(Acta Anaesth. Belg., 2021, 72, 113-122)

A tool to facilitate anesthetic preoperative consultations

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Abstract: As surgical procedures have become more complex and are being performed in populations with higher age and increased comorbidities, preoperative anesthesia consultations (PAC) have become part of the standard perioperative management. Technical progress in healthcare could benefit efficiency, and cost-effectiveness of patient care. In our faster, digitalized society, patient-completed electronic questionnaires are gaining interest over their paper analogue. This study aimed to create and evaluate the reliability of a patient-completed electronic preoperative questionnaire incorporated in an instrument (PAC tool) with a built-in risk score calculator. The electronic preoperative questionnaire was created in Airtable, an online spreadsheet database, and its content was constituted combining the content of the existing paper printed preoperative questionnaire of the University Hospital of Ghent and adding questions relevant to risk score calculation. Twenty-one patients of named center were enrolled, the questionnaire was evaluated using inter-rater reliability analysis and the validity of the risk score calculator was assessed for agreement between automatically calculated risk scores and manually calculated risk scores. Excellent criterion validity for the questionnaire was observed in 86% of the questions, fair to good criterion validity in 7%, 1 out of 70 questions didn't reach criterion validity and 4 out of 70 questions couldn't be analyzed. Regarding the risk score calculator, agreement in risk scores was obtained for all risk scores included in the analysis. 2 risk scores were left out because of an inadequate number of answers. Given a larger sample size population, the content of this patient-completed electronic questionnaire could prove appropriate for obtaining specific medical history, exercise tolerance and more in the context of preanesthetic consultations. Additionally, the use of the built-in risk score calculator in the PAC tool could prove useful and efficient

Keywords: Decision support techniques; referral and consultation/organization & administration; pre-operative care/standards; risk assessment; surveys and questionnaires.

Introduction

The current surgical population is characterized by older age and an increase in comorbidities whilst surgical techniques have become more complex. Anesthetic preoperative assessment is part of the current practice guidelines and its aim is to evaluate the overall risk associated with the perioperative period and to develop strategies that could reduce the perioperative risks (1). As such, the preoperative health condition of the patient could be optimized in order to avoid preventable perioperative complications. Risk stratification has been designed for the purpose of detecting high risk patients so as to do this, to guide clinical decision making and to create awareness for the patients.

There are multiple contributors to the overall risk of surgery that are not only surgery related. Literature states that up to 43% of the patients undergoing surgery will experience some kind of complication and perioperative mortality is presumed to be the third leading cause of death internationally (2-4). A large European study designed to assess outcomes after non-cardiac surgery in Europe found that 4% of the patients died before hospital discharge (5). Risk factors for postoperative complications defined in current preoperative risk scores are either patient related or surgery related.

Organ dysfunction as a part of possible complications is the most important cause of postoperative morbidity and mortality. Dysfunction can lead to failure to maintain physiological hemostasis and thus organ failure.

Inflammation and ischemia are thought to be at the source of the pathophysiology of postoperative organ dysfunction and hemodynamic changes and occlusive events, pre-existing organ susceptibility, comorbidity and procedure-related characteristics can tip the balance in the wrong direction (6).

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Paper submitted on May 06, 2021 and accepted on May 10, 2021.
Conflict of interest: None.

Preoperative consultation

In the last decades safety matters in anesthesia have gained in importance, better monitoring devices and equipment are more readily available, practice guidelines have been developed and the importance of checklists has been extensively emphasized. Preoperative anesthesia consultations have become part of standard perioperative care (1, 8).Preoperative evaluation strategy varies depending on the health care practice and depending on the country. There is no consensus on how preoperative anesthesia consultations should be performed per se. The ESA published recommendations on 'how' and 'by whom' patients should be evaluated preoperatively. They state that standardized questionnaires could prove beneficial in the preoperative setting, that screening of the patients that have to be seen by an anesthetist could be carried out by trainees or nurses, but that the assessment itself should be carried out by an anesthetist (1).

