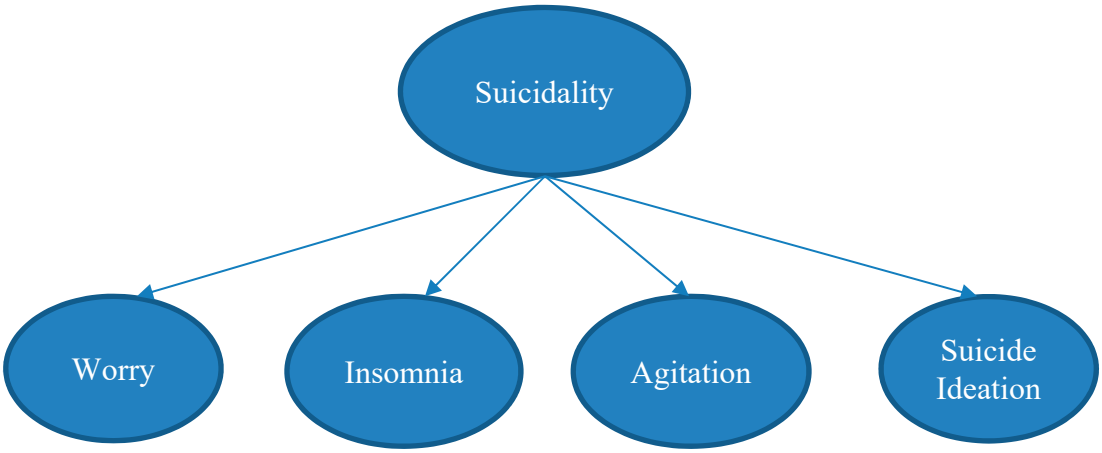
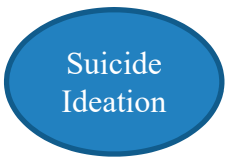


Figure 1: the common cause model. Suicidality causes underlying symptoms such as worrying, insomnia and suicidal ideaton.

This medical common cause model is recently being questioned. It is argued that in psychiatry, there is no common cause, such as a tumor that causes symptoms (for example coughing). Rather, psychiatric symptoms are thought to cause each other [5,6] (Fig 2).



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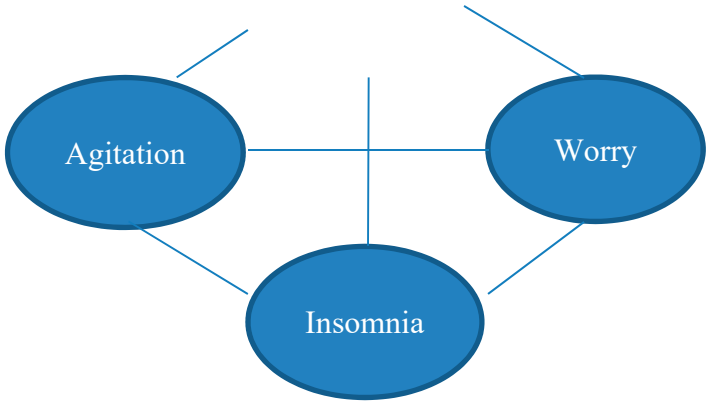

Figure 2. A network perspective on the interaction between four symptoms

In figure two, insomnia, worrying, agitation and suicidal thoughts are related to each other, and thereby influence each other. This shift in thinking about psychopathology is called a network perspective[5,7]. In a network approach to psychopathology, there is no underlying disorder anymore, but only the pairwise interaction between separate symptoms (fig 2). Network analysis makes it possible to analyse how one symptom, such as brooding, is interconnected with other symptoms or with an outcome at follow up. A network perspective has been applied to the field of depression[8], psychosis [9] and Post Traumatic Stress disorder[10] , but not yet to the field of suicidology. As suicidal behavior is argued to be trans diagnostic [11]and the end result of the highly complex interaction between many factors[3], it is highly suited to be analyzed from a network perspective.

2. Materials and Method

In the remainder of this perspective article, I will argue that a network perspective on suicidal behavior can help us to 1) better understand suicidal behavior, 2) develop more sensitive diagnostic tools for subgroups of patients, and 3) help the personalized treatment of suicidal behavior. I will provide examples based on real data, and offer directions for future studies.

3. Results

3.1 Better understanding of the onset and development of suicidal behavior

Despite many years of research and data collection, we are still not able to understand, let alone predict suicidal behavior[4]. Even within a high risk population, such as patients treated in a hospital

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for a suicide attempt, the predictive validity of our current models and assessment tools is only slightly better than change[12]. To help thinking about the complexity of suicidal behavior, the Integrated Motivational Volitional Model (IMV) was developed[3].

