Examining efforts to predict day of surgery cancellation (DOSC): A systematic review protocol

Thomas Sardesai[1], Laura Hobbs[2], Caroline Phillips[3], Tom Bashford[2], Katharina Kohler[2], Daniel Stubbs[4]

1 – School of Clinical Medicine, Addenbrooke's Hospital, Hills Road, Cambridge, UK. ORCid: 0009-0001-5313-0998

2 – International Health Systems, Department of Engineering & Division of Anaesthesia, University of Cambridge, Cambridge, UK

3 – Cambridge University Hospitals NHS Foundation Trust, Cambridge, UK

4 – University of Cambridge Division of Anaesthesia, Addenbrooke's Hospital, Hills Road, Cambridge, UK. ORCid: 0000-0003-2778-5226

Corresponding author:

Dr DJ Stubbs

University of Cambridge Division of Anaesthesia, Addenbrooke's Hospital, Hills Road, Cambridge, CB2 0QQ

Djs225@cam.ac.uk

01223 217889

Word count (including tables, not including abstract or references): 1911

Examining efforts to predict day of surgery cancellation (DOSC): A systematic review protocol

ABSTRACT

Day-of-surgery cancellation (DOSC) in elective surgery occurs in roughly 18% of elective surgeries worldwide. This impacts patient physical health, psychological wellbeing, and social function. Further impacts include reduced health service efficiency and wider economic productivity. There are a range of contributing variables including patient factors, resource constraints, and health service pressures which could be integrated into predictive models. This article describes the protocol for a systematic review to evaluate peer-reviewed original research articles and implementation studies of models to predict DOSC. Such statistical models could, if properly integrated into clinical practice, yield benefits to patients and healthcare providers. The systematic review will provide a comprehensive synthesis of evidence in this area to inform future efforts at gold-standard statistical modelling. Predictor-finding studies, subsequent publications of the same model and publications in which the predictive variables have not been disclosed will be excluded. Searches will be conducted in Medline, Embase, Scopus and Web of science. Risk of bias will be assessed using the prediction model risk of bias assessment tool (PROBAST). Data will be collected on included variables, method of prediction, whether prediction was made at the level of the patient or the system, and training and assessment processes. This data will be subject to qualitative synthesis and used to generate a narrative summary and figures. This systematic review will abide by the 2020 PRISMA guidelines. This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors. This review is registered on PROSPERO, registration CRD42023478984.

Keywords

- Day of surgery cancellation
- Predictive modelling
- Innovation in surgery

INTRODUCTION

Day-of-surgery cancellation (DOSC) in elective surgery is recognized as a serious problem to both patients and healthcare providers [1]. Such cancellations impact on patients through prolonged burden of physical disease, anxiety, and social factors including unnecessary absence from work, childcare and transport. Health services suffer wasted resources, prolonged waiting lists, and poorer clinical outcomes [2, 3]. A range of variables likely contribute to DOSC, including patient factors (e.g. change in medical condition), logistical challenges (e.g. bed pressures) and health service pressures (e.g. staff shortages), necessitating a systems approach [2, 3]. A systematic review suggested DOSC occurs in roughly 18% of elective surgeries worldwide, predominantly due to lack of available operating theatres, insufficient staffing, and change in patient condition [4]. This represents a significant impact on individual patients, the health system and wider economic productivity.

