Computer-assisted Self-triage for the Ophthalmic Emergency Department

Eva van Eijk

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Computer-assisted Self-triage for the Ophthalmic Emergency Department

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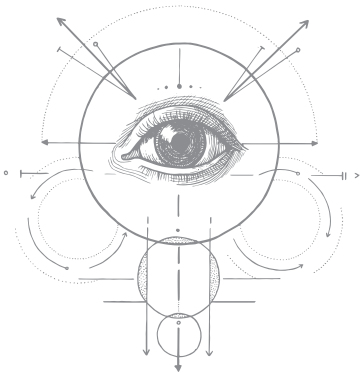
CHAPTER 1

General introduction



Our eyes play a crucial role in our daily functioning. Many people take their vision for granted, but sometimes our vision is threatened. Certain eye conditions, such as an acute retinal detachment, must be treated in time to prevent blindness. The studies presented in this thesis address the development and validation of a self-triage instrument to improve the timely treatment of urgent eye conditions. This chapter provides background information on the most important subjects in this thesis, and states the aims and research questions.

Background

The Rotterdam Eye Hospital in Rotterdam, the Netherlands, is a specialized eye hospital with an emergency department only for acute eye patients. Just like many other emergency departments, this emergency department is often overcrowded and resources are scarce. Approximately 20% of the visiting patients are at risk for permanent damage to the eye and should be seen by a doctor within an hour to receive timely intervention. These high-urgent patients are at risk of waiting too long for medical help due to the attention paid to low-urgent patients. To rapidly decide which incoming patients should be treated first, trained assistants perform triage.

Triage

Triage is the systematically prioritizing of patients by the severity of their complaints.
The term 'triage' originates from the French word 'trier', which means 'divide in three'. It was first used during the Napoleonic wars, to indicate the classification of wounded soldiers returned from the battlefields into three categories[1,2]:

1. likely to live, regardless of what care they receive;
2. likely to die, regardless of what care they receive;
3. immediate care might make a positive difference in outcome

Triage has been used ever since in wars and disasters. Figure 1 shows wounded soldiers arriving at a triage station during the First World War. An example of a triage tag frequently used in present-day battles and disasters is the METTAG, which is shown in figure 2.

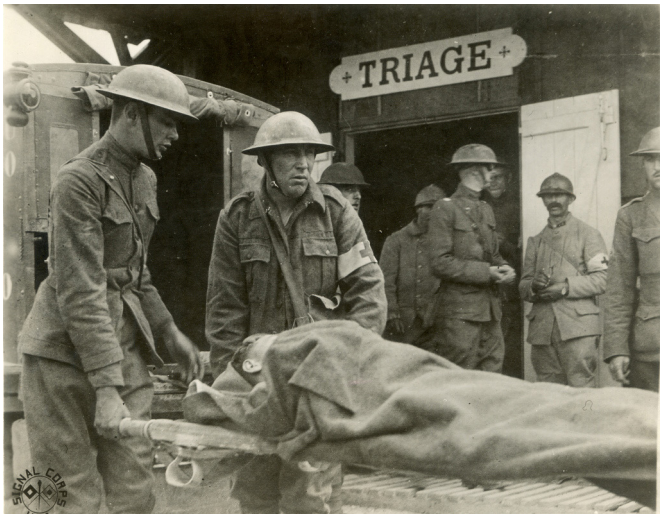


Figure 1: Wounded arriving at triage station, Suippes, France from sanitary train[3]. Selected by Scott.

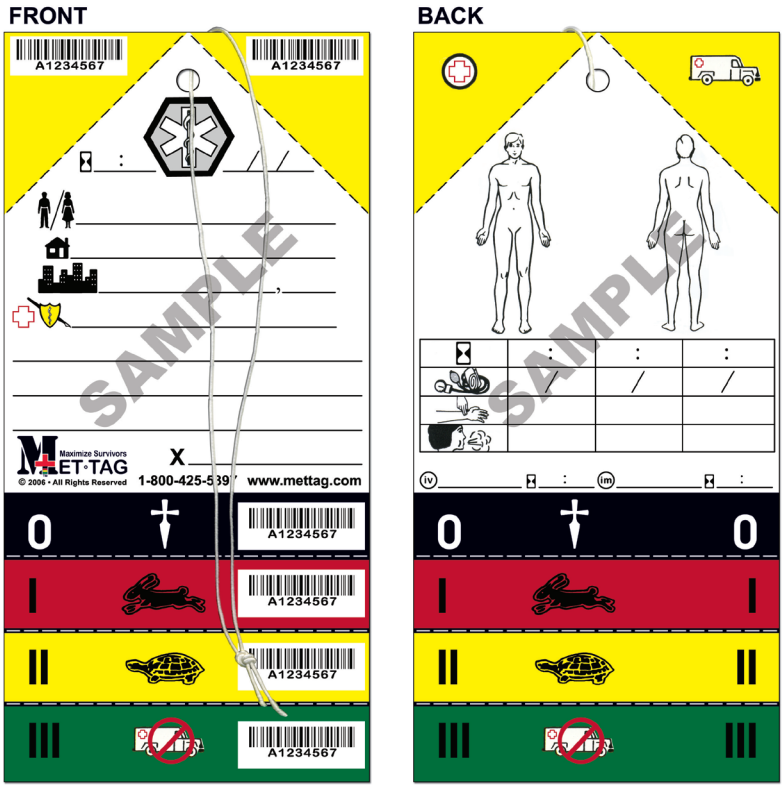


Figure 2: The universal medical emergency tag (METTAG) MT-137 tag[5].

Nowadays emergency departments use triage to prioritize patients in need for urgent care. Triage assistants will ask incoming patients about specific complaints, categorize the urgency of the complaints and provide the patient with an urgency code. Like in the rest of Europe, many general emergency departments in the Netherlands use the Manchester Triage System[4], which is based on 52 flowchart diagrams and categorizes patients in five urgency categories with a colour code.

Route for urgent ophthalmic complaints

In emergency departments, most presented eye problems are the result of an accident or spontanously occuring disease and it is not always clear at first sight whether the situation is urgent or not.

Recognizing an injury from a chemical accident is not so difficult, but visual loss or spots are sometimes missed, also because these are often not painful. Frequently encountered problem are a foreign body in the eye, flashes and redness. Rare problems that still need to be treated fast include severe pain in the eye combined with nausea; acute visual loss; or chemical substance in the eye. Moderate pain in the eye is generally not a marker for an urgent condition.

In the Netherlands, the ageing of the population places a heavy burden on healthcare resources. In 2040 an estimated 4.8 million Dutch citizens will be over 65 years old as compared to 2.9 million in 2014[6]. The aging population will result in more eye problems[7] and therefore in more expensive healthcare.

To maintain and improve health care efficiency, quality and patient safety a more active role of the patient is required. The relationship between a patient and his doctor shifts from a hierarchical one to a relationship where patients are more involved in health care decisions. For patients to play a more active role in their own health care process, technical developments create opportunities: health care portals offer personalized patient information and there is a growing number of e-Health applications available.

Need for standardised triage in the Rotterdam Eye Hospital

The Rotterdam Eye Hospital is the only specialized hospital in the Netherlands. Its emergency department is open 24 hours a day, seven days a week and is visited by 25,000 unique patients annually. During office hours, triage is performed by a triage assistant trained to perform ophthalmic triage. However, outside office hours, triage is the responsibility of the ophthalmologist on duty with no trained triage assistants present. Especially when the waiting room is crowded with patients during night and weekend shifts, the quality of triage may not always be guaranteed as the ophthalmologist is often occupied with treating patients.

Therefore it was thought necessary to develop and validate a self-triage instrument so as to guarantee uniform triage.

Triage systems such as the Manchester Triage System are used in general hospital emergency departments but are less suitable for the Rotterdam Eye Hospital. Therefore in 2003 a decision tree for triage was introduced that was based on the Manchester Triage System and adapted for ophthalmic triage only (figure 3). This decision tree is used by trained staff during office hours. However, at night and in the weekends such trained staff is not always available.

To guarantee uniform triage at night and in the weekends, we considered developing a computer-assisted self-triage instrument that would enable patients to perform triage themselves. Although a more active role for the patient is becoming increasingly common in many health care processes, in triage it is novel. It was still unknown whether patients could manage to do ophthalmic triage themselves.

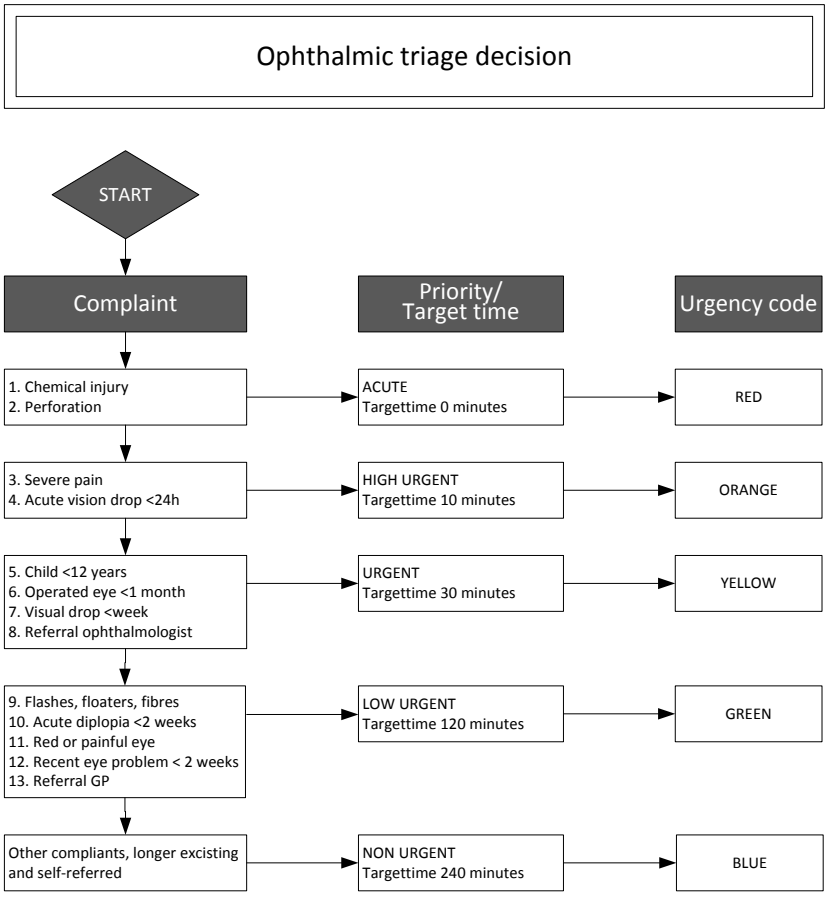


Figure 3: Triage decision tree for the emergency department of the Rotterdam Eye Hospital.

Need for change in timely treatment of retinal detachment

One of the urgent eye conditions frequently encountered in the emergency departments is rhegmatogenous retinal detachment, for which surgery often comes too late. As mentioned above, in high-urgent cases a fast diagnosis and timely surgery are required to prevent blindness.

The retina is a thin layer of receptor cells in the back of the eye that catches the light and sends the signals to the brain. A tear in the retina could cause the retina to detach from the underlying tissue. The detachment often starts in the periphery, and when the central spot in the eye, the macula, is detached, the chances of vision being restored are small. In an ideal situation, retinal reattachment surgery is scheduled before the macula is involved.

In practice, around 55% of the retinal reattachment surgeries are performed when the macula is already detached. Patient delay is the most common reason for late surgery, but differences between macula-ON and macula-OFF are not described.

In this thesis we explored differences in the referral pathways between patients with macula-ON and patients with macula-OFF. Insight in those differences could help us to raise the number of patients undergoing surgical repair before the macula is detached.

Thesis

The aims of the thesis were to:

1. Develop and validate a self-triage instrument for ophthalmic patients who present to the in the specialized emergency department in the Rotterdam Eye Hospital at night and weekend shifts.
2. Explore delays in the referral pathway of patients with a retinal detachment.

To achieve these aims, the following research questions were formulated and answered in subsequent chapters:

1. Is it possible for patients to perform self-triage in the ophthalmic emergency department? (Chapter 2)
2. How is a pen-and-paper ISET questionnaire transformed into a computer-assisted ISET? (Chapter 3)
3. Is valid computer-assisted self-triage possible for urgent ophthalmic complaints? (Chapter 4)
4. Which determinants in the referral pathway of patients with a retinal detachment discriminate between ‘macula-ON’ and ‘macula-OFF’? (Chapter 5)

The final chapter presents the general discussion and the clinical implications.

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CHAPTER 2

Towards patient self-triage in the ophthalmic emergency department: sensitivity and specificity of a self-triage instrument

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Reinier Timman and Marijke Wefers Bettink-Remeijer

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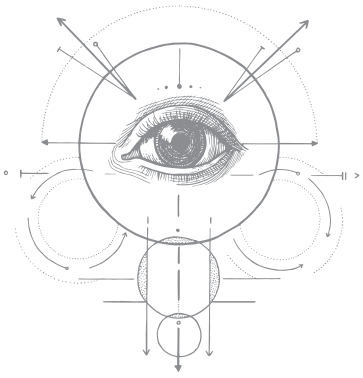

Abstract

Purpose Trained ophthalmic triage staff may not constantly be available in the emergency department of a specialized ophthalmic hospital, particularly at night. To support the current triage process, the aim of this study was to develop an ophthalmic instrument of patient self-triage (ISET).

Methods A preliminary ISET, in the form of a pen-and-paper questionnaire, was refined and validated in a two-step procedure. In a first explorative step, we compared the results of the ISET with the results of the regular triage process during the day, that is, triage by a trained triage assistant in a specialized ophthalmic hospital. As several patients needed guidance completing the questionnaire, the ISET was subsequently refined. The second step was to test the validity of the refined ISET by again comparing the outcome of this triage with that of the triage assistant in the emergency department.

Results The first explorative step involved 279 patients and the final validation step 298. During the validation step, sensitivity of the ISET was 94.3% and specificity 76.4%.

Conclusion The results show that the ISET is a sensitive and specific instrument for ophthalmic triage compared with a trained ophthalmic triage assistant.

Introduction

Several triage systems are available for general hospitals[1-4], but these generic triage instruments may not apply to specialised hospitals such as the Rotterdam Eye Hospital (REH). In the REH around 25.000 unique acute ophthalmic cases are presented at the emergency department annually. The emergency department is open 24 hours a day. During office hours, triage is conducted by a triage assistant who is trained to perform ophthalmic triage. During night and weekend shifts, triage is performed by the resident on duty together with less trained personnel. Especially when large numbers of patients are present during night and weekend shifts, the quality of triage may not always be guaranteed as the resident is often occupied treating patients.

To improve our triage process we found inspiration at the origin of triage. Baron Dominique Jean Larrey, Surgeon in Chief of Napoleon's Imperial Guard decided around 1792 in the battlefields to let a medical team sort surgical patients to handle the great number of casualties more effectively[5]. The role of the surgeon was to focus on treating patients. In our study, we further developed the idea that the physician primarily needs to focus on treating patients. Because triage is based on chief complaints of the patient, and not on symptoms, we aimed to delegate the decision making process of triage to the chief complaint expert: namely the patient. If self-triage could be accurately performed by the patient, we could improve the quality of care, especially the rapid treatment of true urgent disorders. To support the patient in this process and to increase the efficiency and standardization of the triage process, an instrument of self-triage could be a solution. Such proposal would not only be unique in ophthalmology, but also in medicine in general, as we did not find any examples of comparable ophthalmic self-triage methods reported in the literature.

The aim of this study was to develop a paper-and-pencil self-triage instrument for the ophthalmic emergency department of the REH. Our instrument had the following requirements: 1) patients should be able to use the instrument without assistance, 2) the sensitivity should be at least .80 and 3) the specificity should be at least .70.

Methods

Previously we developed a preliminary instrument of patient self-triage that we called the prototype instrument of self-triage (ISET). This prototype ISET was validated in the current study following a prospective two-step procedure. In the first explorative step we compared the results of the ISET with the results of a regular triage assistant in the emergency department. Next, the ISET was refined due to the fact that several patients needed guidance while filling in the ISET. In the final validation step we tested the validity of the refined ISET using the same validation method.

Questionnaire

The final 'prototype pen-and-paper questionnaire' can be found in this thesis as supplement 1. The questionnaire was developed as follows. Ophthalmologists generated a preliminary 18-item questionnaire. Next, patients completing this questionnaire were observed and the accuracy of self-triage outcome was compared to regular triage outcome. The results were discussed at several meetings with ophthalmologists, and items were selected on their appropriateness for patient self-triage until a concise questionnaire was obtained. The resulting 11-item instrument in the form of a flowchart enables patients to reveal their ophthalmic chief complaints. Specific characteristics of the chief complaints indicate different levels of urgency, ranging from need for immediate care to a safe waiting time of a few hours. Patients with chemical substance injuries, wounds, foreign bodies, recent ophthalmic surgical intervention or ophthalmologist's referral were selected and coded by the first five items. The subsequent six items were dedicated to the level of deterioration of sight, moving spots in the visual field, pain in the eyes, headache and other eye-related chief complaints. Completion of the questionnaire resulted in an urgency category colour code classification, each colour referring to a maximum predefined allowed waiting time in minutes, namely red (0 min), orange (10 min), yellow (30 min) and green (120 min). This colour coding is similar to the coding used by our reference standard; the triage assistant.

