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Research paper

Computerized Adaptive Test vs. decision trees: Development of a support decision system to identify suicidal behavior

D. Delgado-Gomez [a], E. Baca-Garcia [b,c], D. Aguado [d], P. Courtet [e,f], J. Lopez-Castroman [f,g,*]

[a] Department of Statistics, Carlos III University, Madrid, Spain
[b] Department of Psychiatry, IIS-Jimenez Diaz Foundation, CIBERSAM, Madrid, Spain
[c] Department of Psychiatry, Columbia University/New York State Psychiatric Institute, New York, United States
[d] Instituto Ingeniería del Conocimiento, Autonoma University of Madrid, Madrid, Spain
[e] CHRU Montpellier and University of Montpellier, France
[f] INSERM Unit 1061, Montpellier, France
[g] CHU Nimes and University of Montpellier, France

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ABSTRACT

Background: Several Computerized Adaptive Tests (CATs) have been proposed to facilitate assessments in mental health. These tests are built in a standard way, disregarding useful and usually available information not included in the assessment scales that could increase the precision and utility of CATs, such as the history of suicide attempts.
Methods: Using the items of a previously developed scale for suicidal risk, we compared the performance of a standard CAT and a decision tree in a support decision system to identify suicidal behavior. We included the history of past suicide attempts as a class for the separation of patients in the decision tree.
Results: The decision tree needed an average of four items to achieve a similar accuracy than a standard CAT with nine items. The accuracy of the decision tree, obtained after 25 cross-validations, was 81.4%. A shortened test adapted for the separation of suicidal and non-suicidal patients was developed.
Conclusion: CATs can be very useful tools for the assessment of suicidal risk. However, standard CATs do not use all the information that is available. A decision tree can improve the precision of the assessment since they are constructed using a priori information.

1. Introduction

The use of Computerized Adaptive Tests (CATs) is becoming popular in clinical psychology and psychiatry, to speed up the assessments while maintaining the accuracy of conventional paper and pencil tests (Gibbons et al., 2014). Time-saving evaluations are particularly important for mental health professionals that have very limited time for structured assessments, and even the more so in hospital settings such as the emergency department. Thus, several studies have tried CATs in the evaluation of different mental conditions, such as depression (Fliege et al., 2005; Gardner et al., 2004; Gibbons et al., 2012), anxiety (Becker et al., 2008; Gibbons et al., 2008), or personality disorders (Simms et al., 2011). Although CATs are not yet implemented in daily clinical practice, they are a promising tool for mental health assessments.

Many different scales are used to evaluate suicidal risk and some of them, such as the Columbia Suicide Severity Rating Scale (Posner et al., 2011) or the Suicide Assessment Scale (Waern et al., 2010), have shown a predictive capacity for future attempts. However, their performance can be improved (Swedish Council on Health Technology Assessment, 2015). Several approaches have been used to select the most informative items from usual assessments. First, changing the weights assigned to each item to increase the accuracy of the scale. For instance, applying a standard logistic regression to combine the items of the Suicide Intent Scale and the Karolinska Interpersonal Violence Scale improved the prediction of suicide deaths (Stefansson et al., 2015). Second, a feature selection algorithm can select directly the most appropriate items. For instance, Blasco-Fontecilla et al. built a small but performing scale to identify suicide attempters, the Personality and Life Event scale (PLE scale), using the Lars-en algorithm (Blasco-Fontecilla et al., 2012). Third, De Beurs et al. have recently proposed the use of a CAT created from Beck's Scale for Suicide Ideation to facilitate the assessment (De Beurs et al., 2014). The advantage of this approach is that the items are tailored to the patient, i.e., non-relevant items are not presented. Of note, relevant information can also be obtained from medical records as

* Correspondence to: Inserm U1061 – Hôpital La Colombière, Pavillon 42, 39 Av. Charles Flahault, B.P. 34493, 34093 Montpellier, Cedex 5, France.
E-mail address: jorgecastroman@gmail.com (J. Lopez-Castroman).

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has been shown in a recent article where prior medical records outperformed an assessment scale in the prediction of suicidal risk (Tran et al., 2014).

When assessing suicidal behavior, clinicians usually have access (through the own patient, his/her relatives or the medical records) to information about previous suicide attempts. This information has never been used to improve the precision of a CAT. We hypothesize that a Decision Tree (DT), using information about the history of suicide attempts, will obtain better results than the standard CAT procedure. Our hypothesis is based in recent results concerning the assessment of depression/anxiety that show how DTs can obtain a similar precision while administering half of the items when compared to a standard CAT (Gibbons et al., 2015). In order to verify the hypothesis, we will test both procedures in a large sample of participants that had completed the PLE scale.