As everything becomes more digitalized, so does the health care system and its practices. Patient-completed electronic questionnaires have shown to be an effective tool in the preoperative setting. Some studies even showed that people are more likely to divulge sensitive information through electronic questionnaires than in real-life and even that computerized patient-reported quality of life questionnaires could offer a more thorough understanding of symptoms and functional status. They can result in an optimization of the time of consultation, of patient satisfaction and interview cost. Literature confirms that electronic questionnaires in the preoperative setting are accurate and efficient in gathering medical information. [7-16]

Different electronic questionnaires (Zuidema et al., Hilditch et al.) and applications (PATCH, ePAQ) have been developed and are aimed at accurately screening patients and/or collecting medical history, some of which have been validated (9, 11, 17, 18).

The aim of this study was to create and evaluate the reliability of a patient-completed electronic pre-operative questionnaire (as part of the PAC tool) in collecting data that would be used for two purposes: firstly to aid in the preoperative anesthesia consultation, secondly to help automatically and accurately calculate existing preoperative risk scores. If valid, it would reduce the work load of the anesthetist who would generally have to gather all the information and calculate risk scores separately. In this setting, the input of the anesthetist would be limited to the data which patients generally don't know the answer to. This data is mostly surgery-related, or data inaccessible for patients (for instance lab results, surgical incision, duration of surgery and so on).

Methodology

This study was approved by the Health, innovation and research institute (HIRUZ) and the ethics committee of the University hospital of Ghent in march 2021. Patients were included in April 2021. Statistical analysis was performed using SPSS Statistics version 27.

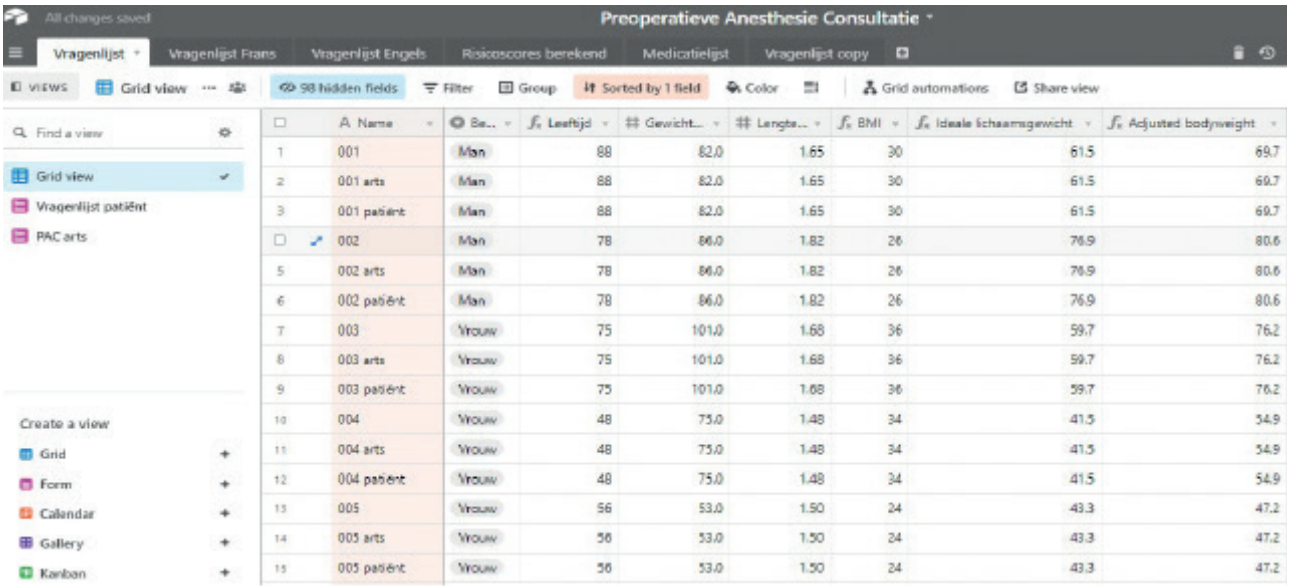

Fig. 1. — Grid view of the PAC base. The grid view combines the patients questionnaire ('vragenlijst patient') and the anesthetist form ('PAC arts'). In the grid view we can see the name of the patients followed by the items of the questionnaire mixed and arranged with the items to be filled in by the anesthetist. A patient's combined form can be opened and adjusted at any time.

Creation of the PAC tool

The content of the online electronic questionnaire was constituted using the substance of the existing paper printed preoperative questionnaire of the University Hospital of Ghent and adding some extra questions in alignment with risk score calculations.