Patients

At days the researcher was present, all patients over 18 years visiting the Emergency Department of the REH with an acute ophthalmic problem during office hours were asked to participate in one of the two validation studies. Patients who previously visited the Emergency Department with the same chief complaints and unaccompanied patients who did not speak/read fluently Dutch were excluded from the study. When patients were unable to read due to an ophthalmic disorder, their companion was asked to complete the questionnaire.

Study procedure

In both steps of the two-step procedure, patients presenting in the Emergency Department with an acute ophthalmic disorder were first registered by the triage assistant and were given an urgency colour code, which was documented by the researcher. While waiting to see a doctor, participants were asked to fill in the ISET. The self-triage colour code resulting from the ISET was calculated and documented afterwards. In the first explorative step, patients filled in the questionnaire in the presence of the researcher, who documented irregularities and ambiguities in the questionnaire. These documented irregularities and ambiguities were later used to fine-tune the ISET for the final validation step. In case of questions by the patients, the researcher had standard instructions on how to answer these questions. Patients were not helped in answering. In the final validation step, participants filled in the

questionnaire individually or with the help of their companion, but without any assistance of the researcher. In both study steps, researcher and participants were blind to the opinion of the triage assistant. Patient characteristics were registered from their medical records. The protocol was approved by the Medical Ethical Commission of the Erasmus MC. Patients were informed about the aim and nature of the study by means of an accompanying patient information folder.

Reference standard and requirements

To define the sensitivity and specificity of the ISET in both the explorative step and the final validation step, we compared the self-triage outcome to the triage outcome by the regular triage assistant. The triage assistants are regularly trained in a modified form of the Manchester Triage System, appropriate for the ophthalmic Emergency Department. After presenting to the Emergency Department, patients were classified by a triage assistant to one of the four urgency colour codes.

For a self-assessment instrument such as the ISET to be useful, it should be designed in a way patients can fill it in without further instructions. As the most important feature of the ISET is the detection of high urgent patients, misclassification of high urgent cases as low urgent should be minimalized. In these patients waiting too long might lead to further deterioration. Misclassification of low urgent cases as high urgent is also undesirable but accepted as long as the percentages can be handled in daily practice in the Emergency Department. We know from our records at the ophthalmic Emergency Department that a high urgency proportion of 0.20 is common. Therefore we wanted the ISET to meet the following requirements: 1) patients should be able to use the instrument without assistance of the staff; 2) a sensitivity of at least 0.80 is considered acceptable and 3) a specificity of at least 0.70 is considered acceptable in clinical practice.

Statistical analysis

In both steps we calculated the sensitivity and specificity for the ISET to investigate its capacity to discriminate between high urgent (0-30 minutes maximum allowed waiting time) and low urgent (30-120 min allowed waiting time) patients. Sensitivity and specificity were analysed with the statistical calculator http://ktclearinghouse.ca/cebm/practise/ca/calculators/statscalc. Uncertainty was quantified using 95% confidence intervals. In VassarStats (http://www.vassarstats.net/) z-scores were calculated to measure a difference in proportions of sensitivity and specificity in the two validation study steps, and linear weighted Kappa was calculated to determine interrater reliability. We followed the Standards for Reporting of Diagnostic Accuracy (STARD) initiative in conducting this study[6,7]. Binary logistic regression was used to investigate whether the following factors influenced the accuracy of the questionnaire: age, gender, or assisted completion of the questionnaire. After applying the

procedure described by Buderer[8] to these values, a minimum sample of 173 patients was needed.

Results

In the first explorative step, between September and December 2009, 296 patients filled in the ISET. Seventeen patients were excluded because they needed extensive help from the researcher. Age of the 279 analysed patients (52% women) ranged from 18 to 96 years. Mean age was 54 years. In the final validation step, between October and November 2011, 298 patients filled in the ISET. No patients were excluded. Age of the patients (43% women) ranged from 18 to 97 years. Mean age was 54 years. In both study steps, some patients needed their companion to fill in the questionnaire. In the explorative step, 35 companions filled in the questionnaire (12.5% of the cases), compared to 36 in the validation step (12.1% of the cases).

Table 1 shows that in the first explorative step, the prototype ISET classified high urgent cases as high urgent in 14% of the cases and low urgent as high urgent in 13% of the cases. Seven high urgent patients (3%) were missed by the prototype ISET and were instead classified as low urgent. After refinement of the prototype ISET, we found an increase in the number of low urgent cases categorized by the ISET as high urgent (21%), and a decrease in the number of high urgent cases categorized as low urgent (1%).

Table 1. Distribution of urgency of patients (%) using the ISET and the reference standard

ISET	Triage according to the triage assistant		
	High Urgency	Low Urgency	Total
First explorative step			
High Urgency	38 (13.6)	37 (13.3)	75 (26.9)
Low Urgency	7 (2.5)	197 (70.6)	204 (73.1)
Total	45 (16.1)	234 (83.9)	279 (100)
Final validation step			
High Urgency	33 (11.1)	62 (20.8)	95 (31.9)
Low Urgency	2 (0.7)	201 (67.4)	203 (68.1)
Total	35 (11.7)	263 (88.3)	298 (100)

A similar pattern can be seen in Table 2: in the explorative step, sensitivity and specificity are both .84. In the final validation step sensitivity increased significantly from .84 to .94 ($z=-3.93$, $p<0.0001$), whereas specificity decreased from .84 to .76 ($z=2.21$, $p<0.0135$).

Table 2. Sensitivity and specificity of the ISET in the explorative and validation step.

	Explorative step n = 279	Validation step n = 298
Sensitivity (CI)	0.84 (0.71-0.92)	0.94 (0.81-0.98)
Specificity (CI)	0.84 (0.79-0.88)	0.76 (0.71-0.81)

Linear weighted Kappa was calculated to test interrater reliability between the ISET and regular triage. In the explorative step, Kappa = 0.54 (95% CI 0.43-0.66). Due to a skewed dataset the maximum obtainable Kappa was 0.69. In the validation step, Kappa = 0.41 (95% CI 0.30-0.51). Here the maximum obtainable Kappa was 0.44.

None of the factors investigated influenced accuracy significantly, apart from when the questionnaire was completed by the patient. Table 3 shows the results of the logistic regression analysis when "completion by patient" was entered as a single factor.

Table 3. Logistic Regression Analysis for the explorative and validation step for triage accuracy.

					95% C.I. for e β	
Predictor	β	SE β	p	e β (odds ratio)	Lower	Upper
Explorative step *n* = 279						
Completion by patient (1=patient. 0=companion)	1.29	.40	.001	3.63	1.67	7.89
Validation step *n* = 298						
Completion by patient (1=patient. 0=companion)	1.05	.37	.004	2.85	1.39	5.85

Discussion

In this article, we presented two steps towards the development of a self-triage instrument to support ophthalmic triage in the Emergency Department of a specialized eye hospital. In our final validation step, the ISET met our predefined requirements: 1) all patients were able to fill in the questionnaire without guidance from the researcher; 2) the sensitivity was well above .80 (94%) and 3) the specificity was above .70 (76%). Compared to the first explorative step, in the final validation step the sensitivity of the ISET increased and the specificity decreased. This indicates that the ability of the final version of the ISET to detect high urgent patients has improved, at the expense of classifying more low urgent patients as high urgent. This is the trade-off we are willing to accept to make sure that patients with high urgent disorders have the least chance to deteriorate due to under-prioritization.

In the explorative step we found moderate agreement between the ISET and regular triage (Kappa of 0.54). In the validation step, Kappa declined to 0.41 which is still moderate. This decline can be explained by the fact that we aimed for a higher sensitivity in the development of the ISET.

In general medicine, the term 'self-triage' often refers to the process by which patients evaluate their health to determine whether or not to see their doctor. Patients often adopt ineffective strategies in this process: they 'wait and see' which can be dangerous, or visit a physician multiple times without the detection of a disorder which unnecessarily consumes health care resources[9-11]. Patient self-assessment in the triage process has only been studied before in a general health care setting[12]. In that particular study, in which patients were asked to evaluate the urgency and severity of their condition, researchers concluded that self-triage seemed to supplement the regular triage process for hospitalization. However, our study results demonstrate that patients are able to perform an accurate triage themselves by using a structured questionnaire. Questions could arise whether patients would exaggerate their complaints to get faster treatment, but our results show that patients are almost 3 times more accurate in performing self-triage than if their companion would perform the triage. This suggests that the ISET can be used as a standalone self-triage instrument.

A next step in the development of the ISET will be to digitalize the pen-and-paper ISET so the questionnaire can be presented in the Emergency Department with a touch screen. Another step in refining the ISET is to translate the questionnaire into different languages. A significant group of non-Dutch speaking patients could perform self-assessment in their preferred language, e.g. English, Turkish, or Spanish, thereby optimizing triage for this specific group. We did not quantify Dutch language skills of the included patients in this study, so we have no data on the effect of language skills on self-assessed triage results. Since we validated a Dutch version of the ISET in this study, results only apply to patients who speak and read Dutch.

It is possible that we have missed some patients with high-urgency levels, as they have shorter waiting times and accordingly less chance of inclusion in this study. This could lead to a biased selection. We tried to partially compensate for this selection bias by including more patients in this study than was required according to our power calculation.

Many emergency rooms have more urgency categories than we have used in our study. The Rotterdam Eye Hospital theoretically works with 5 urgency codes, based on the urgency codes of the Manchester Triage System. However, in practice one of the five codes is never used, i.e. the blue urgency code referring to 240 minutes of waiting time. Furthermore, policy in the Rotterdam Eye Hospital dictates that all patients visiting the Emergency Department should be seen by an ophthalmologist or a resident. Because we developed the questionnaire primarily for the emergency department of the Rotterdam Eye Hospital, we validated the questionnaire with the four urgency codes as used in practice by the emergency department.

A further limitation, tasted upon before, is that we can only estimate the validity of the ISET to the reference used, in this case the regular triage assistants. In the next developmental step, when the ISET is digitalized, prospectively by a physician determined 'real urgency' will be considered as the ultimate 'gold standard'. This would be a combined validation of the ISET triage and regular triage to triage by the physician.

Conclusion

The aim of our study was to make a first step in developing an instrument of patient self-triage. In this two-step validation study, our results suggest that the ISET is a promising, sensitive and specific instrument for triage in the Emergency Department of an ophthalmic hospital.

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CHAPTER 3

From pen-and-paper questionnaire to a computer-assisted instrument for self-triage in the ophthalmic emergency department: process and validation

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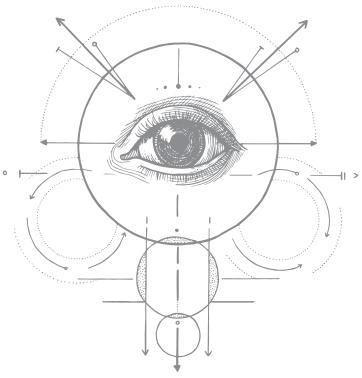

Abstract

Purpose The ISET is a validated pen-and-paper instrument for patient self-triage in ophthalmic emergency departments. The aim of the present study is to develop a validated computer-assisted ISET (ca-ISET) with a touch screen.

Methods In the emergency department of the Eye Hospital Rotterdam, the Netherlands, successive computer-assisted versions of the ISET were tested by patients visiting the emergency department. The versions were developed by iteratively prototyping, testing, analysing and refining the computer-assisted ISET. In three test cycles, 16, 53 and 75 patients ≥18 years old, visiting the emergency department for the first time with their ophthalmic complaint, were monitored while using the ca-ISET. They were debriefed, and their input was used to adapt the computer-assisted ISET. To validate the ca-ISET, a sensitivity outcome of .80 and a specificity of .70 was required (CI=95%). The ca-ISET sensitivity and specificity were tested by comparing ca-ISET triage outcome to triage outcome as decided by the regular triage assistant.

Results ISET accuracy increased from 0.69 in the first test to 0.79 in the third test. Sensitivity increased from 0.66 (CI 0.13-0.98) to 0.80 (0.51-0.95). Specificity increased from 0.69 (0.39-0.90) to 0.78 (0.65-0.88). To improve validity and usability, several adjustments were made in the text and the flow chart of the computer-assisted ISET.

Conclusions A ca-ISET prototype was developed, with minor textual modification of the pen-and-paper version. The new ca- ISET was validated by comparing against triage decided by the regular triage assistant.

Introduction

In our previous study the pen-and paper instrument of patient self-triage (ISET) was presented as a validated, sensitive and specific tool for the ophthalmic emergency department[1]. In the current study we use the pen-and paper version to develop a computer-assisted and touch screen controlled ISET.

Emergency departments are often overcrowded so to ensure that the most urgent patients are treated in time, triage systems are used by trained staff[2,3]. However, these generic triage systems do not suffice for the Rotterdam Eye Hospital, the only specialised hospital in the Netherlands. Therefore the Rotterdam Eye Hospital triage standard is used; a flowchart based on the Manchester Triage System[4] and adapted for ophthalmic emergency departments. The triage is performed by trained staff during office hours. In response to a shortage of trained triage staff in the Rotterdam Eye Hospital outside of office hours, the possibility of self-triage was investigated by developing and validating the pen-and-paper ISET[1]. The pen-and-paper ISET enables patients to perform triage themselves by filling in the ISET questionnaire. Triage outcome is the preferred waiting-time as defined in the Rotterdam Eye Hospital triage standard. However, the triage outcome is calculated manually. This complicates implementation since the staff needs extra time to calculate triage outcome and this will immediately affect handling time for each patient. A computer-assisted ISET was therefore needed to automatically calculate triage outcome.

Computer-assisted triage has been described in literature in several studies. One example is found in Canada, where a Web-based triage decision support tool was developed and validated that was based on the Canadian Triage and Acuity Scale[5,6]. In a study in a Swiss university hospital emergency unit, computer-assisted telephone triage was studied and considered a safe method for walk-in patients with non-life-threatening medical conditions[7]. Another example of computer-assisted triage comes from Australian dental emergency care, where computer-assisted triage was shown useful in response to workforce shortage and funding constraints in the public health sector[8]. However, the implementation in the previous examples was always on medical professionals providing the input in general emergency departments. So far, there has not been any report about computer-assisted triage with the patients themselves providing the input. Self-administered computer-assisted interviewing has been shown a valuable tool for emergency department diagnosis[9], but it was not tested for the purpose of triage.

Changing from pen-and-paper administration mode to computer-assisted administration not always generates the same outcome[10-12]. Consequently we cannot assume that the validity of a computer-assisted ISET is the same as the validity of the pen-and-paper version. The aim of the present study is to develop and validate a computer-assisted ISET with a touch screen.

Methods

Study design

Successive computer-assisted versions of the ISET (ca-ISET) were developed by iteratively prototyping, testing, analysing and refining the ca-ISET. Changes made in the resulting[11] versions are described. In three iterations the validity of the ca-ISET was tested by comparing ca-ISET triage outcome to triage outcome as decided by the regular triage assistant. The patients were monitored and debriefed, and their input was used to adapt the ca-ISET.

Computer-assisted ISET

The ca-ISET is a touch operated software application, its content was based on a pen-and-paper ISET that was developed and validated in our previous study[1]. The ca-ISET was developed by Delft Dimensions, a company specialized in technical and scientific software development and Interaction Design. It is designed as a 'dynamic application'[13], which make the instrument easy to adapt to the intended testing cycles. The pen-and-paper ISET was translated into a specially developed XML based configuration file from which the application generates the screens and which dictates the flow through the questionnaire. These screens are optimized for readability and touch operation. In the prototype a 21" touch screen placed on a wheeled trolley to use for patients visiting the emergency department (figure 1). The application runs on standard Windows-based computer hardware with touch capabilities. The prototype interface background was white with black and dark blue letters to maximize contrast and readability. Depending on the routing of the patient in the flowchart ca-ISET version 1.4 has 3 to 23 questions end version 1.11 has 4 to 24 questions. If patients have chemical substance injuries, wounds, foreign bodies, recent ophthalmic surgical intervention or ophthalmologist's referral, they are selected and routed in the first five items. The subsequent items were dedicated to the level of deterioration of sight, moving spots in the visual field, pain in the eyes, headache and other eye-related chief complaints.

After the patient completed the questionnaire, the triage colour code of the patient was calculated and logged. Each colour code referred to a maximum predefined allowed waiting time in minutes, namely red (0 min), orange (10 min), yellow (30 min) and green (120 min). As with the pen-and-paper ISET, the algorithm for triage came from the REH triage standard, which is based on the Manchester Triage System and is adapted for ophthalmic emergency departments[1].

Figure 1: Ca-ISET with touch screen in a test setting.

Reference standard

The regular triage procedure at the emergency department of the REH is a trained triage assistant. To validate the results of the ca-ISET, triage outcome was compared to regular triage outcome. The triage assistant first decided on the triage colour code of every patient presenting in the emergency department. After this standard triage procedure, the patient filled in the ca-ISET.

Statistics

We investigated ca-ISET ability to discriminate between high urgent (0-30 minutes maximum allowed waiting time) and low urgent (30-120 min allowed waiting time) patients, as indicated by the triage assistant. At three stages in the iterative development process of the ISET this validation check was performed. We used accuracy, sensitivity and specificity statistics to monitor progress in validity. Uncertainty was quantified using 95% confidence intervals. The study was approved by the Institutional Review Board of the Rotterdam Eye Hospital (REH 2009-03). No medical ethical permission was required for this study.