The IMV model defines suicidal behavior as a complex interaction between many different (pre)motivational and volitional phase factors. The motivational phase of the model describes the symptoms that are associated with the emergence of suicidal thoughts. By contrast, volitional phase symptoms are defined as those symptoms that govern the transition from suicidal thinking (ideation/intent) to suicidal behaviour, i.e., when a suicide attempt is more likely. A standard traditional epidemiological analysis will validate the model as follows:

$$Y \text{ (Suicidal Behavior)} = \beta x_1(Worrying) + \beta x_2(entrapment) + \beta x_3(impulsivity) + \beta x_1 * \beta x_2 + \beta x_2 * \beta x_3 + \beta x_1 * \beta x_3$$

where Y stands for the independent variable, β_i for the regression coefficient, x_i for the independent variable, and $\beta x_1 * \beta x_2$ for the interaction between variable x_1 and x_2.

Within standard analysis, it is difficult to add more variables, without compromising on the interpretability of the model. Therefore, any analysis is likely to leave out many different important explanatory variables such as thwarted belongingness, brooding, social support and so on. Importantly, as the variables are likely to interact with each other (i.e. are not independent predictors), this further complicates the possibility to use regression techniques as a way of analyzing complex behavior such as suicidal behavior. With regard to more sophisticated modelling, such as path analysis, these analysis state that there must be an underlying common cause, to which all individual variables are linked[13]. As stated earlier, this is unlikely to be a realistic assumption in psychiatry. Within a network perspective, all separate factors, such as sleeping bad, fatigue, desire for suicide, or social support can be viewed upon as nodes in a network (Fig 3).

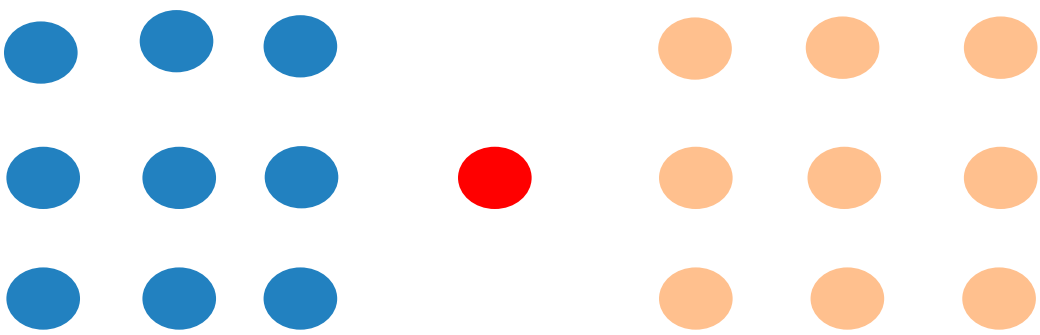

Figure 3: Schematic representation of suicide symptoms as nodes in a network, blue represents motivational factors, orange volitional factors. The red node stands for suicidal behavior at 15 months follow up.

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Two nodes are connected by a line if there is any relevant association between the two nodes. Whether there is a relevant association is determined by a partial correlation matrix, in which spurious (non relevant) correlations are set to zero[14]. Additionally, the so-called Fruchterman Reingold Algorithm places nodes that are most central (most important) in the middle, and less connected or important nodes on the edge of the network[15]. The software package qgraph[16] lets you estimate and visualize such a network. This results can result in a graph such as shown in figure 4.

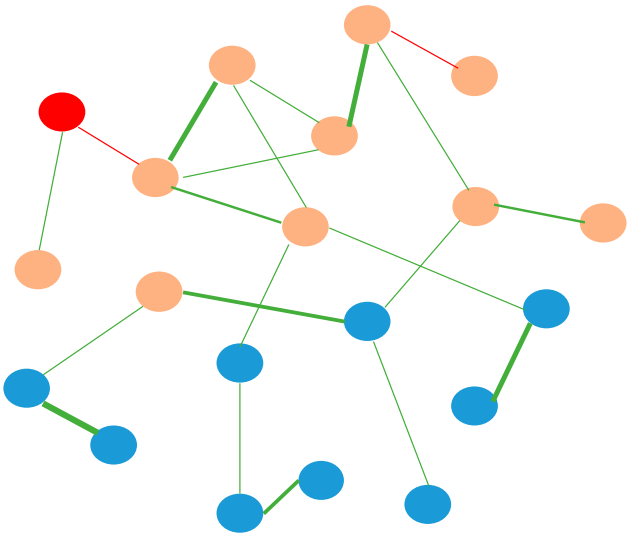

figure 4: Simplified representation of a network of suicidal symptoms of 366 patients treated for a suicide attempt. Placing of the nodes indicate the centrality of the nods. The more central, the more a node is positioned in the middle. Green lines represent positive relationship, red lines a negative association. The thicker the line, the stronger the association.