The electronic questionnaire was then created using Airtable, an online spreadsheet-database. In a base (workspace) called 'Preoperatieve Anesthesie Consultatie' (Preoperative Anesthesia Consultation) two forms were created and termed 'Vragenlijst patiënt' (Patient questionnaire) and 'PAC arts' (PAC anesthetist). The PAC anesthetist form was constituted of additional single select questions and number input possibility for the anesthetist to accommodate for the risk score calculations (for example creatinin level, ASA score, postoperative use of opioids yes/no, liver disease yes/no, …) (see also Table 4). The two forms were accessible as one combined form in the Grid view of Airtable and this is the form used during the consultations (Fig. 1).

Using formula field types, it has been made possible to automatically calculate separate risk scores if all required data for the concerning scores is available. This data comprises both the data obtained by the submitted patient questionnaire and the additional input of the anesthetist during the preoperative anesthesia consultation.

The risk scores used in this study are the CAGE score, the Apfel score, the El Ganzouri Risk Index, the Charlson Comorbidity Index, the Duke Activity Status Index, the Revised Cardiac Risk Index, the Gupta Perioperative Risk for Myocardial Infarction or Cardiac Arrest score, the STOP-BANG score, the Ariscat score, the Gupta Postoperative Pneumonia Risk score, the Gupta Postoperative Respiratory Failure Risk score, the Kheterpal score and the Child-Pugh score (see also Table 4). In addition formula field types were applied to calculate body mass index (BMI), ideal body weight (IBW), adjusted body weight (ABW) and smoking pack years.

Validation of the PAC tool

A total of 21 patients were recruited from the preoperative anesthesia consultations in the University hospital of Ghent. Patients eligible for recruitment had to be at least 18 years old, had to be able to give their consent and were registered for elective surgery with planned preoperative anesthesia consultation. A few days prior to their consultation, patients were recruited. They were contacted by phone and asked for their oral informed consent before a link to the electronic preoperative questionnaire (questionnaire part of the PAC tool) was sent to them by e-mail. For anonymization purposes a pseudonym was given to each patient in the form of a unique number (for example 001). In alignment with GDPR, a data processing agreement was signed with Airtable. Once the electronic questionnaire completed, it was automatically submitted to the Airtable workspace. Patients then underwent a usual face-to-face preoperative anesthesia consultation, the written informed consent was presented for signing and the anesthetist completed the data input for the generation of the risk scores.

A second database for the same patient was then created and filled in entirely by the anesthetist for comparison and questionnaire statistic validation endpoints. Lastly, the risk scores were calculated manually by the anesthetist for comparison with the automatically calculated risk scores (Fig. 2).

Statistical analysis

Sample size: for binary questions we calculated that our sample size had to be 22 using a minimum kappa of 0,4 (fair), an expected kappa of 0,95, a proportion of outcome of 0,5, a significance level of 0,05 and a power of 80%.

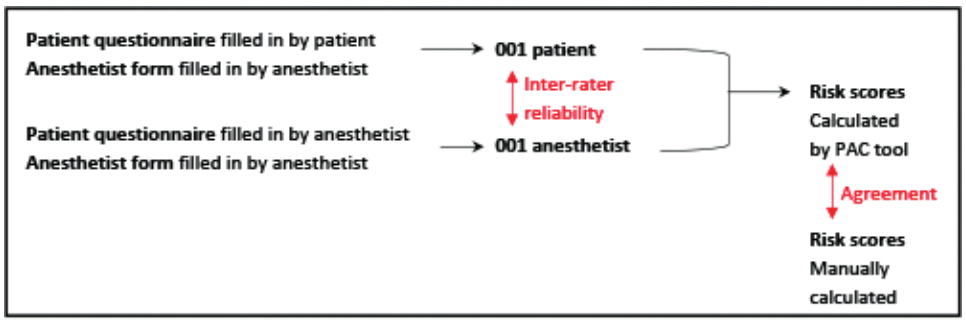

Fig. 2. — Process of data collection and risk score calculation (black) and setup for statistical analyses (red).

Stability of the questionnaire was assessed by comparing the responses of both databases for each patient, the fist database being constituted of the patient questionnaire, the second created and filled in by the anesthetist (see above). The parameter being measured was inter-rater reliability. Binary or dichotomous items were analyzed using Cohen's kappa coefficient, multiple select items were analyzed using weighted kappa. Cohen's kappa coefficient (κ) is used to calculate inter-rater reliability for binary qualitative items and has the advantage that it takes the possibility of agreement happening by chance into account. Weighted kappa allows for partial agreement in the case of multiple options. There are different guidelines for the interpretation of Cohen's kappa, we used a kappa value of more than 0,75 for excellent level of agreement as published by Fleiss. A value of 0,41 to 0,6 is deemed fair to good following Fleiss' guidelines (19-21).