Patients

Patients visiting the emergency department of the REH were only included when the researcher (ESVE) was present. After patients had presented themselves to the triage assistant, and after the triage assistant decided on the colour code, patients were invited to participate in the study and informed consent was obtained. Patients under 18 years old, patients with recurring complaints and patients who could not read the Dutch language were excluded. While patients filled in the ca-ISET the researcher did not give any additional instructions but made observations and afterwards debriefed the patients.

Results

Patient characteristics are presented in table 1. The distribution of triage decisions is represented in table 2. In table 3 it can be seen accuracy, sensitivity and specificity improved from version 1.4 to version 1.11.

Table 1. Patient characteristics for ca-ISET versions 1.4, 1.6 and 1.11.

	Version 1.4 (*n* = 16)		Version 1.6 (*n* = 53)		Version 1.11 (*n* = 75)	
Females	6	(38%)	23	(43%)	40	(53%)
Age, Mean (range) years	55	(27-82)	54	(19-87)	53	(19-89)

Table 2. For ISET versions 1.4, 1.6 and 1.11: distribution of triage outcome when ISET is compared to the triage assistant.

ISET triage	Triage by triage assistant					
	High-urgent		Low-urgent		Total	
Version 1.4						
High-urgent	2	(13%)	4	(25%)	6	(38%)
Low-urgent	1	(6%%)	9	(56%)	10	(63%)
Total	3	(19%)	13	(81%)	16	(100%)
Version 1.6						
High-urgent	8	(15%)	16	(30%)	24	(45%)
Low-urgent	2	(4%)	27	(51%)	29	(55%)
Total	10	(19%)	43	(81%)	53	(100%)
Version 1.11						
High-urgent	12	(16%)	13	(17%)	25	(33%)
Low-urgent	3	(4%)	47	(63%)	50	(67%)
Total	15	(20%)	60	(80%)	75	(100%)

Table 3. Sensitivity and specificity for ca-ISET versions 1.4, 1.6 and 1.11.

	Version 1.4 (*n* = 16)		Version 1.6 (*n* = 53)		Version 1.11 (*n* = 75)	
Accuracy	0.69		0.66		0.79	
Sensitivity (CI)	0.67	(0.38-0.95)	0.80	(0.68-0.92)	0.80	(0.68-0.92)
Specificity (CI)	0.69	(0.42-0.96)	0.63	(0.46-0.79)	0.78	(0.62-0.95)

Figure 2 shows the test process for the 11 versions of the ca-ISET and their subsequent changes. Furthermore the accuracy, sensitivity and specificity for the three test cycles are represented. Please note that version 1.4 was tested on 16 patients. Based on the observations and debriefing observations some textual changes were made. The most important changes

were the addition of response option 'I don't know' for the questions regarding 'chemical substances', 'dirt or metal' and 'wound in eye'. Furthermore the question: 'Were you referred to the eye hospital?' was added.

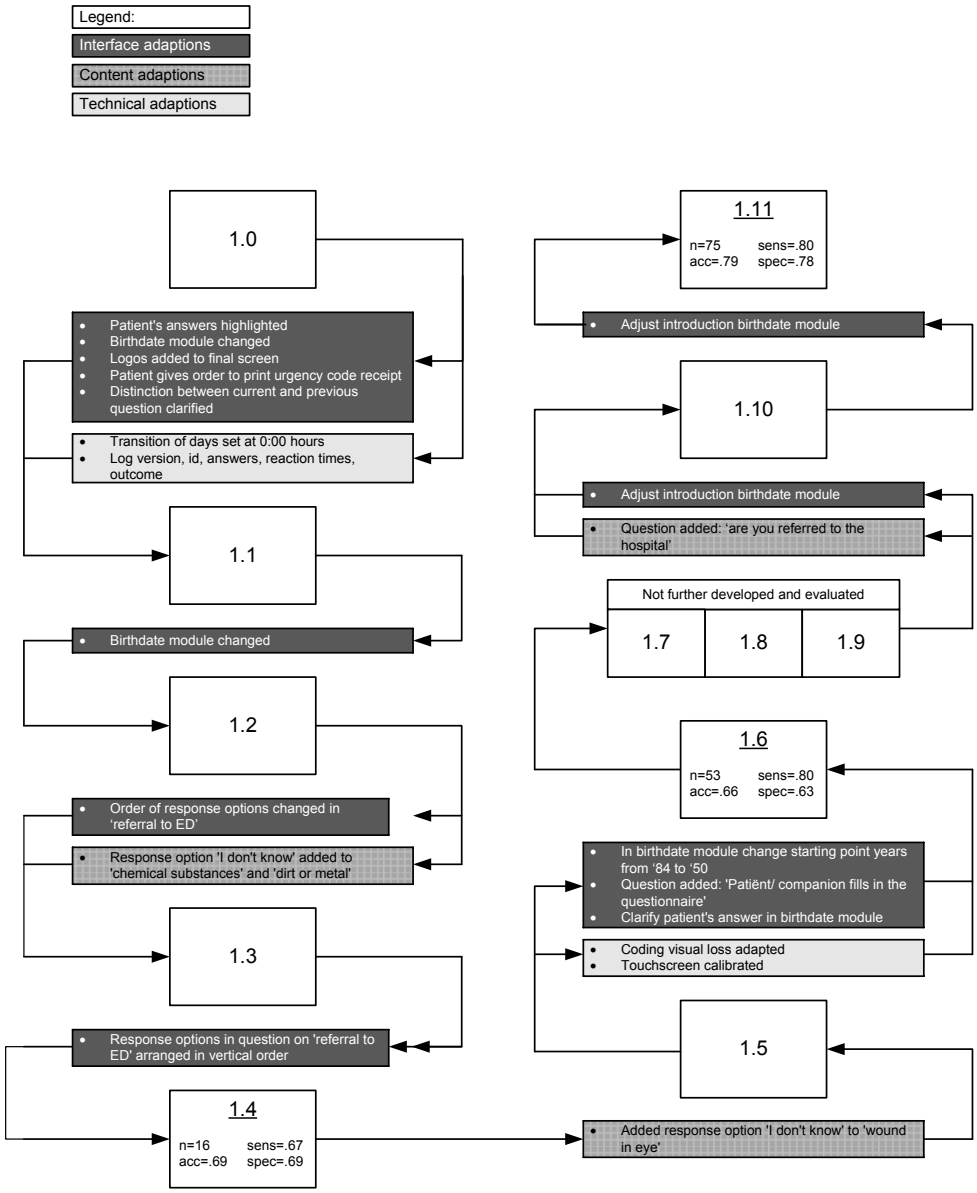

Figure 2: Description of adaptations for ISET version 1.0 to 1.11. For version 1.4, 1.6 and 1.11 the number of patients tested, accuracy (acc), sensitivity (sens) and specificity (spec) are shown in the respective boxes.

Discussion

In 11 steps we developed a ca-ISET prototype, with minor modifications of the pen-and-paper version. Most adaptations were interface adaptations to guarantee quick and smooth answering of the questionnaire.

In this study the ISET triage outcome is compared to regular triage assistant triage outcome. The regular triage assistants are trained to follow the REH triage guidelines. In practice they are the golden standard and this system functions as expected. No complaints were reported. However, no data are available on the accuracy of the guidelines being followed in practice. In a future developmental step we would therefore like to validate the ISET by comparing triage outcome with a new golden standard: a physician strictly following the REH triage guidelines. A cross-over design is desirable in order to control for order effects in this study.

The researcher reported insecurity in some patients about performing a computer task. In daily life we see a growing number of computer-assisted electronic devices, for instance at the entrance of the town hall. It is expected that patients in the near future will be accommodated to working with simple computer assisted devices. In the meantime, the ISET is developed to function as simple as possible. For patient still not able to fill in the questionnaire, an escape route could be created in which the patient's complaints are handled by emergency department assistant.

In developing the ca-ISET we put considerable effort to make the instrument as user friendly as possible. Obviously, the more user friendly the interface, the better the streamlining of triage is supported. Testing whether we have succeeded in making the device user friendly sets us a challenge. As noted before, we first have to establish the criterion validity by comparing the outcome of the ISET with that of the physician diagnosis. Such test will be done in a randomized trial, but such design does not test the user friendliness, given the constraints and imbedding of the logistics in the trial. For instance, in a trial there will always be an instructor present for asking informed consents etc.. Usability testing should be done in the implementation phase, when the ISET is set into action in a real life situation. We have not collected such data yet, but such data would be crucial for maximal usability.

Conclusions

In this investigation we developed a computer-assisted version of the ISET: a patient self-triage instrument for the use in ophthalmic emergency departments. The new ca-ISET was validated by comparing against triage decided by the regular triage assistant and provided high accuracy, sensitivity and specificity. Although further research is needed to validate the criterion and to monitor for cross-over effects, the results of this study imply that the ISET can be used in an ophthalmic emergency department.

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CHAPTER 4

Criterion validity of a computer-assisted instrument of self-triage(ca-ISET) compared to the validity of regular triage in an ophthalmic emergency department

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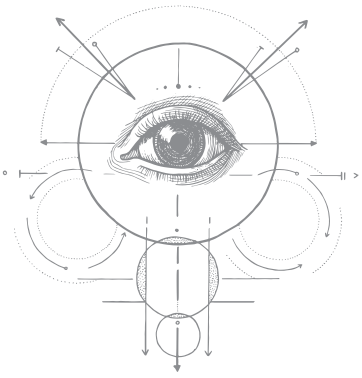


Abstract

Objectives The computer-assisted version of a self-triage tool (ca-ISET) for an ophthalmic emergency department (ED) was developed to increase the validity of the triage procedure when trained ED staff is absent.

Methods We tested whether sensitivity, specificity, Negative Predictive Value (NPV) and Positive Predictive Value (PPV) of the ca-ISET deviated from regular triage. Patients ≥18 years visiting the ED of the Rotterdam Eye Hospital in the Netherlands were invited to participate in this prospective study. This ED focuses on eye-related problems. Patient recruitment was carried out during working hours. The ca-ISET is a touch operated software application and the algorithm of the triage is based in the Manchester triage system. For all participants three triage scores were determined by (1) the participant using the ca-ISET; (2) triage by a regular, trained triage assistant and (3) triage by one physician who was specially trained in ophthalmic triage. The diagnosis of the physician was chosen as the reference standard to define criterion validity. The order of triage administration was alternated per patient. Only cases with triage scores from the two triage systems and the reference standard were included. The outcome variables, four triage colours, were transformed into a binary score: high urgent and low urgent. The difference between the ca-ISET and regular triage in terms of sensitivity, specificity, NPV and PPV was tested by Z-scores.

Results Of 247 eligible patients, data was elicited from 189 patients (average age 54 years, range 18-89). The sensitivity of the ca-ISET (0.89, CI: 0.75-0.96) did not differ from the sensitivity of the regular triage (0.69, CI: 0.53-0.82, Z=1.74, p=0.08). The ca-ISET was less specific (0.78, CI: 0.71-0.84) than the regular triage (0.92, CI=0.86-0.95, Z=3.04, p=0.00). We found no significant difference between the ca-ISET and regular triage for PPV (Z=0.19, p=0.85) and NPV (Z=0.03, p=0.98).

Conclusions The sensitivity, PPV and NPV of the ca-ISET does not differ from the sensitivity of the regular triage, while the ca-ISET retained a reasonable level of specificity. Therefore the ca-ISET can be recommended as a tool for ophthalmic emergency departments, and could be used when trained ED staff is absent.

Introduction

Emergency departments (ED's) are often overcrowded and need triage systems to categorize patients according to the urgency of their complaints[1,2]. In the Rotterdam Eye Hospital in the Netherlands, general triage systems do not apply due to the specialised character of the hospital. In response to a shortage of trained staff outside office hours, the authors of this paper previously developed a pen-and-paper instrument for patient self-triage (ISET)[3] for the ophthalmic emergency department. The ISET enables triage by patients themselves instead of triage by the triage-assistant by assessing the severity of the patient's condition. The pen-and paper ISET was validated by comparing ISET triage outcome to regular triage outcome based on the Manchester Triage System[4] and was presented as a sensitive and specific tool for the ophthalmic ED[3].

To implement the ISET in the ED of the Rotterdam Eye Hospital, a computer-assisted version of the ISET (ca-ISET) was developed[5]. The ca-ISET is a touch operated software application that presents one question at a time about the patient's ophthalmic complaints. After a maximum of 24 questions the ca-ISET assesses patient priority based on the flow charts of the Manchester Triage System.

Digitalization of procedures in the ED[6-9] or computer-assisted triage[10-12] is not new. The benefits of interviewing patients using a computer have been established before[13]. It has previously been shown to be feasible to use a self-administered computer-assisted history-taking device[14,15] for diagnostic support in emergency departments. However, self-administered computer-assisted triage for the prioritization of patients visiting the ED has not been previously reported.

Sensitivity and specificity of the pen-and-paper ISET were established using the judgments of the regular triage assistants as the reference standard[3,5]. In order to validate the ca-ISET in the current study, an even better reference standard criterion was chosen, i.e. the triage scoring by the physician. The physician could be seen as almost the best reference level. In that respect one could say that we test 'the criterion validity' of the ca- ISET. As we also registered the judgments of the regular triage assistant, were able to test could compare the criterion validity of the regular triage assistant as well.

Methods

Setting

The research took place in the waiting room of the Rotterdam Eye Hospital emergency department, which is exclusively visited by patients with an ophthalmic complaint. The Rotterdam Eye Hospital is the only specialist eye hospital in The Netherlands and the ED is visited by approximately 25.000 unique patients annually.

Study design

The study was conducted on 14 test days between 9:00 am and 5:00 pm in the study period between 13th December 2011 and 03rd February 2012. The study was not conducted on national holidays such as Christmas and New Year's Day.

Consecutive patients ≥ 18 years old visiting the ED with ophthalmic complaints were invited by the researcher, ESVE, to participate in the study. Patients who had visited the ED previously with the same complaints were excluded, as well as unaccompanied patients who did not read or speak Dutch well enough to fill in the questionnaire.

Before they formally registered at the ED reception desk, participants were informed about the study by the researcher and they were asked to sign a form giving their consent. In order to obtain the required triage codes to validate the ca-ISET, the participants were allocated alternately to one of the two study routes: 1) first the ca-ISET, then the regular triage, followed by the physician's triage; or 2) first the regular triage, then the ca-ISET followed by the physician's triage. For all participants the three scores were determined consecutively with no pause in between. After the physician's triage, participants proceeded to the ED and waited in the waiting room for their consultation with the ophthalmologist. The order of triage administration was noted. At the end of each test day the triage scores were collected by the researcher from the ca-ISET, the triage assistants and the physician.

Patients were allocated in an alternated sequence as fairly as possible to first the ca-ISET and then the regular administration or the other way around. However, the ED was sometimes confronted with several patients visiting at the same time. When this happened, the researcher lacked time to allocate the participants to one of the two routes and patients would inevitably go directly to the regular triage assistant first.

The participants were unaware of the triage codes received as a result of the interventions or the reference standard. Furthermore, the researcher, triage assistants and physician were unaware of the other triage codes the patient received during the study. When participants were unable to fill in the ca-ISET, their companion was asked to answer the questions on the ca-ISET with the ca-ISET presenting the questions in the third person format.

Study participants

Patients ≥ 18 years old visiting the emergency department for the first time with their complaints were invited to participate. All Dutch citizens have a compulsory social health insurance with guaranteed access to the emergency department.

Procedures

The ca-ISET and the regular triage procedure are described below.