Predictive models can be embedded into efforts to improve patient care [5]. Theoretically DOSC could be predicted by statistical models in which predictive patient and system factors are inputted and either the probability of an individual being cancelled, or the number of cancellations expected at a given point in time calculated. Chosen output would depend on modelling approach, selected variables, data availability, and study aim. Best practice stresses the importance of having a structured approach to identifying relevant explanatory variables before commencing model development [6]. Recognising the potential patient and system benefits of accurate prediction of DOSC, this systematic review will evaluate existing examples of such model development [7]. The resultant review will permit an assessment of current practice and provide a comprehensive repository of information relating to examined explanatory variables. Predictions may be made at the level of the patient (i.e. what is the chance that this patient experiences DOSC) or the system (i.e. how many patients will be cancelled at this centre on this day), both of which will be evaluated. Arguably, a well performing model that identified either an individual as being at high risk of future cancellation (say on a future day of admission) or would allow a hospital to forecast a day when significant numbers of cancellations were expected, would provide an opportunity for intervention. Patients felt to be at a 'high-risk' of future cancellation could be counselled in advance, or given the opportunity to rearrange their admission, whereas days with high cancellation forecasts could trigger hospitals to open contingency areas or prioritise emergency cases in advance to free-up elective capacity. To realise such ambitions, it is vital that well-performing models are identified (to permit their validation in external settings), and that current knowledge is synthesised to inform future statistical development.

We present our protocol for a systematic review to synthesise current best practice on the prediction of DOSC. The aims of this systematic review are to assess the methods used to predict day of surgery cancellations, the statistical methods employed to achieve this, and the breadth of explored explanatory variables. Our proposed review will be a crucial addition to the literature, summarising efforts to predict this important patient and system outcome across income setting, surgical specialty, and predictive level (patient *vs* system). By collating all peer-reviewed studies addressing this question into one location, it will also serve as a resource for future prediction model development and validation studies: providing a comprehensive summary of evaluated predictor variables and study settings. Such a resource will be of great value, as accurate prediction of DOSC could yield significant benefit to both patient experience and hospital flow.

METHODS AND ANALYSIS

This systematic review will abide by the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) guidelines [8]. It is registered with PROSPERO, registration CRD42023478984.

Search strategy

The search strategy included papers from electronic databases: Medline (via Ovid), Embase (via Ovid), Scopus and Web of science. These databases were searched in the timeframe from 1st January 2013 to 13th October 2023, limited to English language, using the strategy in Table 1.

Inclusion and exclusion criteria

This review will include peer-reviewed journal articles detailing the development, validation, updates and implementation of models to predict DOSC in which the methods, variables and performance are reported. The inclusion and exclusion criteria, detailed in Table 2, were validated in pilot screening of 200 randomly selected studies by TS and confirmed by decision with two other authors (KK, DJS). Crucially, we will only include studies where a formal statistical model is formulated as defined by key components of the PROBAST guideline [7]. Broadly we interpret a formal predictive statistical model to comply with the development or validation stages of this document or the derivation and assessment of a model to address a specific research aim [9]. We will not include 'predictor-finding' or simple associative studies that do not proceed to a formal statistical synthesis.

Data extraction

Studies will be uploaded to Zotero version 6.0.27 [10] and duplicates removed using inbuilt features. Title and abstract screening will be carried out by 2 independent authors using Rayyan [11]. Each abstract will be screened by two reviewers, conflicts will be arbitrated by a third senior author (DJS or KK). Full text screening will be carried out by 2 independent authors using Rayyan, recording reasons for exclusions. Each full text will be screened by two reviewers independently and conflicts resolved by DJS or KK. A PRISMA flowchart will be generated from this process.

Risk of bias will be assessed using the PROBAST tool [7]. The results of the risk of bias assessment will be reported for each study and included in supplementary material. Missing results for each parameter of interest will result in the study being excluded from the analysis of that parameter. The studies included and excluded will be reported in the results. Where there is data reported for the parameter but the study states there was missing data, this will also be reported.

Data analysis

Data extraction will be carried out by 2 independent authors. Where the data parameters of interest are stated to have been collected but are not available in the published paper or supplementary material, the study investigators will be sent a request by email. Data will be collected about the method of prediction, level of prediction, cohort characteristics, setting, method of data collection for model training, variables included, model assessment and validation method and performance. Details are outlined in table 3.