In the case of prevalence of an answer of more than 95% (for example everyone in the sample answered 'yes'), percentage agreement was used as kappa becomes unreliable. Percentage agreement calculates the number of agreed answers divided by the total number of answers and a value of more than 95% was used for adequate criterion validity. If percentage of agreement was less than 95%, validity was undetermined.

To examine if the difference in patient and anesthetist answers of the questionnaire would significantly alter the risk scores, inter-rater agreement between the automatically calculated risk scores of both databases forementioned was calculated using Fleiss' kappa. Fleiss' kappa assesses the reliability of agreement between any number of raters when items are given categorical ratings. In risk scoring, the risks are namely attributed to different scales of risk scores. Its interpretation has the same properties as the Cohen's kappa and the weighted kappa.

Validity of the automatically calculated risk scores was first assessed by looking for measurement error using the Bland-Altman scatter plot. Subsequently agreement between the automatically calculated risk scores and the risk scores manually calculated by anesthetist was determined using the Intraclass Correlation Coefficient. The Intraclass Correlation Coefficient (ICC) compares quantitative items organized into groups. If the ICC is 1 it establishes complete agreement, a value of more than 0,7 is recommended (22).

Table 1

Population characteristics

			Sex		
			Female	Male	Total
Age	30-49	Count	3	1	4
		% within Age	75,0%	25,0%	100,0%
	50-69	Count	3	4	7
		% within Age	42,9%	57,1%	100,0%
	>70	Count	4	6	10
		% within Age	40,0%	60,0%	100,0%
Total		Count	10	11	21
% within Age		47,6%	52,4%	100,0%	

Results

Population

Twenty one patients were analyzed. Of the twenty four assessed patients, one was excluded due to lack of basic IT skills. The twenty three others gave their oral consent and thus received a link to the electronic preoperative questionnaire. One patient never showed up due to delayed surgery and another patient forgot to fill in the questionnaire. Baseline characteristics show a balanced sample population based on sex, namely ten women and eleven men. About half of the sample population was older than 70 years (Table 1).

Stability of the electronic questionnaire

The questionnaire constituted a total of 93 questions consisting of 62 binary questions (with 2 options), 9 questions with more than 2 possibilities, 13 extra conditional binary questions that popped up at the answer 'yes' and the remainder of the questions were for input of free text or a number.

For the binary questions Cohen's kappa and percentage agreement was used for the measurement of inter-rater agreement. Most of the questions had answers that didn't have a prevalence of more than 95% ('yes' or 'no') and as such Cohen's kappa could be used. Cohen's kappa reached levels of 0,75 for most of the questions, which means excellent validity (inter-rater reliability) if the sample size is adequate (see also sample size in discussion). Questions that only had fair to good validity included: 'Do you have wheezing?', 'History of stroke or transient ischemic attack?', 'Do you have osteoporosis?', 'Treatment for reflux?', 'Previous gastric ulcer bleed?'. There were no questions with bad criterion validity.