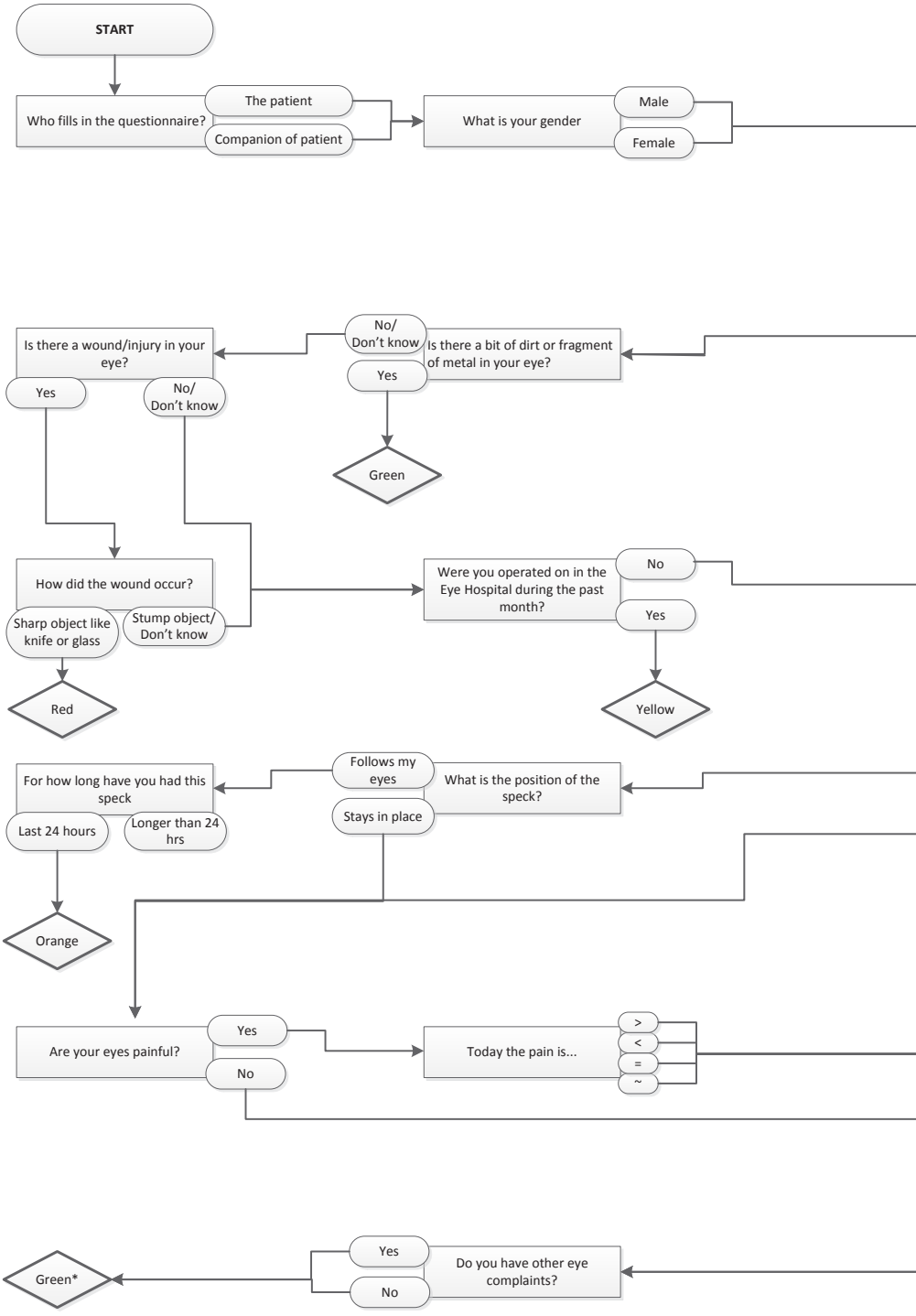
Ca-ISET

The ca-ISET is based on our previously developed pen-and-paper ISET[5] and was developed by iteratively prototyping, testing, analysing and refining. In a pilot study with three test cycles, 16, 53 and 75 patients respectively were invited to use the ca-ISET in the emergency department, with the regular triage as the reference standard. Sensitivity increased from 0.66 (CI: 0.13-0.98) in the first test to 0.80 (CI: 0.51-0.95) in the third test. Specificity increased from 0.69 (0.39-0.90) to 0.78 (0.65-0.88). To improve validity and usability, several adjustments were made in the text and the flow chart of the ca- ISET. A ca-ISET prototype was developed, with minor textual modification of the pen-and-paper version. The algorithm of the ca-ISET is shown in Figure 1 and as an electronic supplement.

The ca-ISET is a touch operated software application developed by Delft Dimensions, a company specialised in technical and scientific software development and Interaction Design. The application runs on standard Windows-based computer hardware with touch capabilities. The prototype interface background is white with black and dark blue letters to maximise contrast and therefore readability. The questions are presented one by one on a 21" computer screen that is placed on a wheeled trolley in the hallway of the waiting room.

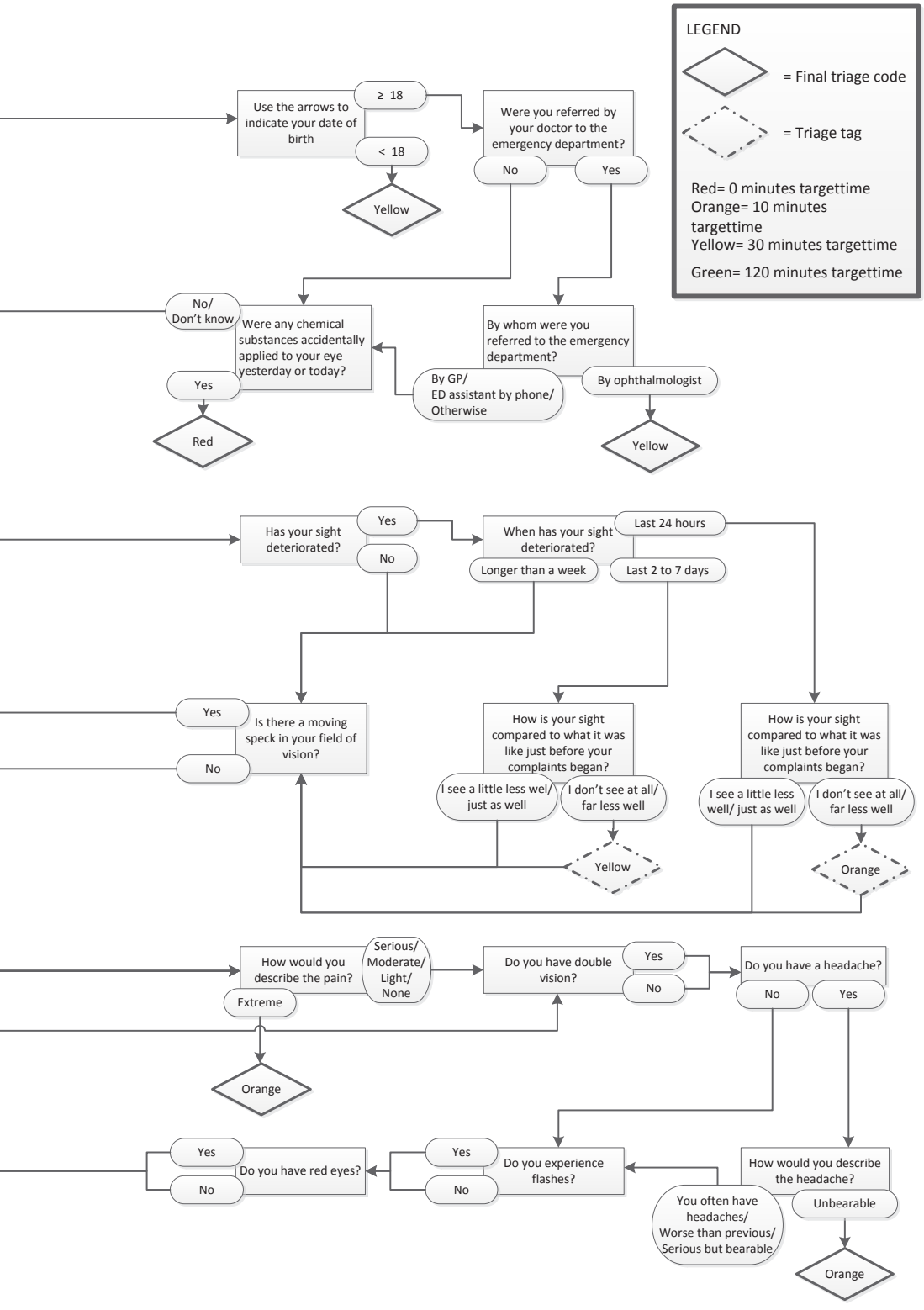
To receive a triage colour code from the ca-ISET, participants fill in the questions presented on the ca-ISET. The questions are answered by touching the screen. When all questions are answered, the participant is asked to register at the ED reception desk or to take a seat with the physician to receive the decision for the reference standard.

The ca-ISET consists of 2 to 24 questions, depending on the main complaints of the patient. Patients with chemical substance injuries, wounds, foreign bodies, recent ophthalmic surgical intervention or ophthalmologist's referral were selected and coded by the first five items. The subsequent items focused on the level of sight deterioration of sight, moving spots in the visual field, pain in the eyes, headache and other main eye-related complaints. Ca-ISET automatically records the time the respondent takes to fill in the questions, the participant's answers and the resulting triage colour code, with each colour referring to a target waiting time in minutes, namely red (0 min), orange (10 min), yellow (30 min) and green (120 min).



* Final triage is green except for when a yellow or orange tag was received in the process

Figure 1: Algorithm presenting the decision making procedure of the ca-ISET.


LEGEND
= Final triage code
= Triage tag
Red= 0 minutes targettime
Orange= 10 minutes targettime
Yellow= 30 minutes targettime
Green= 120 minutes targettime
Use the arrows to indicate your date of birth
≥ 18
< 18
Yellow
Were you referred by your doctor to the emergency department?
No
Yes
No/ Don't know
Were any chemical substances accidentally applied to your eye yesterday or today?
Yes
Red
By whom were you referred to the emergency department?
By GP/ ED assistant by phone/ Otherwise
By ophthalmologist
Yellow
Has your sight deteriorated?
Yes
No
When has your sight deteriorated?
Last 24 hours
Longer than a week
Last 2 to 7 days
Yes
No
Is there a moving speck in your field of vision?
How is your sight compared to what it was like just before your complaints began?
I see a little less wel/ just as well
I don't see at all/ far less well
Yellow
How is your sight compared to what it was like just before your complaints began?
I see a little less well/ just as well
I don't see at all/ far less well
Orange
How would you describe the pain?
Serious/ Moderate/ Light/ None
Extreme
Orange
Do you have double vision?
Yes
No
Do you have a headache?
No
Yes
Yes
No
Do you have red eyes?
Yes
No
Do you experience flashes?
How would you describe the headache?
You often have headaches/ Worse than previous/ Serious but bearable
Unbearable
Orange

Regular triage procedure

In the Rotterdam Eye Hospital ED, the regular triage procedure is performed by triage assistants. The procedure is described as follows. When patients enter the emergency department, they present themselves at the ED reception desk. The triage assistant asks the patient about the reason for their visit. The patient reports his or her complaints and answers the triage assistant's potential additional questions. Based on the patient's major complaints the triage assistant decides on the urgency colour code, makes a note of the code and the main complaints and registers the patient in the electronic hospital database. The note is attached to the patient records and serves as a guideline for the ophthalmologists to decide which patient should be seen next. The patient is then asked to wait in the waiting room.

Triage assistants working in the Rotterdam Eye Hospital have a minimum education level of secondary vocational education. They are not medically trained nurses, but are specifically trained for ophthalmic triage. All triage assistants have had more than 5 years of experience at the ED reception desk. Their triage decisions are based on the Rotterdam Eye Hospital triage standard, which has been used for almost ten years in the ED of the Rotterdam Eye Hospital. It is based on flowcharts of the Manchester Triage System adapted for the ophthalmic emergency department. Each colour code refers to a maximum predefined allowed waiting time, namely red (0 min), orange (10 min), yellow (30 min) and green (120 min).

In the test setting, the triage assistants followed the regular triage procedure. The difference between the regular triage procedure and the procedure in the test setting was that before presentation at the ED reception desk, some patients filled in the questions on the ca-ISET. The triage assistants noted the colour codes the participants had received for the study.

Reference standard

In order to qualify as a reference standard, a physician was trained in ophthalmic triage to provide a triage colour code for the participating patients in the study. Participants were triaged by the physician directly after the two interventions, and before consultation with the ophthalmologist.

In this study we employed one physician with a MSc and MD degree and research experience in the ophthalmic field. He was trained by the ED chief of the in applying the Rotterdam Eye Hospital triage standard as a checklist to interview the participating patients.

In the research setting, the physician sat at a special table in the waiting room of the emergency department. Patients sat down at the table and answered the physician's questions about their ophthalmic complaints. If the physician was not completely sure of his decision, he was allowed to discuss the complaints with the officiating ophthalmologists.

Primary outcome variable

The primary outcome was the agreement between the interventions and the reference standard on triage outcome. For all participants three triage scores were determined with 1) the ca-ISET; 2) triage by regular trained triage assistant and 3) triage by one physician who was specially trained in ophthalmic triage. The four triage colour outcomes were transformed into a binary score to test the sensitivity of the ca-ISET: 'high urgent' refers to the red, orange and yellow triage score (0–30 minutes maximum allowed waiting time) and 'low urgent' refers to the green triage score (31–120 minutes allowed waiting time). In the ED of the Rotterdam Eye Hospital, around 80% of the presented patients are low urgent (green colour code).

Handling of missing information

On quiet days patients could be called in for a consultation with the ophthalmologist before the two interventions and the reference standard provided a triage colour code. In these instances the participants were excluded from analysis.

Statistical analysis

Criterion validity was expressed in sensitivity and specificity to investigate the capacity of the ca-ISET and regular triage to discriminate between high urgent patients and low urgent patients. To estimate the possibility that a high urgent result of one of the interventions was also a high urgent condition according to the reference standard, we reported the Positive Predictive Value (PPV). To estimate the possibility that low urgent test results of the interventions were low urgent according to the reference standard, we reported the Negative Predictive Value (NPV). In this study, the NPV of the ca-ISET is more critical than the PPV because undertriage could have more direct negative implications for patients than overtriage. Uncertainty was quantified using 95% confidence intervals. Standards for Reporting of Diagnostic Accuracy (STARD) were followed[16,17]. Power was calculated by applying the procedure described by Buderer to these values[18]. We assumed an expected sensitivity of 0.90 and an expected specificity of 0.80. The clinically acceptable 95% confidence interval was set at 10%, and the proportion of the target disorder was 0.20. For the sample size of sensitivity we applied: $N_2 = Z^2_{\alpha/2} \frac{SP(1-SP)}{W^2(1-P)}$ and for specificity: $N_1 = Z^2_{\alpha/2} \frac{SN(1-SN)}{W^2 P}$, where SN is the expected sensitivity, SP the expected specificity, W the acceptable confidence interval, P the proportion of the target disorder and $Z_{\alpha/2}$ the z-value associated with the alpha level. For sensitivity this resulted in a minimum sample size of 173, for specificity a sample size of 77. Therefore we calculated that a minimum of 173 participants was needed in this study.

The sensitivity, specificity, PPV and NPV of the ca-ISET related to the reference standard was compared with the sensitivity, specificity, PPV and NPV of the regular triage related to the reference standard. To make this comparison, Z-scores were calculated by applying the fourfold table procedure described by Fleiss[19].

Logistic regression was performed to investigate whether the order of administration mode for triage influenced the results. The study was approved by the Institutional Review Board of the Rotterdam Eye Hospital (Rotterdam Eye Hospital 2009-03).

Results

On the days the researcher was present, 303 consecutive patients visited the ED of the Rotterdam Eye Hospital. 247 were eligible and we elicited data from 189 participants for analysis. A flow diagram with the patient recruitment process and the exclusion of participants is presented in figure 2. Patient characteristics are shown in table 1.

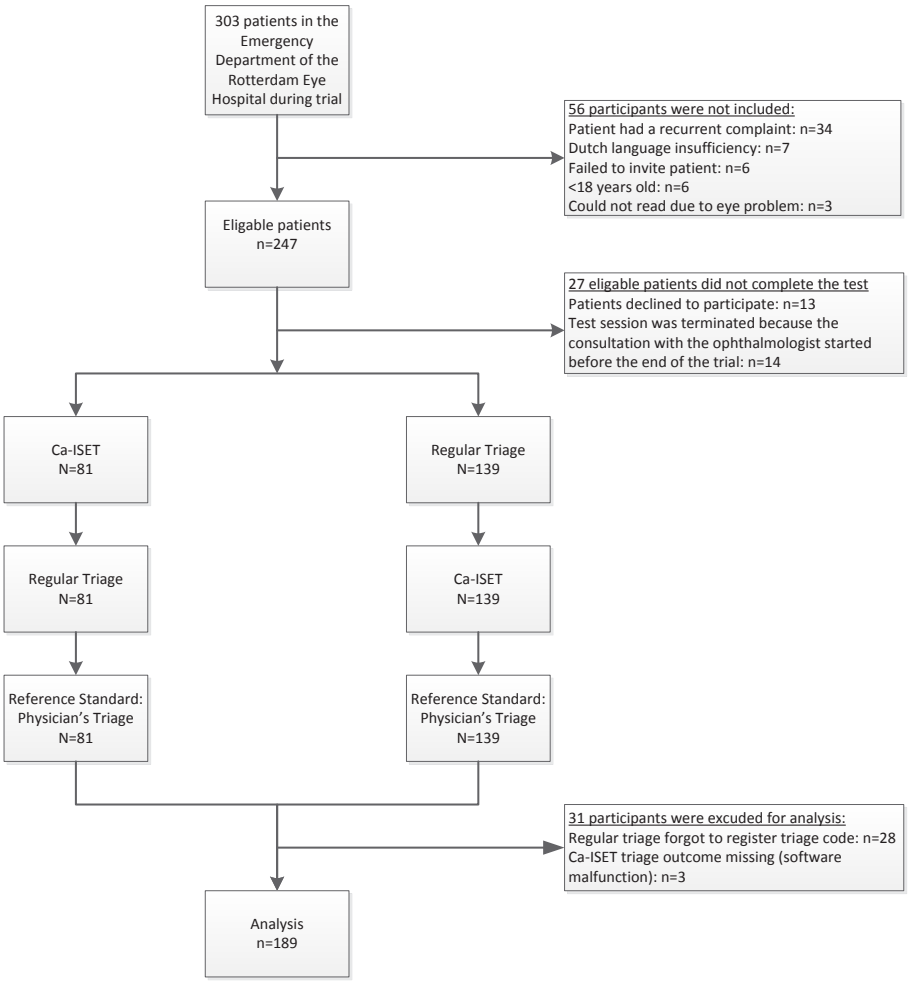


Figure 2: Standards for Reporting of Diagnostic Accuracy (STARD) study flow diagram.

Table 1: Patient characteristics (*n* = 189)

Woman, No.	90	(48%)
Age, Mean (range) in years	54	(18-89)
Companions completing the ca-ISET	30	(16%)
Triage administration order		
Ca-ISET; regular triage; physician's triage	70	
Regular triage; ca-ISET; physician's triage	119	
Time needed to fill in the ca-ISET, Median (range) in seconds	72	(25-220)

The performance of the ca-ISET and the regular triage procedure, when compared to the physician's triage, is presented in figure 3. Except for specificity, there was no statistical significant difference in criterion validity between the ca-ISET and regular triage.