Data will be subject to qualitative synthesis. Qualitative synthesis will be structured around the 9 points of the SWiM (synthesis without meta-analysis) guidelines [13]. Studies will be sub-grouped for analysis by prediction level (prediction made at the level of the patient vs at the level of the system) and setting (studies in HIC vs LMIC) [12]. Analysis will be carried out on all studies in aggregate, in 2 sub-groups by prediction level, in 2 sub-groups by setting and in 4 sub-groups by prediction level and setting. Studies with missing data for the parameter of interest will be excluded from the analysis and those included or excluded stated in the results. Results of synthesis will be reported in a narrative summary and displayed in tables and graphs.

This article reports on a protocol for a systematic review to identify studies developing statistical models to predict day of surgery cancellations at both patient and system levels. The resultant review will be a valuable synthesis of current best-practice and could serve as a core reference for emerging studies in this field. Our proposed review involves a comprehensive search of four major literature databases and complies with best practice on dual screening of abstracts and data-extraction. By stratifying identified studies by income setting we hope to be able to provide insights into data variables examined in different income settings that may be driven by potential data availability. As with many systematic reviews we acknowledge the limitations of our proposed search, especially only including studies published in English language [14]. The use of multiple reviewers aims to minimise bias.

ETHICS AND DISSEMINATION

No ethical approval is required.

This systematic review will be disseminated in a peer-reviewed journal article.

Conflict of interest statement - all authors declare no completing interests.

All contributors to study conceptualisation, data extraction, data analysis or write-up will be recognised as authors.

FUNDING STATEMENT

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

REFERENCES

1. Nasr A, Reichardt K, Fitzgerald K, Arumugusamy M, Keeling P, Walsh TN. Impact of emergency admissions on elective surgical workload. Ir J Med Sci. 2004;173(3):133–5.

2. Krueger CA, Kozaily E, Gouda Z, Chisari E, Courtney PM, Austin MS. Canceled Total Joint Arthroplasty: Who, What, When, and Why? J Arthroplasty. 2021 Mar;36(3):857–62.

3. Gillies MA, Wijeysundera DN, Harrison EM. Counting the cost of cancelled surgery: a system wide approach is needed. British Journal of Anaesthesia. 2018 Oct 1;121(4):691–4.

4. Abate SM, Chekole YA, Minaye SY, Basu B. Global prevalence and reasons for case cancellation on the intended day of surgery: A systematic review and meta-analysis. Int J Surg Open. 2020;26:55–63.

5. Tran ET, Ho KM. Utility of the National Emergency Laparotomy Audit prognostic model in predicting outcomes in an Australian health system. Anaesth Intensive Care. 2023 Jan;51(1):51–8.

6. Leisman DE, Harhay MO, Lederer DJ, Abramson M, Adjei AA, Bakker J, et al. Development and Reporting of Prediction Models: Guidance for Authors From Editors of Respiratory, Sleep, and Critical Care Journals. Crit Care Med. 2020 May;48(5):623–33.

7. Wolff RF, Moons KGM, Riley RD, Whiting PF, Westwood M, Collins GS, et al. PROBAST: A Tool to Assess the Risk of Bias and Applicability of Prediction Model Studies. Ann Intern Med. 2019 Jan 1;170(1):51–8.

8. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021 Mar 29;372:n71.

9. Steyerberg EW, Vergouwe Y. Towards better clinical prediction models: seven steps for development and an ABCD for validation. Eur Heart J. 2014 Aug 1;35(29):1925–31.

10. Roy Rosenzweig Center for History and New Media. (2023) Zotero [Computer software]. Retrieved from www.zotero.org/download

11. Mourad Ouzzani, Hossam Hammady, Zbys Fedorowicz, and Ahmed Elmagarmid. Rayyan — a web and mobile app for systematic reviews. Systematic Reviews (2016) 5:210, DOI: 10.1186/s13643-016-0384-4.

12. World Bank Country and Lending Groups – World Bank Data Help Desk [Internet]. [cited 2023 Nov 1]. Available from: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

13. Campbell M, McKenzie JE, Sowden A, Katikireddi SV, Brennan SE, Ellis S, et al. Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline. BMJ. 2020 Jan 16;368:l6890.