Table 2

Questions, Cohen's kappa, percentage agreement and level of criterion validity

Question	K coefficient	Percentage agreement	Criterion Validity
Sex? (Male/Female)	1	-	Excellent
Functional status? (Independent/Dependent)	1	-	Excellent
Smoking in the last year?	1	-	Excellent
Alcohol consumption? (Social/Exaggerated)	1	-	Excellent
History of motion sickness or postoperative nausea and vomiting?	1	-	Excellent
Drug use?	-	100	Yes
Previous surgery?	1	-	Excellent
Problems with general anaesthesia in the family?	1	-	Excellent
History of myocardial infarction or surgery/stent in the coronaries?	1	-	Excellent
Retrosternal pain on exertion?	-	100	Yes
Palpitations?	1	-	Excellent
Sporadic swollen feet?	1	-	Excellent
Half-seated sleep?	-	100	Yes
Night-time dyspnea?	-	95	Yes
Problems during work around the house?	1	-	Excellent
Dyspnea after climbing two flights of stairs?	1	-	Excellent
Treatment for cardiac disease?	1	-	Excellent
Stable cardiac status last year?	1	-	Excellent
History of phlebitis?	-	100	Yes
Chronic peripheral vascular disease (with now and then pain on exertion)?	1	-	Excellent
Vascular bypass?	1	-	Excellent
Vascular stent?	1	-	Excellent
Surgery of arteries?	1	-	Excellent
Hypertension or treatment for hypertension?	1	-	Excellent
Varicose veins or varices surgery?	1	-	Excellent
Airway infection previous month?	1	-	Excellent
Treatment for lung disease?	-	100	Yes
Chronic obstructive pulmonary disease (COPD)?	-	95	Yes
Do you have wheezing?	0,62	-	Fair to good
Asthma or hay fever?	1	-	Excellent
Asthma or hay fever controlled?	-	100	Yes
Loud snoring?	1	-	Excellent
Daytime fatigue?	1	-	Excellent
Night-time apnea?	1	-	Excellent
Do you use a CPAP device?	1	-	Excellent
Kidney dialysis?	-	100	Yes
Current or history of treatment for kidney disease?	1	-	Excellent
Epilepsy?	-	100	Yes
Treatment by psychiatrist or neurologist?	1	-	Excellent
Tingling or numbness to extremities?	1	-	Excellent
Back problems?	1	-	Excellent
Radiation to arms or legs?	1	-	Excellent
Previous spine surgery for hernia or pinched nerve?	1	-	Excellent
History of stroke or transient ischemic attack?	0,64	-	Fair to good
Residual injury of stroke?	-	50	No
Do you sometimes have joint pain?	1	-	Excellent
Do you have arthrosis?	0,82	-	Excellent
Do you have rheumatism or arthritis?	0,83	-	Excellent
Do you have osteoporosis?	0,64	-	Fair to good
Gastric acid reflux?	0,91	-	Excellent
Treatment for reflux?	0,60	-	Fair to good
Previous gastric ulcer bleed?	0,63	-	Fair to good
Liver disease?	1	-	Excellent
History of jaundice?	1	-	Excellent
Thyroid disease?	1	-	Excellent
Current cancer?	1	-	Excellent
Cancer treatment?	1	-	Excellent

Table 3

Question, possible answers, weighted kappa, criterion validity

Question	**Possible answers**	**Weighted kappa**	**Criterion Validity**
Allergies	Latex/Band-Aids/Local anesthetics/ Disinfectants/iodide/Medication/Food/No known	1	Excellent
Smoking?	Yes/No/Ex	1	Excellent
Do you have?	Dentures/Artificial teeth/Loose teeth/Contact lenses/ A hearing aid/Piercings/Artificial nails/ Pacemaker or stimulator/ Implanted pump for analgesia or other medical use	1	Excellent
Dependence?	None/Partially /Totally	1	Excellent
U can easily?	Take care of self/Walk indoors/Walk 1-2 blocks on level ground/Climb a flight of stairs or walk up a hill/Run a short distance/Work around the house/Do yard work/Have sexual relations/Participate in recreational activities	1	Excellent
Work around the house?	None/Light/Moderate/Heavy	1	Excellent
Recreational activity?	None/Moderate/Heavy	N/A[a]	
Dialysis type?	Catheter/Fistula/Peritoneum (abdomen)	N/A[a]	
Days of dialysis?	Monday/Tuesday/Wednesday/Thursday/Friday/Saturday/Sunday	N/A[a]	
Prosthesis?	Knee/Hip/Shoulder	1	Excellent
Diabetes mellitus?	No or diet-controlled/Uncomplicated/End-organ damage	1	Excellent
Diabetes treatment?	Oral antidiabetics (not insulin)/Insulin	N/A[a]	
Cancer treatment plan?	Radiotherapy/Chemotherapy/Hormonal therapy/Surgery	1	Excellent

[a] Not applicable: only one answer used.

Questions with answers of more than 95% (‘yes’ or ‘no’) were interpreted using percentage agreement and included: ‘Drug use?’, ‘Retrosternal pain on exertion?’, ‘Half-seated sleep?’, ‘Night-time dyspnea?’, ‘History of phlebitis?’, ‘Treatment for lung disease?’, ‘Chronic obstructive pulmonary disease (COPD)?’, ‘Asthma or hay fever controlled?’, ‘Kidney dialysis?’, ‘ Epilepsy?’, ‘Residual injury of stroke?’. All except ‘Residual injury of stroke?’ demonstrated adequate criterion validity (Table 2).