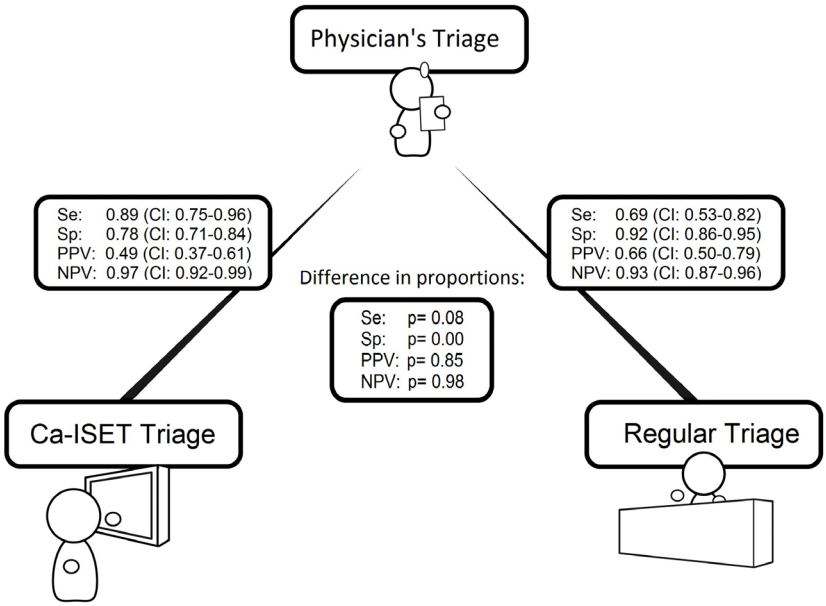


Figure 3: Performance of ca-ISET and regular triage when compared to the reference standard: physician's triage: sensitivity (Se), specificity (Sp), Positive predictive Value (PPV) and Negative Predictive Value (NPV) (95% C.I.). Except for specificity, there were no statistical significant difference in criterion validity between the ca-ISET and regular triage.

Overtriage and undertriage are presented in table 2. In four participants the ca-ISET resulted in a low urgent triage code while the physician decided it was high urgent. In these four cases, the answers to the questions of the ca-ISET did not generate any alarm signals. During the consultation with the ophthalmologist, one patient was diagnosed with a cataract and the other three patients received no diagnosis.

Table 2: Distribution of triage outcome for ca-ISET triage and regular triage both compared to physician's triage.

		Reference Standard: Physician					
		High urgent		Low urgent		Total	
ca-ISET	High urgent	32	(17%)	33	(17%)	65	(34%)
	Low urgent	4	(2%)	120	(63%)	124	(66%)
	Total	36	(19%)	153	(81%)	189	(100%)
Regular triage	High urgent	25	(13%)	13	(7%)	38	(20%)
	Low urgent	11	(6%)	140	(74%)	151	(80%)
	Total	36	(19%)	153	(81%)	189	(100%)

On thirty-three occasions the ca-ISET generated a high urgent triage code while the physician decided it was low urgent. Thirteen participants responded that they had experienced acute visual loss. Six participants indicated that they saw a spot in the eye that remained in the same place in the visual field. Five patients indicated that they had received eye surgery during the last month. Four participants mentioned that they suffered from a chemical substance in the eyes. Three patients said that the ophthalmologist had referred them to the emergency department. Two patients reported extreme pain.

In reporting overtriage and undertriage by the regular triage assistant we shall report the agreement of the ca-ISET with the regular triage, as the reasons for the decisions of the triage assistants were not noted during the study. In 11 cases the triage assistants decided that the participant's triage code was low urgent while the physician decided it was high urgent. In 10 of these 11 cases, the ca-ISET agreed with the physician to label the complaints as high urgent. In 13 cases regular triage resulted in a high urgent code while the physician decided it was low urgent. In 10 of the 13 cases the ca-ISET agreed with the physician.

The order of triage administration had no influence on study outcome as determined by logistic regression, neither did self-completion or completion by companions have any influence.

Discussion

In this study we tested the criterion validity of the ca-ISET and compared it with the validity of the regular triage procedure in the ED of the Rotterdam Eye Hospital. We found that the ca-ISET did not differ in sensitivity from regular triage by triage assistants, whilst retaining a reasonable specificity and a high negative predictive value. These results show that the ca-ISET is a valid tool for the triage assistants in an ophthalmic ED setting. The ca-ISET shows a high sensitivity and appears to follow the guidelines for the high urgent patients. The results

compared favourably to triage by one physician who was specially trained in ophthalmic triage. In the literature we found that strict adherence to triage guidelines can lead to an optimal use of resources[20].

Some limitations of the study restricted the generalizability of the results mentioned above. One limitation was due to the unpredictable patient flow through the emergency department. When several patients simultaneously visited the department it was not always possible to alternately assign patients to one of the two test arms. The order effect was therefore tested in data that cannot be considered to be randomly assigned.

Another limitation was the use of one physician in the study to provide the criterion on the basis of the Rotterdam Eye Hospital Triage Standard. Multiple physicians would have complicated the logistics of an already complex test location such as an ED and would involve substantial additional costs. However, in future research, it is highly recommended to use the consensus of multiple physicians to provide a criterion, as this would substantially increase the validity of the reference standard.

Another limitation was that we did not weigh undertriage and overtriage according to clinical relevance. An example of undertriage is when a patient with acute visual loss lasting three hours receives a green colour code and has to wait for 2 hours. An example of overtriage is when a patient with only a red eye receives a high urgent code and is consequently treated faster than necessary. One could argue that 'undertriage' has more clinical implications or has more severe clinical implications than 'overtriage'. Further research is needed to provide the weights (values) of false alarms and missed diagnoses.

It might be possible that the time of the study period (winter) could have caused a possible bias in the data. However, there is no evidence that acute pathology was related to season or time of day. The only exception was New Year's Eve, because of accidents with firecrackers. At this time the whole hospital is on full alert and most patients fall under a unified emergency category and are investigated directly by a physician.

Ethnicity of the participants could have played a role in the results of this study. In a former investigation, we had some problems defining ethnicity but it had no direct effect on the test results. Dutch reading and writing skills probably influenced the test results more but were also difficult to measure in an ED test setting. Nevertheless, it could be relevant, especially as the ca-ISET in future will include a facility to switch language. We believe however that the results apply to different ethnicities, as 46% of the population of Rotterdam is defined as immigrants or second generation Immigrants. A next step in the developmental process would be to translate the ca-ISET questionnaire into the languages of the most common minority groups in the Netherlands.

Three patients were excluded from the analysis due to software errors in the ca-ISET. For further research and implementation, these software errors should be solved. Also it should be mentioned that due to the exclusion criteria of this study, the ca-ISET has not yet been validated for ophthalmic patients younger than 18 years old.

The researcher noticed some reluctance in older patients in regard to performing a computer task; nevertheless they did not abort the task. It is expected that older patients in the near future will increasingly adapt to the use of technology in their daily lives[21] such as working with simple computer assisted devices. The ca-ISET has been developed to function as simply and easily as possible but in the meantime, patients still unable to fill in the questionnaire will have their complaints handled by an ED assistant.

Conclusion

In this study we found that the Ca-ISET and regular triage by the triage assistants were equally sensitive, while the ca-ISET retained a reasonable level of specificity. Therefore, the ca-ISET can be recommended as a tool for ophthalmic emergency departments to increase the validity of a triage procedure when trained ED staff is absent.

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CHAPTER 5

What made you wait so long? Delays in presentation of retinal detachment: knowledge is related to an attached macula

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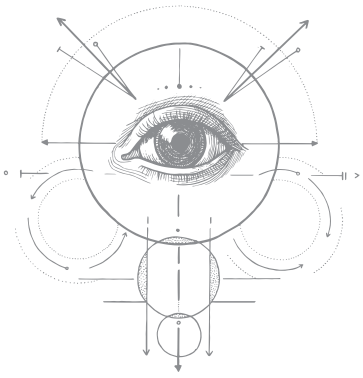

Abstract

Purpose In rhegmatogenous retinal detachment, the time between first symptoms and reattachment surgery is critical to prevent macular detachment. We explored which determinants discriminate between 'macula-ON' and 'macula-OFF' retinal detachments to improve timely treatment.

Methods Eight-hundred patients with rhegmatogenous retinal detachment admitted for surgery at the Rotterdam Eye Hospital in the Netherlands were eligible to complete a questionnaire to explore the following determinants: 1) patient's delay and doctor's delay; 2) patient reported causes for delay; 3) symptoms as early warning signals; 4) patient's prior knowledge about retinal detachment, 5) trait anxiety.

Results Five-hundred-and-twenty-one (65%) questionnaires were analysed. Median interval between first symptoms and surgery was 14 days. Macula-ON/OFF ratio was 46/54. Patient's delay in macula-ON patients (median 3 days) was shorter than in macula-OFF (5 days, p=0.026). No difference was found in doctor's delay except for 'waiting time for surgery': macula-ON patients were operated on faster (median 1 day) than macula-OFF (median 5 days, p <.001). Macula-ON patients more often attributed symptoms to retinal problems. Except floaters, no symptoms were determined as early warning signals for macula-ON. Macula-ON patients more often reported knowing that prognosis would be worse when treated later, even when controlled for previous experience with retinal detachment.

Conclusion Macula-ON patients seem to self-refer faster to a health care provider, seem more sensitive to floaters and seem more informed. This suggests that increasing awareness, especially about floaters, might increase the proportion of patients with macula still on at the moment of referral to the ophthalmologist.

Introduction

In patients with rhegmatogenous retinal detachment, the time interval between the first symptoms of detachment and the intervention is critical. Even after successful surgical repair, the major determinant for functional outcome is whether the macula was still attached (macula-ON) or already had detached (macula-OFF)[1]. In an ideal situation retinal detachment surgery should be scheduled before macular involvement. In practice, many retinal reattachment surgeries are performed after the macula is detached. With a higher percentage of patients treated before their macula gets involved in the retinal detachment, more patients would have a chance to retain good vision. The aim of this study was to explore differences in the referral pathways between patients with macula-ON and patients with macula-OFF. Furthermore, we explored differences in patient's preliminary knowledge about retinal detachment, education and trait anxiety, as these factors could influence the delay. With these outcomes, strategies could be developed that would result in more frequent surgical repair before the macula is detached.

Delays between the first symptoms and surgical repair may occur at several steps in the healthcare process: the moment of recognising the first symptoms, the moment of reporting these symptoms to primary health care providers, referral to an ophthalmologist, referral to a surgical treatment centre, presentation at the surgical centre and surgery itself. 'Patient's delay' is the delay between experiencing first symptoms and the first contact with a health care provider. The delay between the first contact with a health care provider and surgery is labelled 'doctor's delay'. Doctor´s delay is further divided into subcategories as proposed by Vissers, et al[2]. Although the word delay generally has a negative connotation, in this article we speak of delay as the interval between two points of measurement.

In a retrospective study in the UK using questionnaires involving 60 patients, patient's delay was found to be the main reason for late surgery[3]. Similar results were found in a retrospective study in the Netherlands involving 186 patients: almost 60 % of overall delay was due to patient's delay and the general practitioners' delay. Patient ignorance could be seen as the main reason for patient's delay[4]. In both studies no distinction was made between patients with macula-ON or macula-OFF. In the current study we investigate differences in patient's delay and doctor's delay between patients with macula-ON and macula-OFF. We investigate time intervals as well as causes for the delay as reported by the patient in a specifically developed questionnaire.

In this study we also investigate whether there is a relationship between patient knowledge about retinal detachment and patient's delay. We see knowledge as an important variable in our study, because unlike anxiety and characteristics like age, sex and educational level, knowledge can be influenced by the health care system. Therefore knowledge can be an important vehicle to reduce patient's delay. The influence of knowledge about a disease

and health seeking behaviour like patient's delay has been confirmed before, e.g. in systemic cancer[5], melanoma[6] and heart failure[7]. It would therefore be interesting to investigate if we can find a relationship between knowledge about retinal detachment and the speed of self-referral. It would further be helpful if such relation did not depend on educational level, as increasing the educational level is not within the scope of the health care professionals dealing with macula retinal detachment.

For several diseases a relation between self-referral and anxiety has been described: the more anxious the patients would be, the sooner the patient would refer himself to medical help[8]. To test this hypothesis in patients with a retinal detachment, we estimated the trait anxiety and related that to macula-ON/OFF and patient's delay.

With this investigating we want to add to the widening body of evidence about quality of care for patients with retinal detachment[9,10].

Aim and hypothesis

To summarise, this study aims to explore several aspects of possible differences between patients with macula-ON or macula-OFF retinal detachments: 1) patient's delay and doctor's delay; 2) patient reported causes for delay; 3) symptoms that are considered as early warning signal; 4) patient's prior knowledge about retinal detachment and 5) trait anxiety.

Methods

Study population

Between June and November 2009 and between January and July 2010, we invited 800 consecutive patients in the Rotterdam Eye Hospital (REH) with a rhegmatogenous retinal detachment to complete the questionnaire.

Procedure

At the moment of scheduling retinal detachment surgery, the nurses would present the questionnaire, patient information form and informed consent to the patient. The instruction for the patients was to complete the questionnaire, sign an informed consent form and return the questionnaire and informed consent form to the nursing department before the patient's first check-up on the day after surgery. Before that first check-up on the day after surgery, patient and investigator were not yet informed whether the macula was ON or OFF during surgery. In this way a potential poor prognosis could not influence the patients' responses. The investigator collected the medical data from the patient's chart. The status of the macula was diagnosed with a dilated fundus examination on the day of retinal detachment diagnosis in the Rotterdam Eye Hospital, with a vision of 0.7 or more as an additional sign of macula on; an OCT scan was not performed for this purpose.

Questionnaire development

The questionnaire was developed in order to capture the referral pathway of the patients. The questionnaire was developed by experts from the MGZ (Social Health Care Institute) of the Erasmus University, Rotterdam, the Netherlands, who used similar questionnaires for breast cancer screening[11], and Helma Monteban, who is an outcomes research consultant from Monteban Value Services. The questionnaire is available in Dutch on request. The questionnaire was designed with 27 items, to be filled in by the patient, if necessary with the help of relatives or accompanists. Filling in the questionnaire took the respondents approximately 40 minutes. To ensure that the questions were clear to the patients, the questionnaire had been tested and refined in a pilot study in 25 retinal detachment patients. The patients were requested to complete the questionnaire in the proximity of the investigator. Additional questions were asked to investigate the comprehensibility of the questionnaire. Based on the comments of the patients the questionnaire was finalised. The contents of the questionnaire are summarised in Table 1.

Table 1: Purpose and content of the questionnaire

Purpose	Content of question

Calculate delay	• Date of filling in the questionnaire
	• Date of the start of symptoms
	  o Loss of visual acuity
	  o Partial visual loss
	  o Total visual loss
	  o Flashes
	  o Floating parts
	  o 'Curtain'
	• Date of first visit to a health care provider
	  o Pharmacist
	  o Optometrist/Optician
	  o GP assistant
	  o GP
	  o Emergency Department
	  o Ophthalmologists receptionist
	  o Ophthalmologist
	  o Rotterdam Eye Hospital
	• Date of referral to an ophthalmologist
	• Date of first visit to an ophthalmologist
	• Date of referral to retinal surgery
	• Date of surgery (noted from the medical record by the investigator)

Causes of patient's delay & Symptoms	• Do you perceive any changes in your vision before surgery? • What were these changes? • When you had not yet heard the diagnosis, what did you initially think was the most likely cause of the changes in your eye? • What were your initial considerations not go to a health care provider? • What were your considerations to go to a health care provider?
Causes of doctor's delay	• How was your retinal detachment discovered? • When you consulted a health care provider for the first time for
	• the changes to your eye, what advice were you given? • How often have you visited a health care provider for your symptoms? • What was the reason for your eventual referral to an ophthalmologist in response to the changes in your eye by retinal detachment?
Retinal detachment knowledge	• Have you ever had surgery for retinal detachment? • Have you ever had a retinal tear or retinal weak spot? • Have you ever had a posterior vitreous detachment? • Before your eye problems arose, did you know what a retinal detachment was? • Before you went to a healthcare provider with your symptoms for the first time, did you know that the chance of visual recovery is smaller if you are treated later? • The last two years, have you been under the supervision of an ophthalmologist for other eye problems?

Socio-demographics	• Gender • What is the highest level of education you have completed with a diploma? • What is your living situation?
Trait anxiety	• 20 questions of the trait inventory of the STAI (DY) [12,13]
Medical information	• Affected eye • Macula-ON /macula-OFF • Affected quadrants • Type of surgery

Analysis

Sample Size

For the difference in time between the onset of the symptoms and surgery between macula-on and macula-off patients we consider an effect size of Cohen's d=0.25 clinically relevant. For a power of 0.80, a 2-sided alpha of 0.05 and an allocation ratio of 45 (macula-on) to 55 (macula-off), a total of 510 patients are needed.

Exclusion

Patients who had not experienced any changes in the eye or in their sight prior to diagnosis of retinal detachment were excluded. Patients with a recurrent retinal detachment in the same eye were also excluded.