14. Moher D, Pham B, Lawson ML, Klassen TP. The inclusion of reports of randomised trials published in languages other than English in systematic reviews. Health Technol Assess. 2003;7(41):1–90.

Tables

DATABASE	SEARCH STRATEGY
Medline (via Ovid)	(day of or same day or on the day or same date).ab,ti. and ((surger* or operation* or procedure*).ab,ti. or exp Surgical Procedures, Operative/) and (cancel* or defer* or delay* or postpone*).ab,ti. and ((predict* or machine learning or model* or logistic regression).ab,ti. or exp Models, Statistical/ or exp Probability/ or exp Regression analysis/ or exp Machine learning/)
Embase (via Ovid)	(day of or same day or on the day or same date).ab,ti. and ((surger* or operation* or procedure*).ab,ti. or exp surgery/) and (cancel* or defer* or delay* or postpone*).ab,ti. and ((predict* or machine learning or model* or logistic regression).ab,ti. or exp statistical model/ or exp probability/ or exp regression model/ or exp machine learning/)
Scopus	(TITLE-ABS-KEY ("day of" OR "same day" OR "on the day" OR "same date")) AND (TITLE-ABS-KEY (surger* OR operation* OR procedure*)) AND (TITLE-ABS-KEY (cancel* OR defer* OR delay* OR postpone*)) AND (TITLE-ABS-KEY (predict* OR "machine learning" OR model* OR "logistic regression"))
Web of Science	((TI=("day of" OR "same day" OR "on the day" OR "same date")) OR (AB=("day of" OR "same day" OR "on the day" OR "same date"))) AND ((TI=(surger* OR operation* OR procedure*)) OR (AB=(surger* OR operation* OR procedure*))) AND ((TI=(cancel* OR defer* OR delay* OR postpone*)) OR (AB=(cancel* OR defer* OR delay* OR postpone*))) AND ((TI=(predict* OR "machine learning" OR model* OR "logistic regression")) OR (AB=(predict* OR "machine learning" OR model* OR "logistic regression")))

Table 1 – Search strategies used in electronic databases

	CRITERIA	INCLUDES	EXCLUDES
0	English language	English language	
1	Publication type	Peer-reviewed journal articles	Magazine articles Conference abstracts Theses
2	Study type	Development, validation and updates of models Novel models and implementation studies If the same model is published multiple times, include the first paper and an implementation study if available	Review articles Systematic reviews Meta-analyses Discussion papers Subsequent publications of models without implementation
3	Subject	Day of surgery cancellation	
4	Method	Risk prediction, statistical model	Predictor-finding studies
5	Outcome 1	Method of prediction specified	
6	Outcome 2	Reports the variables used in the model	Variables kept secret
7	Outcome 3	Measures the performance of the model	

Table 2 – Inclusion and exclusion criteria

DATA ITEM	DETAILS
Method of prediction	Model type (e.g. logistic regression), variable selection process (e.g. stepwise regression)
Level of prediction	Whether prediction was made at the level of the patient (i.e. risk of an individual patient being cancelled) or the system (i.e. number of cancellations per centre)
Cohort characteristics	Number of patients Type/specialty of surgery
Setting	Distinguish between high (HIC) and low- and middle-income countries (LMIC), as defined by the world bank [12]
Method of data collection for model training	Bespoke prospective cohort or re-utilised randomised controlled trial (RCT) data vs retrospective extraction from electronic patient records
Variables included in the model	Grouped into patient (e.g. comorbidities), operative (e.g. specialty, need for higher level postoperative care) and system factors (e.g. bed availability)
How the model was assessed in the training dataset and its performance	Measures of discrimination Measures of calibration
Validation method and performance (if performed)	Internal vs external validation Measures of discrimination Measures of calibration

Table 3 – Data items to be collected