For questions that weren’t binominal/dichotomous and consisted of multiple possible answers, weighted kappa was calculated. All ques-tions had excellent criterion validity, except for four questions in which the same answer was given by all patients that had to answer that question or too little answers were given for those questions: ‘Recreational activity?’, ‘Dialysis type?’, ‘Days of dialysis?’, ‘Diabetes treatment’.(Table 3).

Agreement between risk scores of patient database and anesthetist database (using the PAC tool) was defined using Fleiss’ kappa. The majority of the risk scores had a Fleiss’ kappa value of 1, meaning a total agreement between anesthetist and patient and by extension reflecting inter-rater agreement of the questionnaire items for those risk scores. Charlson Comorbidity Index (CCI) and Gupta postoperative pneumonia risk had values of 0,83 and 0,95 respectively, which still represents an excellent level of agreement, but demonstrates that not all items of the questionnaire were agreed upon (Table 4).

Two risk scores were not included in the analysis: CAGE score and Child-Pugh score. The former had zero responses because of the way the questionnaire was constituted, that is, questions only came up when the answer to the question ‘Alcohol consumption?’ was ‘Exaggerated’. The latter had never been calculated because the formula only allowed for calculation of the score if the anesthetist indicated that the patient had a liver disease, which wasn’t the case in any of the patients of the sample population.

Validity of the automatically calculated risk scores

Fist, Bland-Altman plotting was attempted to control for measurement error between the risk score values (manual calculation versus automatic calculation by PAC tool) or in other words to control for difference in risk score values. The initial early

analysis revealed that the difference between all the values were zero and that the One Sample T test of the difference of the measures could not be calculated and the t value could not be computed because of a standard deviation of zero. Total agreement was then determined using Intraclass Correlation Coefficient (ICC). All of the separate risk scores were identical between both groups, illustrated by ICC values of 1. This reflects a correct input of the formulas for the risk score algorithms. Again CAGE and Child-Pugh were excluded for abovementioned reasons.

Table 4 delineates the analyzed risk scores, their variables and who's responsible for their input. It also enumerates the Intraclass Correlation Coefficient, being the agreement between automatically calculated risk scores of the anesthetist database (PAC tool) and manually calculated risk scores by the anesthetist. Furthermore it summarizes the Fleiss' kappa for each risk score, being the agreement between risk scores of the patient database and the anesthetist database using PAC tool (Table 4).

Discussion

General considerations

The objective of this research was to evaluate the reliability of a patient-completed electronic preoperative questionnaire as part of a created

Table 4

Risk scores, variables and individual responsible for input of those variables, Intraclass Correlation Coefficient (ICC) and Fleiss' kappa

Risk score	Variable	Input	Intraclass Correlation Coefficient	Fleiss' kappa
Apfel	Gender	Patient	1	1
	Smoking	Patient		
	History of motion sickness or PONV	Patient		
	Postoperative use op opioids	Anesthetist		
CCI	Age	Patient	1	0,83
	History of MI	Patient		
	Peripheral vascular disease	Patient		
	History of a CVA or TIA	Patient		
	COPD	Patient		
	Peptic ulcer disease	Patient		
	Diabetes Mellitus	Patient		
	History of or active CHF	Anesthetist		
	Dementia, hemiplegia	Anesthetist		
	Connective tissue disease	Anesthetist		
	Liver disease, CKD	Anesthetist		
	Solid/metastatic tumor, leukemia, lymphoma	Anesthetist		
	AIDS	Anesthetist		
EGRI	Weight	Patient	1	1
	Mouth opening	Anesthetist		
	Thyromental distance	Anesthetist		
	Mallampati	Anesthetist		
	Neck movement	Anesthetist		
	Inability to prognath	Anesthetist		
	History of difficult intubation	Anesthetist		
CAGE	Cut down	Patient	N/A[a]	NA[a]
	Annoyed	Patient		
	Guilt	Patient		
	Eye-opener	Patient		
Child-Pugh	Bilirubin, Albumin, INR	Anesthetist	N/A[a]	N/A[a]
	Ascites	Anesthetist		
	Encephalopathy	Anesthetist		
DASI	Ability to…	Patient	1	1
RCRI	History of ischemic heart disease	Patient	1	1
	History of cerebrovascular disease	Patient		
	Pre-operative treatment with insulin	Patient		
	Pre-operative creatinine > 2 mg/dL	Anesthetist		
	History of congestive heart failure	Anesthetist		
	Intraperitoneal/intrathoracic /suprainguinal vascular surgery	Anesthetist		

