Predictive modelling of no-show in outpatient forensic mental health care: a machine-learning approach

Administrative information

Trial registration:

Protocol version: 2024-02-20 version 0.1

Funding: The Dimence Group facilitated this project. The Dimence Group was not involved in the study (e.g., design, analysis, and interpretation of data).

Roles and responsibilities:
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AK played a major role in the data collection, data analysis, interpretation of the data. EG initiated the study, leads the project, maintaining contact with stakeholders, coordinates the study and wrote the protocol. JM engage in collaborative analysis and maintaining contact with stakeholders. SB played a major role in the data collection, data analysis, interpretation of the data and wrote the protocol. RR facilitated budget for hiring external support and allocating hours to start working on this project. GR allocating hours to start working on this project. MV and LC contributed to the study protocol and will supervise the intervention in their teams.

Introduction

Background and objectives

The issue of patient non-attendance or tardy cancellation of appointments is a prevalent challenge for healthcare facilities (Fenger et al., 2011). These occurrences, commonly labeled as ‘no-shows’, have significant implications for financial costs, treatment progression, and patient waiting periods. Several factors have been found in the literature that can be associated with no-shows, for example previous no-show (Woicik, 2016; Dantas, 2018) and low socio-economic status (Neal et al., 2001; Dantas, 2018).
Oikonomidi and colleagues (2023) concluded in a systematic review that employing predictive modeling alongside text message reminders, phone call reminders, and patient navigator calls likely leads to a reduction in no-show occurrences.
The objectives of this study were 1) to build a predictive model for no-show for patients in forensic mental health, incorporating factors previously identified in the literature as

influencing no-show rates, 2) to implement the model in clinical practice, and 3) to determine if phone call reminders, for the group with a considerable predicted risk of no-show at the next appointment, leads to a reduction in no-show occurrences.

Trial design
A no-show prediction model for outpatient forensic mental health care will be developed using data between January 2020 and June 2024 and validated prospectively using data of minimal one month.
This model will be implemented and tested in clinical practice using data of minimal three months. The six outpatient forensic locations of Transfore, part of the Dimence Groep, will be divided into two different groups. One group, consisting of two locations (Enschede and Zwolle), will implement the model and patients with a high risk of missing their appointment will receive a reminder phone call. More specially, patients whose appointments are registered as not cancelled at the time of the calls and whose predicted risk of no-show is at least 0.50 receive a reminder phone call. These reminder calls are made two days in advance. In the other group, no information is shared about patients with at higher risk of no-show and no intervention is applied.
The consequence of this method of group allocation is that the outpatient forensic locations are not randomised.

Methods: Participants, interventions, and outcomes

Study setting: Six outpatient forensic outpatient locations of Transfore, part of the Dimence Groep, a mental health care institution in the Netherlands.

Inclusion and exclusion criteria: All appointments for participants who received outpatient treatment at Transfore between the earlier mentioned period were included. Exclusion criteria were appointments that were cancelled by the therapist or the patient more than 24 hours before the appointment and crisis appointments.

Interventions: Patients whose appointments, at the time of the calls, were recorded as not having been cancelled, and whose predicted risk of no-show was at least 0.50 received a reminder phone call. These reminder calls are made two days in advance. Reminder calls scheduled on Saturday and Sunday were combined with those of Friday. A call script was developed to ensure uniformity in reminder phone calls. A successful phone call was defined as one in which the caller conversed with the patient regarding the appointment with a maximum of two attempts. The outcomes related to the appointment reminder (i.e., whether the patient was reached, appointment cancellation or rescheduling, appointment attendance) were registered.

Outcomes: The outcome variable was patient attendance at an appointment, with two possible outcomes: 1) attendance and 2) no-show (defined as the patient not attending the appointment or the patient cancelling the appointment less than 24 hours before the appointment).

Participant timeline: All appointments for participants who received outpatient treatment at Transfore between January 2020 and the end of the pilot. The pilot is expected to be completed by mid-2025.

Sample size: The estimated number of appointments needed is 2.858. The calculation is attached below.

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POWER PROPORTIONS ONESAMPLE
 /PARAMETERS TEST=DIRECTIONAL ESTIMATE=NORMAL CONTINUITY=TRUE SIGNIFICANCE=0.05 POWER=0.80
   NULL=0.12 ALTERNATIVE=0.105.
```

Power Analysis - One-Sample Proportion

Power Analysis Table

			Test Assumptions			
	N	Actual Power[b]	Power	Null	Alternative	Sig.
Test for Proportion[a]	2858	,800	,8	,12	,105	,05

a. One-sided test.
b. Based on normal approximation with continuity correction.

The no-show rate for these teams is around 13%. If this no-show rate can be reduced by 1.5%, this will have a positive impact on the financial results of around € 100,000 per year.

Recruitment: Since these are existing patient's appointments, no recruitment is necessary.

Methods: Data collection, management, and analysis

Data collection methods: This concerns existing data recorded in the electronic patient file of Dimence Group. The data will be accessed from this.

Data management: The data will be stored at the network drive. The network drive is protected for unauthorized access and the measures in the dataset are pseudonymized.

Statistical methods: Missing data will be imputed using Machine Learning approaches. To build the predictive model, the statistical program R, more specifically Tidymodels packages, was used. Various prediction models have been developed, such as the Random Forest and XGBoost.
In order to test the model in clinical practice, the effect of the reminder phone calls was analysed using a one-sample t-test. The no-show rate in the intervention teams (two outpatient forensic locations of Transfore) during the intervention was compared with the no-show rate in the recent past. Additionally, no-show rate in the intervention teams is compared to the no-show rate in the control group (the four other outpatient forensic locations of Transfore), using the chi square test.
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Ethics and dissemination

Research ethics approval: n/a

Protocol amendments: n/a

Consent or assent: An informed consent for the participants is not necessary.

Confidentiality: The information of the appointments will be collected out of the electronic patient file of Dimence Group. The data will be stored at the network drive. The network drive is protected for unauthorized access and the measures in the dataset are pseudonymized.

Declaration of interests: There are no competing interests.

Access to data: The data will be stored at the network drive, with limited access.

References

Dantas, L. F., Fleck, J. L., Cyrino Oliveira, F. L., & Hamacher, S. (2018). No-shows in appointment scheduling - a systematic literature review. Health policy (Amsterdam, Netherlands), 122(4), 412–421. https://doi.org/10.1016/j.healthpol.2018.02.002

Fenger M, Mortensen EL, Poulsen S, Lau M (2011) No-shows, drop-outs and completers in psychotherapeutic treatment: Demographic and clinical predictors in a large sample of non-psychotic patients. *Nordic Journal of Psychiatry 65:* 183–191. DOI:10.3109/08039488.2010.515687.

Oikonomidi, T., Norman, G., McGarrigle, L., Stokes, J., van der Veer, S. N., & Dowding, D. (2023). Predictive model-based interventions to reduce outpatient no-shows: a rapid systematic review. *Journal of the American Medical Informatics Association: JAMIA, 30*(3), 559–569. https://doi.org/10.1093/jamia/ocac242

Woicik, K., van der Lem, R., Sijtsema, J. J., & Bogaerts, S. (2017). Treatment no-show in forensic outpatients with ADHD. *Criminal behaviour and mental health: CBMH, 27*(1), 76–88. https://doi.org/10.1002/cbm.1989