Delay in the referral pathway

To compare delays in the macula-ON referral pathway with delays in the macula-OFF referral pathway, the time intervals, with skewed distribution, were analysed with a Mann Whitney analysis. In figure 1 we present the studied total delay, patient's delay and doctor's delay. In the results we also specify doctor's delay from the first visits to the specific health care providers to the first visit to an ophthalmologist.

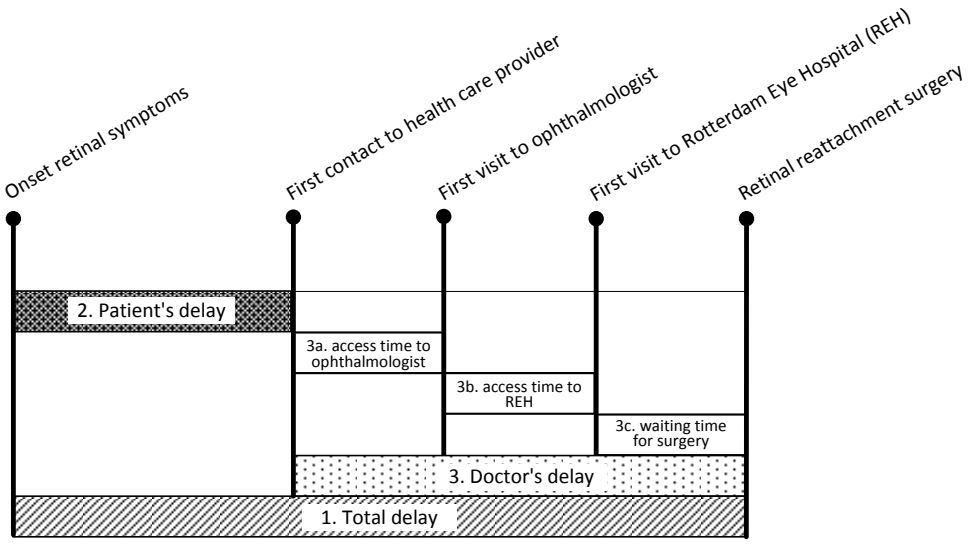

Figure 1: Delay in the referral pathway of patients with retinal detachment from the onset of retinal symptoms to retinal reattachment surgery.

In case the patient reported more than one date per question, for instance because several different symptoms started at different times, then the date of symptom the symptom that started first was used for analysis. In case the total delay exceeded 120 days, those symptoms were excluded for analysis. Most likely those symptoms were not a symptom of the retinal detachment.

Patient reported causes for delay and symptoms

In patients with macula-ON and macula-Off detachments, differences in causes for delay as reported by the patient and reported symptoms were analysed with a Chi^2 test. In questions with answer options that were mutually unrelated, the adjusted standardised residuals were reported to indicate what factor caused the statistical significance. This resulted in 60 tests, a Bonferroni correction would result in an alpha level of 0.05/60 = .000855. However, because of the explorative character of our study we considered an alpha level of <0.01 significant. Statistical significant differences were controlled for age with a logistic regression analysis.

Retinal detachment knowledge

The difference between patients with macula-ON and macula-OFF detachment for preliminary knowledge about retinal detachment was analysed with a binary logistic regression analysis, and controlled for level of education.

Trait anxiety

The relationship between trait anxiety measured by the STAI (DY)[12,13] and macular involvement in retinal detachment and between anxiety and the patient's delay time interval was tested with a Mann Whitney analysis.

Results

General results

A total of 545 patients with rhegmatogenous retinal detachment responded (68% of the 800 invited patients). Twenty-four patients indicated that they had not experienced any visual changes or symptoms before retinal detachment diagnosis and were therefore excluded. Mean age was 57 years (range 18-90). Patient characteristics are shown in table 2. 46% of the patients had macula-ON retinal detachment at the time of intervention.

Overall median time between first symptoms and intervention was 14 days. Median patient's delay (the interval from the first symptom to the first visit to a healthcare provider) was 4 days. Median doctor's delay (the interval from the first visit to a pharmacist, optician, optometrist or GP to referral to Rotterdam Eye Hospital) was 7 days.

Table 2: Patient characteristics

	macula-ON		macula-OFF		Total	
	n	%	n	%	n	%
Macula status	239	(46%)	282	(54%)	521	(100%)
Gender						
Female	83	(35%)	91	(32%)	174	(33%)
Male	156	(65%)	191	(68%)	347	(67%)
Affected Eye						
OD	117	(49%)	136	(48%)	253	(49%)
OS	121	(51%)	145	(51%)	266	(51%)
Not registered	1	(0%)	1	(0%)	2	(0%)
Quadrants affected						
0	3	(1%)	5	(2%)	8	(2%)
1	123	(51%)	10	(4%)	133	(26%)
2	56	(23%)	123	(44%)	179	(34%)
3	7	(3%)	65	(23%)	72	(14%)
4	2	(1%)	30	(11%)	32	(6%)
Missing	48	(20%)	49	(17%)	97	(19%)

Table continues on the next page

Table 2: Patient characteristics *(continued)*

	macula-ON		macula-OFF		Total	
	n	%	n	%	n	%
Surgery						
Cerclage Plombe	131	(55%)	146	(52%)	277	(53%)
Gas	3	(1%)	0	(0%)	3	(1%)
Vitrectomy/Plombe	2	(1%)	5	(2%)	7	(1%)
Vitrectomy	102	(43%)	128	(45%)	230	(44%)
Missing	1	(0%)	3	(1%)	4	(1%)
Currently under treatment for other eye disease						
No	153	(64%)	175	(62%)	328	(63%)
Yes	85	(36%)	105	(37%)	190	(36%)
Missing	1	(0%)	2	(1%)	3	(1%)
Previous experience with retinal problems						
Retinal detachment in the other eye	36	(15%)	12	(4%)	48	(9%)
Previous retinal tear	45	(19%)	25	(9%)	70	(13%)
Posterior Vitreous Detachment	16	(7%)	5	(2%)	21	(4%)
Educational level						
Level 0: Pre-primary education	7	(3%)	16	(6%)	23	(4%)
Level 1: Primary education	30	(13%)	55	(20%)	85	(16%)
Level 2: lower secondary education	39	(16%)	43	(15%)	82	(16%)
Level 3: Upper secondary education	49	(21%)	51	(18%)	100	(19%)
Level 4: Post-secondary education	21	(9%)	16	(6%)	37	(7%)
Level 5: 1st and 2nd stage tertiary education	48	(20%)	68	(24%)	116	(22%)
Level 6: 2nd stage of tertiary education	37	(15%)	23	(8%)	60	(12%)
Other	5	(2%)	5	(2%)	10	(2%)
Missing	3	(1%)	4	(1%)	7	(1%)
Living circumstance						
Living with partner	194	(81%)	213	(76%)	407	(78%)
Relationship but not living together	3	(1%)	7	(2%)	10	(2%)
Single	32	(13%)	44	(16%)	76	(15%)
Otherwise	7	(3%)	16	(6%)	23	(4%)
No answer	3	(1%)	2	(1%)	5	(1%)

Differences in time intervals

Patient's delay

Patients with macula-ON retinal detachment showed a shorter patient's delay (median 3 days) than patients with macula-OFF retinal detachment (median 7 days, p=0.026, Mann Whitney analysis), as can be seen in table 3.

Table 3: Differences in referral time intervals (days) from first symptoms to reattachment surgery for patients with macula-ON and macula-OFF.

Interval	macula-ON detachment			macula-OFF detachment			p-value*
	Median	Mean rank	N	Median	Mean rank	N	
1. Total delay	15	227	221	13	251	258	0.056
2. Patient's delay	3	196	185	5	223	236	0.026
3. Doctor's delay	3.5	194	194	7	243	248	<0.001
Doctor's delay specified							
3a. Access time to ophthalmologist	0	238	211	0	233	259	.679
Time between the first contact with a health care provider and the first visit to an ophthalmologist							
3a1. Pharmacist	17	3	2	3	1	1	.221
3a2. GP assistant	1	14	10	0	9	12	.065
3a3. GP	1	114	91	0	104	124	.207
3a4. Optician	1	38	34	1	39	42	.966
3a5. Ophthalmologist's receptionist	0	19	24	3	24	18	.186
3a6. Emergency Department	0	10	7	0	12	14	.423
3b. Access time to Rotterdam Eye Hospital	0	218	198	0	212	231	0.427
3c. Waiting time for surgery	1	136	193	5	280	236	<0.001

* Mann-Whitney U test

Doctor's delay

Doctor's delay from the first visit to a health care provider to surgery was shorter for macula-ON (median 1 day) than for macula-OFF (median 7 days, p<0.001). When doctors delay was specified there was no difference in doctor's delay between macula-ON and macula-OFF, except for 'waiting time for surgery': macula-ON patients were operated on faster (median 1 day) than macula-OFF (median 5 days, p <.001)(table 3). We found no differences in; 1) Total delay; 2) access time to the ophthalmologist, and 3) access time to the Rotterdam Eye Hospital.

Patients reported causes for delay

The causes for delay in the referral pathway as reported by the patients were first analysed with a Chi^2 test and the statistical significant differences were subsequently controlled for age in a logistic regression analysis. An overview of the differences controlled for age is shown in table 4. A full report of the 60 variables tested with a Chi^2 test is available on request.

Prior to diagnosis, patients with macula-ON retinal detachment more often thought that the most likely cause for the changes in their eye was aging of the retina (p=.006, logistic regression analysis), retinal tear (p=.004) or retinal detachment (p=.001). Patients with macula-OFF retinal detachment more often thought that prior to diagnosis there was something wrong with their glasses or contact lenses (p=.001).

As a reason to seek help after experiencing changes in their vision, patients with macula-OFF retinal detachment more often reported that the symptoms aggravated (p=.000).

Patients with macula-OFF reported more often than patients with macula-ON that the first visited health care professional referred them to an ophthalmologist (p=.002). Patients with macula-OFF reported more often (p<.001, Chi^2 analysis) that the reason for the GP or optician to refer them to an ophthalmologist was because they found an abnormality in the patients' eye. However, this difference disappeared when the analysis was controlled for age.

No difference is found in attributing the symptoms to a foreign body in the eye, problems with a blood vessel, cataract, high age or fatigue.

Symptoms as early warning signal

We explored whether patients with macula-ON used different symptoms as an early warning signal in their self-referral than patients with macula-OFF. In table 4 we show that, prior to retinal reattachment surgery, patients with macula-ON experienced more floaters (p=.002) than patients with macula-OFF. Adversely, patients with macula-OFF experienced more often visual acuity drop (p<.001), more difficulty reading (p<.001), more complete visual loss (p<.001) and more 'curtains' (p=.003). No difference was found in partial visual drop, flashes and other symptoms.

Knowledge, experience and educational level

Patients with macula-ON reported more often that they knew the prognosis would be worse if they would be treated later (p<.002). There was no difference in prior knowledge of retinal detachment and no difference in experience

Trait anxiety

Two-hundred-thirty-one of the 239 patients with macula-ON retinal detachment filled in the trait inventory of the STAI (DY) and 264 of the 282 patients with macula-OFF. No difference was found between macula-ON and macula-OFF; median score was 31 for macula-ON and also 31 for macula-OFF.

Table 4: Differences, analysed with logistic regression and controlled for age, between patients with macula-ON and macula-OFF in causes for patient and doctor's delay as reported by the patients, reported symptoms, retinal detachment knowledge and experience.

	macula-ON detachment N=239		macula-OFF detachment N=282		EXp(B)	df	p-value
Causes for patient's delay as reported by patient							
What did you think, at first, was the most likely cause of the changes in your eye or vision (when you had not heard the diagnosis yet)?							
Something wrong with glasses/contact lenses	22	9%	52	18%	2.556	1	0.001
Aging of retina	13	5%	2	1%	0.125	1	0.006
Retinal tear	25	10%	11	4%	0.340	1	0.004
Retinal detachment	52	22%	32	11%	0.445	1	0.001
What were your initial considerations to visit the doctor, optician, optometrist or ophthalmologist?							
Symptoms aggravated	88	37%	149	53%	1.955	1	<0.001
Causes for doctor's delay as reported by patient							
What was the advice from the first visited health care professional							
Referral to an ophthalmologist	72	30%	120	43%	1.786	1	0.002
Reason for referral to ophthalmologist							
GP/Optician saw abnormality in the eye	67	28%	128	45%	0.992	3	0.084
Reported symptoms as an early warning signal							
Drop in visual acuity	67	28%	120	43%	2.006	1	<0.001
Difficulty reading	22	9%	70	25%	3.379	1	<0.001
Complete visual loss	7	3%	33	12%	4.178	1	0.001
Floaters	153	64%	142	50%	0.563	1	0.002
Curtain	89	37%	142	50%	1.685	1	0.003
Retinal detachment prior knowledge							
Prior knowledge of retinal detachment*	121	51%	98	35%	.822	1	.382
Prior knowledge that later treatment would result in worse prognosis*	92	39%	53	19%	.464	1	.002
Experience with retinal problems* (RD, PVR or retinal tear)	55	23%	35	12%	.103	1	.654

* Corrected for level of education

Discussion

General conclusions

In this study we investigated the differences between patients with macula-ON detachments and patients with macula-OFF detachments and found that: 1) Patients with a macula-OFF at the time of intervention had waited longer to seek help and more often went to seek help when the symptoms got worse; 2) In line with the accepted practice patterns, patients with

a macula-ON were operated on faster than macula-OFF; 3) Patients with a Macula-ON retinal detachment seemed to attribute their initial symptoms to retinal problems, whereas macula-OFF patients more often seemed to attribute their symptoms to a more external factor, i.e. a problem with their glasses or contact lenses; 4) Macula-ON patients reported to have experienced more floaters; 5) Patients with a macula-ON more often knew that the prognosis would be worse if they would be treated later, even when the results were controlled for previous experience with retinal detachment; 6) there was no relation between anxiety or educational level and macula-ON/OFF.

Implications

The conclusions above have a number of policy and clinical implications. The first conclusion, patients with a macula-OFF had waited longer to seek help, means that there is room for improvement in the early detection and awareness among the general public. Early detection and awareness could result in less macula-OFF patients. The potential benefit of increased awareness is underlined by the conclusion that patients with a macula-ON retinal detachment seemed to attribute their initial symptoms more often to retinal problems. In increasing awareness, floaters seem to be a good early warning signal for retinal detachment, as macula-ON patients reported to have experienced more floaters. That information is the basis of the decision to visit a health care provider and not just attitude or personality, was confirmed by the observation that patients knowing that later treatment would result in worse prognosis had higher chances for macular-ON, while there was no relation between anxiety and educational level and macula-ON/OFF.

All of the above is a strong plea to arrive at a higher level of understanding of retinal problems in the population at risk. We could imagine that awareness campaigns and open door policy of medical and commercial eye experts could help to reduce the complications of retinal problems. It will be a challenge to implement such policy, given the large number of stakeholders involved and a potential large patient flow. Nevertheless, such implementation might reduce a serious health problem.

An alternative for a campaign might be to develop an app of other device that helps the patient to decide what to do at home. We have already experience with such device in an emergency setting[14-16] and we also found that particular floaters are more related to retinal detachment than others[17,18].

The conclusions above also have an implication for the referral pathway of retinal detachment. It is a comforting thought that at least 50% of the patients with a retinal detachment visit an ophthalmologist within one day after the first contact with a health care provider, furthermore there seems to be no significant delay in e.g. GP practice for both macula-ON and macula-OFF patients. On the other hand we found that patients with a macula-ON were operated on faster than macula-OFF, in line with the accepted practice patterns.

Although the current practice is to focus on early treatment of macula-ON detachment as reflected by the median we found of one day, we should aim at scheduling earlier surgery of recent macula-OFF detachment [19] to bring down the current median of five days.

Limitations

One of the limitations in the study is the assumption that progress and symptoms of retinal detachment follow the same patterns in all patients. In young phakic patients progress may be slower and symptoms may be more readily perceived. In our data lens status is not easily retrievable, but the percentage of patients under 40 years, the age of typically slow, phakic with still attached hyaloid retinal detachment, was similar in the macula-On and macula-OFF groups.

In practice not all patients experience the same symptoms. A possible explanation could be that not all symptoms are presented in individual cases, but it could also be that patients just did not recognize the symptoms and therefore did not give the symptoms any attention. In this investigation we could not distinguish between those sources of variance.

Another limitation in the present study is that we had to rely on the self-administration of dates. Although we aimed to have the questionnaire answered as soon as possible before the doctors and the patient would discuss surgery outcome, macular status and possible delay, it can be expected that the dates reported by the patients were not always precise, which might have influenced the results.

We excluded 24 patients whose retinal detachment was discovered by the health care professional before any symptom was noted by the patient. This was because these patients cannot help us in determining which symptoms might precede retinal detachment. We also excluded the recidivists. This means that the results found only represent patients who had any sigh before their first retinal detachment, which might not fully represent the general population.

Lens status was neither registered electronically, nor was it part of the questionnaire for the patients. After the study was conducted, we planned to retrieve the lens status from the paper patient files, but found that this information was difficult to recover. We therefore analysed a sample of 69 patients from whom we obtained data about the lens status. In this subsample, we found that there was no effect on the macula status at all ($p=0.962$, logistic regression analysis), with or without control for age. Obviously, the advice for future research should be to register lens status from the start.

In this study, the type of detachment (signs of longstanding detachment) was not studied in relation to the rate of reaching the surgeon with the macula attached. This was because signs of a longstanding detachment could not be identified reliably from the patient files.