Risk score	Variable	Input	Intraclass Correlation Coefficient	Fleiss' kappa
MICA	Age	Patient	1	1
	Dependence	Patient		
	ASA	Anesthetist		
	Creatinin	Anesthetist		
	Type of procedure	Anesthetist		
Gupta post-operative pneumonia	Smoking in the last year	Patient	1	0,95
	COPD	Patient		
	Dependence	Patient		
	ASA	Anesthetist		
	Sepsis	Anesthetist		
	Type of procedure	Anesthetist		
Gupta post-operative respiratory failure	Dependence	Patient	1	1
	Emergency case	Anesthetist		
	ASA	Anesthetist		
	Sepsis	Anesthetist		
	Type of procedure	Anesthetist		
Ariscat	Age	Patient	1	1
	Respiratory infection last month	Patient		
	Preoperative SpO_2	Anesthetist		
	Preoperative anemia	Anesthetist		
	Surgical incision	Anesthetist		
	Emergency procedure	Anesthetist		
	Duration of surgery	Anesthetist		
STOP-BANG	Loud snoring, daytime fatigue, observed apnea	Patient	1	1
	Hypertension, BMI >35, Age > 50 years	Patient		
	Male gender	Patient		
	Neck circumference > 40 cm (women)/> 43 cm (men)	Anesthetist		
Kheterpal	Age ≥ 56 years	Patient	1	1
	Male	Patient		
	Hypertension	Patient		
	Diabetes mellitus	Patient		
	Congestive heart failure	Anesthetist		
	Emergency surgery	Anesthetist		
	Intraperitoneal surgery	Anesthetist		
	Creatinin ≥ 1,2 mg/dL	Anesthetist		
	Ascites	Anesthetist		

ICC: agreement between automatically calculated risk scores of the anesthetist database (PAC tool) and manually calculated risk scores by anesthetist. Fleiss' kappa: agreement between risk scores of patient database and anesthetist database using PAC tool. [a] Not applicable/Not answered.

instrument, the 'PAC tool'. Additionally, the validity of a built-in risk score calculator as part of the PAC tool had to be demonstrated. Our analysis accordingly focused on both these questions.

Caution should be taken interpreting the results of this analysis on the grounds of a small sample size population (see below). That in mind, our study showed that the criterion validity for most of the questions was excellent for both binary questions ('yes'/'no') as for multiple choice questions. Questions that only had fair to good validity included: 'Do you have wheezing?', 'History of stroke or transient ischemic attack?', 'Do you have osteoporosis?', 'Treatment for reflux?' and 'Previous gastric ulcer bleed?'. There were no questions with bad criterion validity. For answers of binary questions with a prevalence of more than 95%, percentage agreement was used and all questions except 'Residual injury of stroke?' reached our cut-off for criterion validity. Some of the multiple choice questions weren't included in this analysis due to paucity of responses or due to the fact that all patients answered a question in an identical fashion (see above).

The reasons for above-mentioned moderated criterion validity for some of the items could be partially due to the small sample size (see below), or could be associated to the difference in patient characteristics such as age, literacy and social factors. Rephrasing and reanalyzing these items may be necessary if follow up studies would show identical findings of only fair to moderate criterion validity for these items.

The validity of the built-in risk calculator, or merely the coding of the risk score algorithms in Airtable, was established for all risk scores included

in the analysis. 2 scores however could not be validated, namely the CAGE score because of lack of responses and the Child-Pugh score because of lack of liver disease in the sample population.

Of the 96 items needed to calculate the risk scores, 49 were auto-inputted items through the electronic patient-completed questionnaire. The remaining 47 items had to be inputted by the anesthetist, but then again some items were recurring in the different risk scores (for example 'Ascites?', 'Congestive heart failure?', 'Creatinin level', …) thereby narrowing down the items to be filled in by the anesthetist to 36 of the total 96 items.

Continuous items were not analyzed in this research as they were obvious (age), they weren't measured during the preoperative anesthesia consultation (height, body weight) or they couldn't objectively be double checked (smoking years, number of cigarettes during active smoking, alcohol units each week, …).