Figure 4 is a simplified representation based on the network of suicidal symptoms of 366 hospital treated suicidal patients. Full details this particular network analysis can be found in de Beurs et al [17]. For this perspective article, the most important message is that the relationship between different symptoms (the blue and orange nodes) and suicidal behavior at 15 months follow up (the red node) can be visualized as a network. Most importantly, one can see the network as the development of the suicidal process. One can calculate which symptoms are most central or important, i.e. connected to other symptoms[7]. These symptoms are argued to be most contagious, and change on that symptom is most likely to trigger a negative feedback loop. Within the current sample, the Beurs et al [17] found that the desire for an active attempt was most contagious symptom. Early identification and early

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treatment can focus on this most contagious symptom, as any interventions will likely influence other symptoms, and this symptom may serve as a smoke detector for the start of a (new) suicidal crisis.

3.2 Differences between subgroups of patients

It is widely known that male suicidal behavior differs from female suicidal behavior[11]. After 2007, male suicides have significantly increased, while female suicidal behavior kept on declining[18]. However, in many studies of suicidal behavior, females and males are analyzed as one group (see for example [19]). This results in non-specific risk factors for suicidal behavior, that are of limited use when predicting suicidal behavior. Understanding the difference in symptom structure between subgroups of patients will help develop more sensitive diagnostics. Using the earlier mentioned dataset, I estimated the network of five suicide symptoms (wish to live, wish to die, reasons for living, desire for an attempt, wiliness to save ones live) separate for males (n = 158) and females (n = 258) (Fig 5).

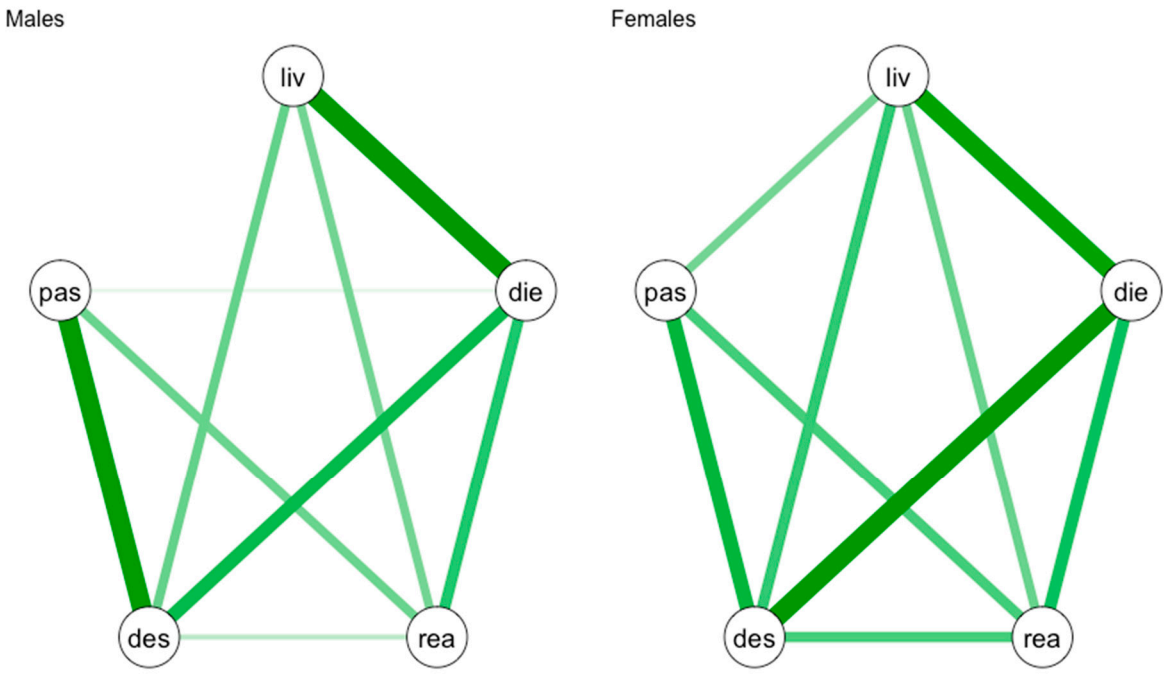

Figure 5: network of 5 suicidal symptoms for males and females. Liv, wish to live; Die, Wish to die; Rea, reasons for living/dying; Des, desire for an active attempt; Pas; passive desire

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One sees that there are subtle differences in network structure for males and females. The network of females looks denser (strongly connected) when compared to the network of males. In the field of depression research, a more dense network was linked to worse outcome at follow up[8]. Additionally, it is possible to formally test the difference between networks using the R package NCT[8]. In our example the difference was not significant ($p = 0.07$), indicating that within a sample of hospital treated suicide attempters, the interaction between these five suicide symptoms does not differ between males and females. This quick example gives an insight in the potential of network analysis to better understand differences between subgroups of patients. These insights can then be translated into more calibrated diagnostic criteria to determine if somebody is in risk for suicidal behavior.