2. Methods

2.1. Sample

The study sample comprised a total of 902 participants aged 18 years or older. All of them had completed the PLE Scale. There were three subsamples: 356 first-time suicide attempters (226 women and 130 men), 120 psychiatric inpatients without current or past history of suicidal behavior (71 women and 49 men) and 426 healthy controls (blood donors; 226 women and 130 men). All participants were recruited in two university hospitals in Madrid (Fundacion Jimenez Diaz and Ramon y Cajal), Spain, between 1999 and 2003. Healthy controls had neither Axis I diagnoses nor a history of suicidal behavior. A description of the sample is provided in Table 1. The appropriate ethics committee approved the study. The study was carried out in accordance with the latest version of the Declaration of Helsinki. All participants provided written informed consent before participating in the study.

2.2. Assessment

We used the items of the PLE scale, designed to assess suicidal risk and composed by 27 items (Table 2). All the items, with the exception of the age variable, were selected from psychological scales frequently used in the assessment of suicidal behavior, such as the Barratt Impulsivity Scale (Patton et al., 1995), the social readjustment rating scale (Holmes and Rahe, 1967), the Brown and Goodwin scale of aggression (Brown et al., 1979) and the International Personality Disorder Examination Screening Questionnaire (IPDE-SQ; Loranger, 1994). However, three items were excluded from the analyses in this study. The item "Armed aggression to others", which was answered positively by less than 0.5% of the sample, was removed because it would have reduced the clinical utility of the CAT. In addition, a parallel analysis (Hayton et al., 2004) of the PLE scale found two factors accounting for 25.2% of the variance and 5.8% of the variance, respectively (Fig. 1). The second factor included only two items ("I plan for job security" and "I plan trips well ahead of time") that were excluded to fulfill the assumption of one dimensionality.

Table 2
Personality and Life Events Items and the corresponding Samejima's parameters.

PLE scale Item Bank	B1	B2	B3	A
1. I am self-controlled	−0.62	0.55	1.61	1.47
2. I act "on impulse"	−0.82	0.71	1.89	1.24
3. I spend or charge more than I earn	1.08	1.91	2.89	1.10
4. I often feel "empty" inside	0.16	–	–	3.01
5. I worry about being alone and having to care for myself.	0.78	–	–	1.65
6. I have tantrums or angry outbursts.	0.22	–	–	1.82
7. I have been the victim of unfair attacks on my character or reputation	0.41	–	–	1.57
8. I can't decide what kind of person I want to be	0.76	–	–	1.16
9. I think my spouse (or lover) may be unfaithful to me	1.14	–	–	1.12
10. I usually feel uncomfortable or helpless when I am alone	0.59	–	–	1.54
11. I won't get involved with people until I'm certain they like me	0.58	–	–	1.13
12. I have little or no desire to have sex with anyone	1.46	–	–	0.97
13. People think I am odd or eccentric	1.03	–	–	1.46
14. I go to extremes to try to keep people from leaving me	1.12	–	–	2.17
15. My feelings are like weather, they are always changing	0.71	–	–	1.78
16. People have a high opinion on me	1.48	–	–	0.66
17. I usually get fun and enjoyment out of life	0.99	–	–	1.89
18. Major change in frequency of arguments with spouse	1.45	–	–	1.19
19. Revision of personal habits	3.32	–	–	0.86
20. Marital separation	2.04	–	–	0.92
21. Major personal injury or illness	2.11	–	–	1.01
22. Gaining a new family member (i. e. birth, adoption older adult move in, etc.)	2.61	–	–	0.61
23. Adult self-harm	1.63	1.84	2.57	1.63
24. Armed aggression to others	–	–	–	–
25. I plan for job security.	–	–	–	–
26. I plan trips well ahead of time.	–	–	–	–

Table 1
Description of the sample.

Features	Suicide attempters (N=356) n (%)	Healthy controls (N=426) n (%)	Psychiatric inpatients (N=120) n (%)	Stats	df	p-value
Sex (female)	226 (63.5)	163 (38.3)	71 (59.2)	52.99	2	<0.001
Age (mean ± SD)	37.3 ± 13.9	35.8 ± 11.3	42.5 ± 13.5	13.1	2 (899)	<0.001
Marital Status						
Single	159 (44.7)	198 (46.5)	70 (58.3)	11.4	2	0.003
Married/cohabiting	126 (35.4)	214 (50.2)	34 (28.3)			
Separated/widowed	71 (19.9)	14 (3.3)	16 (13.4)			
Years of education						
<8	117 (32.8)	95 (22.3)	37 (30.8)	23.1	2	<0.001
9–12	157 (44.1)	169 (39.7)	44 (36.7)			
>12	77 (21.6)	158 (37.0)	38 (31.7)			
Employment status						
Unemployed	97 (27.2)	38 (9.4)	40 (33.3)	122.8	2	<0.001
Employed	169 (47.5)	362 (85.0)	46 (38.3)			
Disabled/retired	85 (23.9)	8 (2.0)	33 (27.5)			

P-values were obtained with Kruskal-Wallis tests with the exception of age that was calculated using Anova.