Limitations and recommendations

– Sample size: as calculated above, our sample size had to be 22. As such, our sample size is not meeting the exact amount needed for definite analysis. More so, popped up binary questions didn't always have the total number of included patients as the question was only presented to a proportion of the population.

– Only two raters were compared in this study, namely the patient and one anesthetist. To optimize validation, an additional rater or multiple additional raters could be added.

– This study didn't statistically analyze patients' willingness and receptiveness to adopt digital tools. However, during the consultations patients were asked how they experienced the electronic questionnaire with reference to ease of use and questionnaire difficulty level and all but one confirmed the smooth use of the electronic questionnaire and stated they experienced more comfort doing this at home. Even in the elderly population, for whom digitalization is deemed difficult, a general acceptance was observed.

– The applicability of the Airtable database on a general population that is not pseudonymized or anonymized is doubtable. For starters Airtable is based in the USA, outside Europe. A data protection agreement (DPA) was signed for this study, but storing patient records on an online database located in the USA can be questionable. The question arises if Airtable can be compliant with European jurisdiction. As depicted by the implementation of the GDPR (General Data Protection Regulation) a few years ago, it can't be stressed enough that data security and data confidentiality is of utmost importance. As such we don't recommend at this time that the PAC tool has to be linked per se with Airtable. This said, the aim of this study was only to assess the reliability of an electronic questionnaire and to validate the inputted formulas used to calculate risk scores based on the answers to these questions. The PAC tool as such comprises the data analyzed, not the medium per se. The cost of a fully developed application or software package easily rises to a few thousand euros and the need for secure firewalls, data protection and possibility of incorporation of the data in the patient's personal records were major obstacles. As this was a short term study, Airtable was chosen to conduct this research. Future software should focus on regulation and compliance with GDPR standards, secure networks, data encryption, login controls and auditing.

– Some anesthetic complications are not yet specifically included in the patient questionnaire and this still has to be analyzed. Examples are malignant hyperthermia and local anesthetic systemic toxicity (LAST). It is possible patients would have answered these specific complications in the text field 'Specify problems during previous surgery' or 'Specify problems with general anesthesia in the family', but the specific complications are not delineated. A possibility for future questionnaires is to accommodate a conditional dropdown tiered field for serious anesthetic complications that arises if the question 'Problems during previous surgery?' is checked 'Yes'.

Conclusion

Based on the results this article puts forward, if not taking into account the small sample size, we could conclude it is realistic that the content of this patient-completed electronic questionnaire is appropriate for obtaining specific medical history, exercise tolerance and more in the context of preoperative anesthesia consultations. That in addition to its use in partially calculating automatic risk scores is a feasible alternative for classic paper preoperative questionnaires and subsequent manual/online risk score calculation.

Further research will have to focus on better analyzing the validity of the questionnaire's items and estimate the extent to which (the features of) the PAC tool could be implemented in everyday clinic. A new study with a larger sample size could better prove reliability of the electronic questionnaire.

Keeping in mind previous studies conducted on computer system-assigned ASA scoring and potential implementation for the timing of preoperative anesthesia consultation, possibilities for use and application of patient-completed electronic questionnaires to generate additional data and incorporating clinical decision tools are considerable. For example, features addressing patients' personal medication with automated identification of the drugs and suggestions regarding perioperative adjustment (such as discontinuation and bridging of anticoagulants, fine tuning of antidiabetics during the perioperative period, rules for taking medication on the day of surgery) could be incorporated and analyzed for efficacy. Additionally, it could help to direct patient flow in the preoperative anesthesia consultation: patients with a high risk score are seen by a physician, low risk patient can be seen by a nurse practitioner.

A follow up study could measure the efficiency of the electronic preoperative questionnaire and of the automated risk score calculator. This could be effectuated by comparing the time needed to conclude preoperative anesthesia consultations in a conventional face-to-face contact with the time needed to conclude preoperative anesthesia consultations using our online preoperative questionnaire. This however is difficult as it has many variables to take into account. Another way to measure the efficiency is to compare the mean number of patients seen daily in both ways.

Acknowledgment

The authors report no conflict of interest and there was no financial support for this research. The authors would like to thank the medical staff members of the University Hospital of Ghent for their guidance throughout the whole process of the master thesis.

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