3.3 Personalized treatment

When data is collected on multiple time point per patients (for example via a mobile phone[19]) it is possible to form a unique network per patient. Through this unique network, the patient can learn how different psychopathological symptoms interact within himself, and how to recognize the start of a new suicidal crisis. For example, one patient can discover that there is a strong connection between fatigue, worrying and suicidal thoughts. Another patient can be more sensitive to a negative social experience, which results in suicidal ideation. A patient can use his unique network as a tool to improve and personalize treatment. Ideally, the unique network should be shared with professionals and significant others, and the three actors should consider the network structure when discussing therapy and safety planning. Such a research program on mobile phone data and suicidal behavior has just been started at the VU Amsterdam. The program is called CASPAR (Continuous Assessment for Suicide Prevention and Research) and will collect data among 30-60 patients in treatment of specialized health care. This data will be available end of 2017 and will offer the first opportunity to develop individual networks of suicide symptoms.

4. Discussion

Network analysis can help us to better understand the complex interaction between symptoms that result into suicidal behavior, and it can help us better differentiate between subgroups of patients. Network studies in other field of psychiatry have resulted in new insights. For one, it was found that a more densely connected network at baseline predicts the presence of depression at follow up[8]. Within the field of psychosis, network analysis revealed the relationship between childhood trauma and psychotic symptoms[9]. For individual suicidal patients, the main asset lies in the fact that they

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can get insights in their own unique personalized network, making personalized treatment and safety planning much more likely. As suicidal behavior is both trans diagnostic and highly complex, a network analysis of has much to offer to suicidologist, clinicians and suicidal patients.

Future studies

For the application of network analysis on suicidal behaviour, two things are needed: A large enough dataset containing relevant suicidal symptoms, and the software program R. R has a steep learning curve, but R studio offers an intuitive user interface. Additionally, there have been published many tutorial papers, and the R package qgraph offers easy to use syntax[16]. Sites like psychosystems.org offer a lively community of scientists using network analyis within the field of psychiatry.

Together with a international consortium of suicide researchers, I am reanalyzing national and internationally datasets with information on suicidal behavior from a network perspective. In the Netherlands, there are several large databases such as the NESDA (Netherlands study of depression and anxiety[20]). The NESDA is a longitudinal cohort study that collected the depressive, anxiety and suicidal symptoms of about 3000 patients. Within the Scottish Wellbeing study from the Suicidal Behavior Research Laboratory, data is collected among 3500 Scottish adolescents on many different suicidal symptoms such as entrapment, defeat, social exclusion, intrusion of images, perceived burdensomeness etc. Other datasets of interest are the national inquiry into suicide and homicide of the university of Manchester, and the Belgium self-harm database that contains data on over 15.000 patients treated for a suicide attempt in Belgium hospitals during a 26-year study period[21]. By re-analyzing these large datasets, I expect to better understand the interaction between many different suicidal symptoms, learn about the differences between male and female suicidal behavior, and zoom in on the difference between depressed patients that show suicidal behavior, and depressed patients that do not.

As network analysis is relatively new technique, there are some important disclaimers to make. For one, it is of importance to have large datasets before one can estimate a stable analysis. Although the psychometrics are still being tested, as a rule of thumb, it is argued that you need at least as many observations as you have parameters. So, for 10 symptoms, you need at least 55 observations (10 nodes + 10*9/2 possible interactions), for 20 210 and for 50 already 1250[22]. Additionally, as the example in this article is based on cross-sectional data, there is no direct evidence of causality[7]. The

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desire for an active attempt was indeed most central, but longitudinal studies have to prove that intervening on these symptoms indeed results in less psychopathology at follow up. Finally, both the theory and software are still being improved. I therefore recommend anyone interested in these kind of analysis to closely follow the papers of the psychosystems.org group.

5. Conclusion

Network analysis can help us better understand suicidal behavior as it allows to visualize and quantify complex association between many symptoms without the assumption of an underlying common cause.

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Conflict of interest

The author declares no conflict of interest

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