Conclusion

We found indications that patients with macula-ON retinal detachment are more prone to self-referral to a health care provider, are more sensitive to floaters and are more informed that later treatment would result in worse prognosis. This suggests that increasing awareness, especially about floaters, might increase the proportion of patients with macula still on at referral.

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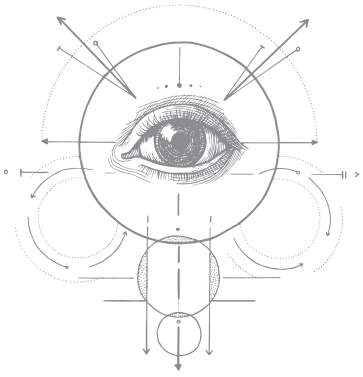
CHAPTER 6

General discussion



General discussion

Before this study started, the Rotterdam Eye Hospital emergency department (ED) applied two different triage procedures to categorise the incoming patients by their urgency; one during office hours and one outside office hours.

During office hours trained triage assistants performed the triage. They wrote down the symptoms and urgency colour code on a post-it sticky note and attached it to the patient record. The ophthalmologists treated the registered patients in order of urgency.

Outside office hours the triage was performed by the ophthalmologist as no trained triage assistants were available. However, since there was only one ophthalmologist available outside office hours, triage was delayed if the ophthalmologist was busy attending to a patient. The front desk employees took notes of the patients' symptoms and passed these notes on to the ophthalmologist. The delay puts patient at risk, especially when the ophthalmologist was occupied for a longer time.

To enhance uniform and timely triage outside office hours, implementation of a computerised self-triage instrument was considered. Although a more active role for the patient is becoming increasingly common in many health care processes, an active role of the patient in triage is novel. It was unknown whether patients could perform the ophthalmic triage themselves, with the aid of a computerised self-triage instrument, and this was the starting point of this thesis.

This final chapter summarizes the research on the basis of the research questions and aims. Although the development and validation of the Instrument for Self-Triage (ISET) were successful, the implementation in the Rotterdam Eye Hospital was cumbersome, as described below. The chapter concludes with a pronouncement on the final development and validation of the ISET.

Development and validation of the ISET

First we answer the research questions as formulated in the introduction and next clarify whether the aims of the research were achieved.

1. Is it possible for patients to perform self-triage in the ophthalmic ED? In **Chapter 2** we describe that with the ISET (instrument for self-triage), patients can perform triage themselves.

2. How is a pen-and-paper ISET questionnaire transformed into a computer-assisted ISET? In **chapter 3** we report that with iterative testing the computer-assisted ISET (ca-ISET) is developed.

3. Is valid computer-assisted self-triage possible for urgent ophthalmic complaints? In **chapter 4** is described that the sensitivity, PPV and NPV of the ca-ISET does not differ from the sensitivity of the regular triage, while the ca-ISET retained a reasonable level of specificity.

4. Which determinants in the referral pathway of retinal detachment patients discriminate between 'macula-ON' and 'macula-OFF'? In **chapter 5** we conclude that macula-ON patients seem to self-refer faster to a health care provider, seem more sensitive to floaters and seem more informed about retinal detachment.

After answering these research questions we are able to formulate whether we succeeded in achieving the 'aims' of the research:

1. Develop and validate self-triage for ophthalmic patients in the specialized ED for triage at night and weekend shifts in the Rotterdam Eye Hospital. This aim was achieved: ISET was shown to be a valid instrument.

2. Explore delays in the referral pathway of patients with retinal detachments. This aim was achieved by exploring the differences in the referral pathway between macula-ON and macula-OFF. We found that knowledge about retinal detachments is related to an attached macula.

Implementation of the ISET

Although the development and validation of the ISET were successful, its implementation in the Rotterdam Eye Hospital had a remarkable course. It started with an optimistic view on implementation. In a next stage, however, it seemed that this would turn out to be a scientific project only, and that implementation in practice would be a bridge too far. Nevertheless, in the end the ISET did find its place in the complex hospital logistics. Below, this course of events is described in more detail to learn lessons from it.

Implementing the ISET outside office hours

After the ISET was successfully validated the next step was to put it into practice. In the developmental and validation phase the ISET was a movable computer screen on a trolley, but now the ISET is permanently mounted on the wall in the ED outside office hours (see figure 1).

Figure 1. Colleague Hanjo de Vries fills in the ISET questionnaire in the ED of the Rotterdam Eye Hospital ©Paula Romein Fotografie.

Several pilots were launched to test the ISET outside office hours. We noticed that the front desk staff always guided patients to the ISET when the researcher was present. Still, at times when the researcher was absent, they claimed to have forgotten this. Indeed the number of patients filling in the ISET was much lower when the researcher was absent. In the validation phase of the study with the researcher present, only few patients had questions about the use of the ISET. But when the researcher was absent, patients asked many questions about the device to the front desk staff and felt annoyed by being directed to the ISET: they just wanted to be treated. Questions included for instance: "Why do I have to fill in these questions?", or "How do I fill in my birth date?". The consequent delay in the triage process was a source of irritation for the front desk staff. Their workload did not diminish as promised but even increased. Their reservations regarding the effectiveness of the largely contributed to the initial failure of the implementation.

Although initial attempts to stimulate active use of the ISET outside office hours failed, at one point more patients started to use it. This coincided with the start of sending email messages on the results of the ongoing pilot to several layers in the organisation: the front desk obviously, but also the management, the IT staff and the CEO. From that time on, patients were invited more actively by the front desk staff to use the ISET. The use of the ISET increased from 38% in May 2014 to 64% in August 2014. Although we are unable to determine a direct link between the distribution of emails and the increasing use of the ISET, we assume that monitoring by different layers of the organisation may have contributed.

When in 2015 the researcher took a position elsewhere and left the Eye Hospital Rotterdam, responsibility for the implementation of the ISET was transferred to a policy advisor. Partly because of major organizational changes in the hospital, including a new electronic patient

file system, implementation of the ISET was not seen as a priority. Furthermore, a policy change effective from the first of January 2015 made implementation of the ISET less urgent, as self-referrers were no longer admitted in the ED. On a positive note, the waiting room was less crowded with lower risk of delayed triage outside office hours. This policy change in was associated with a significant drop in patient numbers in the ED outside office hours: from 6061 in 2013 to 3645 in 2015.

Directions for the future

We could identify at least four obstacles in the implementation process that added to the misgivings of the front desk staff: 1) the ISET was an unfinished prototype; 2) the staff was scared of being replaced by a computer; 3) implementation of the ISET coincided with a major IC T reorganization; and 4) policy changes had an effect on the work process. Below these four obstacles are describe in more detail.

The first obstacle was that the ISET was not a finalized prototype when put to use. The development of the ISET was directed at the patients, rather than at the front desk staff. For instance, we had to make sure that any patient would be able to use the ISET, provided patient or she can understand simple Dutch texts. Thus much of the team's efforts during the development of the ISET were directed towards the perspectives and experiences of the patients instead of the experience of the ED staff. These employees have an executive job. A device like the ISET should be fine-tuned to the work setting logistics to prevent it from being obstructive, especially when the device's teething troubles are still present.

The second obstacle was the fear of being replaced by a computer. The triage process is the main part of the interaction between front desk staff and the patient. Front desk employees like this part of their job, and they feared that outsourcing the triage to a "tool" would deprive them of the most satisfying part of their work. They feared that their job would be reduced from a clinical one to an administrative job or even worse, that they would be replaced.

The fear of technological developments changing our society and changing jobs is not unique to the front desk staff of the Rotterdam Eye Hospital. Professional services multinational Deloitte stated in a 2014 report that 2 to 3 million jobs are at risk of disappearing due to automation of our society[1]. And the current Dutch Minister of Social Affairs and Employment Lodewijk Asscher stated in 2014: "And although I am a born optimist, I must admit that the scenario that robots will lead to especially technological unemployment is certainly not inconceivable." ["En hoewel ik een rasoptimist ben, moet ook ik toegeven dat het scenario dat robots zullen leiden tot vooral technologische werkloosheid zeker niet ondenkbaar is."[2]]. In the industrial revolution labourers also feared losing their jobs because of technological development. But after World War II we have seen technological advances leading to job creation and increased prosperity.

The fear for replacement affects people in one of their most basic needs: security. This is something we need to take into account when designing a workspace device. For instance, the management should coach the workers into the new role, and should acknowledge that the workers would like to do something meaningful. For instance, the focus should be more on service and on helping emotional patients. Then uniform triage could be combined with patient empowerment and would lead to greater patient satisfaction[6].

The third obstacle was that the implementation of the ISET coincided with a major ICT reorganization in the Rotterdam Eye Hospital. While the ISET project was being set up, we did not take into account organizational changes at hand as it was still unknown how and when these would be realized was still unknown. We knew that a change was imminent; the paper patient files would be digitalized and an electronic patient filing system was to be introduced. But at the start of the ISET project.

In practice this meant an uncomfortable situation for the front desk staff. In the transition phase of this large organizational change, the front desk employees had to perform many extra tasks: files had to be stored in paper form as well as digitally. What is more, because the ISET was being implemented they were confronted with many questions from the patients. In order to successfully implement a device in an organization, it is essential to keep a continuous exchange of information going between the innovative project and related changes and innovations in the surroundings. In a busy healthcare environment it requires effort and planning to stay updated.

The fourth obstacle was that during the implementation, policy changes had an effect on the work process. Since the first of January 2015, self-referrers have no access to the ED of the Rotterdam Eye Hospital, because of a national change in reimbursement policy. Full waiting rooms became a thing of the past. Therefore there was less need for self-triage and the original triage procedure could be used without many problems. Although patients are generally still invited by the front desk staff to fill in the questions of the ISET, and many patients do so, the ISET urgency output receipt is not yet used by the ophthalmologists. So when developing an innovation, one should not only try to estimate the need for the innovation at the beginning of the development, but also during this process. Moreover, one should be aware that the need for any innovation is not driven by what can be done, but what needs to be done.

Resurrection of the ISET

The year 2016 saw an unexpected development in that some of the triage assistants deployed during office hours retired and new inexperienced staff was hired. One of the staff members remembered the ISET and considered a new application: use it to train the new staff to perform triage. A pilot was launched to use the ISET for training purposes.

In this pilot, the ISET appeared useful to guarantee uniform triage when deployed by the new inexperienced staff. In March and April of 2016, two new triage assistants were trained. After the successful training, the ISET is now used to standardize the triage in general. In June 2016, another pilot test was initiated and currently all triage assistants question patients about their symptoms on the guidance of the ISET and then assign the urgency code. The ISET receipt with the patient's birth date, triage colour code and symptoms is filed in the patient record.

Although the 'elder' triage assistants still have some reservations, the ISET is being used for every patient. The ISET forces the assistants to ask all patients the same essential questions. The triage assistants now acknowledge the need for standardized triage for all patients. Successful implementation during office hours is facilitated by the fact that new colleagues do not know of the 'old' triage procedure. Yet, the elder and experienced triage assistants are still less enthusiastic, because they consider use of the ISET unnecessary additional work. They read the ISET questions to the patients from their own computer screens, and document the printed receipt in the electronic patient file.

Although implementation outside office hours was not a great success, the ISET was finally embraced by the ED organisation during office hours.

ISET abroad

Shortly after the publication of our second article on the ISET, in November 2015, we were contacted by the ophthalmic department of a US University Hospital. They wished to learn more about the development and background of the ISET. At the moment of writing this thesis, they are working together with US eye ED experts to explore the possibilities of the ISET in the context of the US health care system.

Furthermore, they created a new questionnaire to capture symptoms of patients with anterior eye diseases on the basis of the ISET and other validated questionnaires. With this new eye symptom questionnaire they investigated whether patients who report certain symptoms are more likely to have anterior eye diseases than people without these symptoms. The results of this research have not yet been published, but we are pleased to hear that the ISET has found a place in acute ophthalmic care.

Future of the ISET

Now that the ISET has been implemented in the work process, the next step is to implement it in the digital patient data management system of the Rotterdam Eye Hospital. The ISET is now used in the ED during office hours and the urgency output receipt is printed and added to the paper patient file, which is later scanned and stored digitally. The next step is to interlink the output of the ISET directly to the patient's electronic file.

The ISET was launched at a time when the health care environment is changing rapidly, partly due to technological progress. We all know about IBM Watson, the self-learning

supercomputer that defeated humans in the popular television show Jeopardy in 2011. In October 2016 it was announced that Rhön-Klinikum, a private clinic in Germany, will start a pilot to study how IBM Watson as a cognitive assistant can support the rare diseases team.

Technical development influences the way health care develops. It is estimated that in 2020, medical data will double every 73 days[3]. How are health care systems going to be influenced by this increase? It is not unthinkable that a part of the current tasks in decision making will be increasingly outsourced to technological solutions. With big data available and with stronger computers to connect datasets, customized care will become more important.

Recruitment expert organisation Hays studied employees in the financial sector and reported that 70% of the respondent thought that in 2030 soft skills are valued more than knowledge of facts[4]. It is conceivable that the role of the medical staff will shift towards the soft skills. In a Harvard study it was found that social skills are becoming more and more important in jobs[5]. Communication skills, empathy, support, creativity, coaching for a healthy lifestyle, these are the competences that should be developed by the medical staff to stand out in a changing work environment[6].

Conclusion

The eyes are a small part of the human body but have a great influence on our daily functioning. Therefore they deserve our attention. This discussion illustrates the complexity of the implementation of new technologic devices. When properly implemented in an ophthalmic ED, the ISET provides uniform triage while the medical staff can pay all attention to their medical task and patient care.

References

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Summary

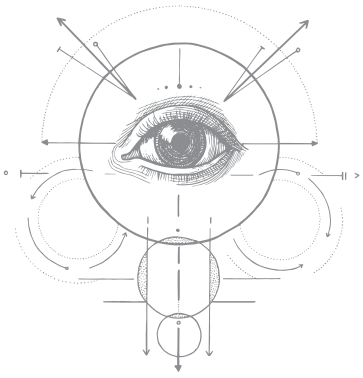
Samenvatting

PhD portfolio

Curriculum Vitae

Acknowledgements

Sup. 1: pen-and-paper ISET questionnaire



Summary

Our eyes play a crucial role in our daily functioning. Many people take their vision for granted, but sometimes our vision is threatened. Certain eye conditions, such as an acute retinal detachment, must be treated in time to prevent blindness. The studies presented in this thesis address the development and validation of a self-triage instrument to improve the timely treatment of urgent eye conditions.

Before this study started, the Rotterdam Eye Hospital emergency department (ED) applied two different triage procedures to categorise the incoming patients by their urgency; one during office hours and one outside office hours. During office hours trained triage assistants performed the triage. They wrote down the symptoms and urgency colour code on a post-it sticky note and attached it to the patient record. The ophthalmologists treated the registered patients in order of urgency. Outside office hours the triage was performed by the ophthalmologist as no trained triage assistants were available. However, since there was only one ophthalmologist available outside office hours, triage was delayed if the ophthalmologist was busy attending to a patient. The front desk employees took notes of the patients' symptoms and passed these notes on to the ophthalmologist. The delay puts patient at risk, especially when the ophthalmologist was occupied for a longer time.

To enhance uniform and timely triage for the ophthalmic emergency department outside office hours, a computerised self-triage instrument was considered. In **chapter 2** the development of self-triage by ophthalmic patients is described. The aim of this study was to develop an ophthalmic instrument of patient self-triage (ISET). The study consisted of two steps. In the first explorative step, 279 patients visiting the ED of the Rotterdam Eye Hospital filled in a pen-and-paper questionnaire. The results of this questionnaire were compared with the with the results of the regular triage process during the day, that is, triage by a trained triage assistant in a specialized ophthalmic hospital. As several patients needed guidance completing the questionnaire, the pen-and-paper questionnaire was subsequently refined. In the validation step, 298 ophthalmic urgent patients filled in the refined questionnaire. During that validation step, sensitivity of the ISET was 94.3% and specificity 76.4%.These results show that the ISET is a sensitive and specific instrument for ophthalmic triage compared with a trained ophthalmic triage assistant.

To enhance the usability of the ISET in practice, the ISET was transformed into a computer-assisted ISET (ca-ISET) with a touch screen. Successive computer-assisted versions of the ISET were tested by patients visiting the emergency department and the tests are described in in **chapter 3.** The versions were developed by iteratively prototyping, testing, analysing and refining the computer-assisted ISET. In three test cycles, 16, 53 and 75 patients were monitored while using the ca-ISET. They were debriefed, and their input was used to adapt the computer-assisted ISET. To validate the ca-ISET, a sensitivity outcome of .80 and a specificity

of .70 was required (CI=95%). The ca-ISET sensitivity and specificity were tested by comparing ca-ISET triage outcome to triage outcome as decided by the regular triage assistant. ISET accuracy increased from 0.69 in the first test to 0.79 in the third test. Sensitivity increased from 0.66 (CI 0.13-0.98) to 0.80 (0.51-0.95). Specificity increased from 0.69 (0.39-0.90) to 0.78 (0.65-0.88). To improve validity and usability, several adjustments were made in the text and the flow chart of the computer-assisted ISET.

The next step was to define the criterion validity of the ca-ISET. In **Chapter 4** we describe how the validity is established. We tested whether sensitivity, specificity, Negative Predictive Value (NPV) and Positive Predictive Value (PPV) of the ca-ISET deviated from regular triage. Again, patients visiting the ED of the Rotterdam Eye Hospital in the Netherlands were invited to participate. For all participants three triage scores were determined by (1) the participant using the ca-ISET; (2) triage by a regular, trained triage assistant and (3) triage by one physician who was specially trained in ophthalmic triage. The diagnosis of the physician was chosen as the reference standard to define criterion validity. The order of triage administration was alternated per patient. Only cases with triage scores from the two triage systems and the reference standard were included. The outcome variables, four triage colours, were transformed into a binary score: high urgent and low urgent. The difference between the ca-ISET and regular triage in terms of sensitivity, specificity, NPV and PPV was tested by Z-scores. We found that the sensitivity, PPV and NPV of the ca-ISET does not differ from the sensitivity of the regular triage, while the ca-ISET retained a reasonable level of specificity. Therefore the ca-ISET can be recommended as a tool for ophthalmic emergency departments, and could be used when trained ED staff is absent.

One of the eye problems often found in the ophthalmic emergency department is rhegmatogenous retinal detachment. The time between first symptoms and reattachment surgery is critical to prevent macular detachment, but many patients arrive in the ED after the macula is already detached. In **chapter 5** is described how we explored which determinants discriminate between 'macula-ON' and 'macula-OFF' retinal detachments to improve timely treatment. Eight-hundred patients with rhegmatogenous retinal detachment admitted for surgery at the Rotterdam Eye Hospital in the Netherlands were eligible to complete a questionnaire to explore the following determinants: 1) patient's delay and doctor's delay; 2) patient reported causes for delay; 3) symptoms as early warning signals; 4) patient's prior knowledge about retinal detachment, 5) trait anxiety. Five-hundred-and-twenty-one (65%) questionnaires were analysed. Median interval between first symptoms and surgery was 14 days. Macula-ON/OFF ratio was 46/54. Patient's delay in macula-ON patients (median 3 days) was shorter than in macula-OFF (5 days, p=0.026). No difference was found in doctor's delay except for 'waiting time for surgery': macula-ON patients were operated on faster (median 1 day) than macula-OFF (median 5 days, p <.001). Macula-ON patients more often attributed symptoms to retinal problems. Except floaters, no symptoms were determined

as early warning signals for macula-ON. Macula-ON patients more often reported knowing that prognosis would be worse when treated later, even when controlled for previous experience with retinal detachment. Macula-ON patients seem to self-refer faster to a health care provider, seem more sensitive to floaters and seem more informed. This suggests that increasing awareness, especially about floaters, might increase the proportion of patients with macula still on at the moment of referral to the ophthalmologist. Another option could be to adapt the ISET to a home-self-triage instrument to help patients at home with making a decision to visit their GP with their eye problems.

The general discussion in **chapter 6** summarizes the research in this thesis on the basis of the research questions and aims. Although the development and validation of the ca-ISET were successful, the implementation in the Rotterdam Eye Hospital was cumbersome. It started with an optimistic view on implementation. In a next stage, however, it seemed that the ca-ISET would turn out to be a scientific project only, and that implementation in practice would be a bridge too far. Nevertheless, in the end the ca-ISET did find its place in the complex hospital logistics. This course of events is described in more detail to learn lessons from it. The chapter concludes with a pronouncement on the final development and validation of the ca-ISET. When properly implemented in an ophthalmic ED, the ca-ISET provides uniform triage while the medical staff can pay all attention to their medical task and patient care.

Samenvatting

Onze ogen spelen een cruciale rol in ons dagelijks functioneren. Veel mensen nemen hun gezichtsvermogen voor lief, maar soms wordt ons gezichtsvermogen bedreigd. Sommige oogaandoeningen zoals bijvoorbeeld een acute netvliesloslating moeten tijdig behandeld worden om blindheid te voorkomen. De studies in dit proefschrift vertellen over de ontwikkeling en validatie van een zelf-triage instrument om de tijdige behandeling van urgente oogaandoeningen te verbeteren. Triage is in dit proefschrift het categoriseren van oogaandoeningen op de spoedeisende hulp naar urgentie.

Toen de studie naar de ontwikkeling van het zelftriage-instrument begon, werden het Oogziekenhuis Rotterdam op de spoedeisende hulp (SEH) twee verschillende triage procedures toegepast om de binnenkomende patiënten naar hun urgentie te kunnen categoriseren; één tijdens kantooruren en één buiten kantooruren. Tijdens kantooruren voerden speciaal daarvoor opgeleide triage-assistenten de triage uit. Een triage-assistente schreef de symptomen en de urgentie-kleurcode op een Post-it en plakte de Post-it op het patiëntendossier. De urgentiekleurcode correspondeert met een maximaal gewenste wachttijd voor de patiënt. De oogartsen behandelden de geregistreerde patiënten op volgorde van urgentie, en dus niet op volgorde van binnenkomst. Buiten kantooruren werd de triage uitgevoerd door de oogarts omdat dan geen gekwalificeerd triage-assistenten beschikbaar waren. Echter, omdat er slechts één oogarts beschikbaar was buiten kantooruren, kon het zijn dat de oogarts druk bezig was met een andere patiënt. De aanwezige frontdesk-medewerker maakte aantekeningen van de symptomen van de patiënten en gaf deze door als notitie aan de oogarts. Hierdoor was een kans op vertraging van het diagnostisch proces aanwezig.

Om tot een uniforme en tijdige triage voor de oogheelkundige afdeling spoedeisende hulp buiten kantooruren verbeteren, werd gedacht aan een geautomatiseerd zelf-triage instrument als mogelijke oplossing voor de vertraging beschouwd. In **hoofdstuk 2** wordt de ontwikkeling van zelf-triage voor oogheelkundige patiënten beschreven. Het doel van deze studie was een oogheelkundig instrument van de patiënt zelf-triage (ISET) ontwikkelen. Het onderzoek bestond uit twee stappen. In de eerste verkennende stap vulden 279 patiënten die met hun spoedeisende oogklachten de SEH van het Oogziekenhuis Rotterdam bezochten een pen-en-papieren vragenlijst in. De uitkomst van de vragenlijst was een kleurcode. De resultaten van deze vragenlijst werd vergeleken met de resultaten van de reguliere triage tijdens kantooruren, dat wil zeggen triage door een getrainde triage-assistente. Omdat verschillende patiënten begeleiding nodig hadden bij het invullen van de vragenlijst, werd de pen-en-papieren vragenlijst vervolgens verbeterd en opnieuw getest. In die volgende stap werd aan 298 patiënten op dezelfde SEH gevraagd de verbeterde vragenlijst in te vullen. Tijdens die validatiestap was de sensitiviteit van de ISET was 0.94 en de specificiteit 0.76. Met deze resultaten bleek dat ISET een sensitief en specifiek instrument voor oogheelkundige triage wanneer hij werd vergeleken met een getrainde oogheelkundige triage-assistent.

Om de bruikbaarheid van de ISET in de praktijk te verhogen, werd de ISET omgetoverd tot een computergestuurde ISET (ca-ISET) met een touch screen. Opeenvolgende versies van de ca-ISET werden getest door patiënten die een bezoek aan de SEH brachten, de resultaten hiervan worden beschreven in **hoofdstuk 3**. De versies zijn ontwikkeld door herhaaldelijk een ca-ISET prototype te maken, te testen, te analyseren en te verfijnen. In drie testcycli werden respectievelijk 16, 53 en 75 patiënten gevolgd tijdens het gebruik van de ca-ISET. Ze werden ondervraagd en hun inbreng werd gebruikt om de ca-ISET passen. Om de ca-ISET te valideren was een sensitiviteit van 0.80 en een specificiteit van 0.70 vereist (CI = 95%). De sensitiviteit en specificiteit werden getest door het vergelijken van de ca-ISET triage uitkomst met de triage-uitkomst zoals besloten door de reguliere triage-assistent. De accuraatheid van de ca-ISET steeg van 0.69 in de eerste test naar 0.79 in de derde test. De sensitiviteit steeg van 0.66 (CI 0.13-0.98) naar 0.80 (0.51-0.95). De specificiteit nam toe van 0.69 (0.39-0.90) naar 0.78 (0.65-0.88).

De volgende stap was om de criteriumvaliditeit van de ca-ISET te definiëren. In **hoofdstuk 4** testen we of de sensitiviteit, specificiteit, negatief voorspellende waarde (NPV) en positief voorspellende waarde (PPV) van de ca-ISET afwijken van de reguliere triage. Weer werden patiënten op de SEH van Het Oogziekenhuis Rotterdam uitgenodigd om de vragen van de ca-ISET te beantwoorden. Voor alle deelnemers werden drie triage-scores bepaald; (1) triage met behulp van de ca-ISET; (2) triage door een getraind triage-assistent, en (3) triage door een arts die speciaal was opgeleid in oogheelkundige triage. De diagnose van de arts werd gekozen als de referentiestandaard om de criteriumvaliditeit definiëren. De volgorde van het bepalen van de triagescores werd per patiënt afgewisseld. Alleen proefpersonen met triage-scores van de twee triage-procedures en de referentie-standaard werden opgenomen. De uitkomstvariabelen, vier triage kleuren, werden omgevormd tot een binaire score: hoog urgente en lage urgent. Het verschil tussen de ca-ISET en de reguliere triage qua sensitiviteit, specificiteit, NPV en PPV werd getest door middel van Z-scores. We vonden dat de sensitiviteit, PPV en NPV van de ca-ISET wijkt niet af van de sensitiviteit van de reguliere triage, terwijl het CA-ISET een redelijke specificiteit behouden. Daarom kan de ca-ISET worden aanbevolen als een instrument voor oogheelkundige SEH's en kan het instrument worden gebruikt wanneer opgeleid triage-personeel afwezig is.

Een van de oogproblemen die we vaak tegenkomen op de oogheelkundige SEH is een rhegmatogene netvliesloslating. Een korte tijd tussen de eerste symptomen en de hersteloperatie is van cruciaal belang om ook loslating van de macula te voorkomen. Als de macula ook loslaat dan is de kans dat het gezichtsvermogen helemaal terugkeert kleiner. Helaas komen veel patiënten met netvliesloslating op de SEH als de macula ook al los is. In **hoofdstuk 5** is verkennend onderzoek beschreven naar de determinanten die het onderscheid maken tussen patiënten met 'macula-AAN' en 'macula-AF' om daarmee meer tijdige behandelingen te kunnen bewerkstelligen. Achthonderd patiënten met rhegmatogene

netvliesloslating die opgenomen waren voor een operatie in Het Oogziekenhuis Rotterdam kwamen in aanmerking voor een vragenlijst. Deze vragenlijst was ontwikkeld om de volgende factoren te ontdekken: 1) vertraging in het verwijstraject door de patiënt en de vertraging door de zorgverlener; 2) oorzaken van vertraging volgens de patiënt; 3) vroege alarmsymptomen; 4) de voorkennis van patiënten over netvliesloslating, 5) angstdispositie. 521 (65%) vragenlijsten werden geanalyseerd. De mediaan van het interval tussen de eerste symptomen en de operatie was 14 dagen. De macula-AAN/AF verhouding was 46/54. De vertraging in het verwijstraject van patiënten met macula-AAN (mediaan 3 dagen) was korter dan bij macula-AF (5 dagen, p = 0,026). Er werd geen verschil gevonden in de vertraging in het verwijstraject door de arts, behalve voor 'wachttijd voor een operatie': macula-AAN patiënten werden sneller geopereerd (mediaan 1 dag) dan macula-AF (mediaan 5 dagen, p <0,001). Macula-AAN patiënten vaker toegeschreven symptomen retinale problemen. Behalve floaters werden geen symptomen gevonden die kunnen dienen als vroege alarmsymptomen voor macula-AAN. Macula-AAN patiënten melden vaker te weten dat de prognose zou nog erger zijn wanneer ze later behandeld zouden worden, en dit effect blijft staan als gecontroleerd wordt voor eerdere ervaringen met netvliesloslating. De conclusie van onze bevindingen is dat patiënten met macula-AAN zichzelf sneller lijken te verwijzen naar een zorgverlener, lijken gevoeliger voor floaters en lijken beter geïnformeerd. Dit suggereert dat het verhogen van het bewustzijn, in het bijzonder met betrekking tot floaters, het aandeel zou kunnen vergroten van patiënten die op het moment van verwijzing naar de oogarts nog met macula-AAN hebben. Een andere optie zou kunnen zijn om de ca-ISET door te ontwikkelen naar een home-zelf-triage instrument voor patiënten thuis. Zo kan de ca-ISET helpen met het maken van een beslissing om met de oogklachten de huisarts bezoeken.

De algemene discussie in **hoofdstuk 6** geeft een overzicht van het onderzoek in dit proefschrift aan de hand van de onderzoeksvragen en doelstellingen. Hoewel de ontwikkeling en validatie van de ISET succesvol waren, was de implementatie in Het Oogziekenhuis Rotterdam ingewikkeld. Het project begon met een optimistische kijk op de implementatie. In een volgende fase leek het er echter op dat de ca-ISET slechts een wetenschappelijk project zou blijken te zijn dat niet in de praktijk ten uitvoer zou komen. Toch heeft de ca-ISET uiteindelijk zijn plaats in de complexe ziekenhuis-logistiek weten te vinden. Hoe dit is gebeurd is in hoofdstuk 6 beschreven. Het hoofdstuk wordt afgesloten met een uitspraak over de definitieve ontwikkeling en validatie van de ca-ISET. Wanneer correct op een oogheelkundige SEH geïmplementeerd, dan is de ca-ISET een tool die zorgt voor uniforme triage terwijl de medische staf alle aandacht kan besteden aan hun medische taken en patiëntenzorg.

PhD portfolio

Summary of PhD training and teaching

Name PhD student: E.S. van Eijk
Erasmus MC, Department of Psychiatry, section Medical Psychology and Psychotherapy
Research School: NIHES.

PhD period: 2009-2017
Promotor: Prof.dr. J.J. van Busschbach
Co-promotor: Dr. R. Timman

1. PhD training

	Year	Workload (ECTS)
General courses		
- Basisdidactiek voor docenten: Teach the Teacher I. Erasmus MC, Rotterdam.	2015	0.7
- Klinimetrie: het ontwikkelen en evalueren van meetinstrumenten. VU MC, Amsterdam.	2013	3.0
- Cursus Endnote. Erasmus MC, Rotterdam.	2013	0.11
- Systematisch Literatuuronderzoek in andere databases. Erasmus MC, Rotterdam.	2013	0.11
- Systematisch Literatuuronderzoek in PubMed. Erasmus MC, Rotterdam.	2013	0.11
- Biomedical English Writing and Communication, Nihes, Erasmus MC, Rotterdam.	2012	4.0
- Introductiecursus Good clinical practice. Rotterdam Ophthalmic Institute, Rotterdam.	2009	0.15
Specific courses (e.g. research school, Medical training)		
- Basiscursus SCID I en II. De viersprong, Bergen op Zoom.	2013	2.0
Seminars and workshops		
- BKO workshop Individueel begeleiden. Erasmus MC, Rotterdam.	2016	0.14
- Coach vervolgtraining. Erasmus MC Rotterdam.	2016	0.14
- BKO workshop Tentamenvragen maken. Erasmus MC, Rotterdam.	2015	0.14
- Coach training Erasmus MC, Rotterdam.	2015	0.14
- Postdoc network Workshop Presenting yourself and your work. Erasmus MC, Rotterdam.	2014	0.11
- Seminar Science in Transition, Erasmus MC, Rotterdam.	2014	0.71
- Seminar “Hoe vertel ik het mijn gebruikers?”. Corpus, Oegstgeest.	2013	0.11
- Workshop Feedback geven en begeleiden. Risbo, Rotterdam.	2011	0.23
- Workshop Mindmapping. MTcompany, Amsterdam.	2010	0.22
- Seminar Translational research is a two way street. Rotterdam Eye Hospital, Rotterdam.	2009	0.29
- Monthly department research club Rotterdam Ophthalmic Institute, Rotterdam.	2009-2014	1.0

Presentations

-	Multiculturaliteit in de arts-patiënt communicatie; Brainstormsessie during the Erasmus MC student-docentdagen.	2016	1.0
-	Nazorg voor blinden en slechtzienden in Het Oogziekenhuis Rotterdam. Oral presentation during the research meeting of the Erasmus MC, section MPP, Rotterdam.	2015	0.5
-	Nazorg voor blinden en slechtzienden in Het Oogziekenhuis Rotterdam. Oral presentation during the research meeting of the Rotterdam Ophthalmic Institute, Rotterdam.	2015	1.0
-	Vertraging in het verwijstraject van netvliesloslatingen. Oral presentation during "Wetenschapsdag" of the Rotterdam Eye Hospital, Rotterdam.	2015	1.0
-	Zelftriage op de oogheelkundige spoedeisende hulp: Ontwikkeling, validatie en implementatie van een e-health toepassing in Het Oogziekenhuis Rotterdam. Oral presentation during the research meeting of the Erasmus MC, section MPP, Rotterdam.	2014	1.0
-	Patient self-triage in the ophthalmic emergency department. Oral presentation during the Symposium E-health, Erasmus MC, Rotterdam.	2014	1.0
-	Ophthalmic emergency department self-triage: Development, validation and implementation of an e-health application in the Rotterdam Eye Hospital. Oral presentation during the research meeting of the Rotterdam Ophthalmic Institute, Rotterdam.	2014	1.0
-	Self-triage at the A&E ENP Pathways. Oral presentation during a meeting of the World Association of Eye Hospitals (WAEH) in the Rotterdam Eye Hospital, Rotterdam.	2014	1.0
-	Wetenschappelijk Onderzoek in Het Oogziekenhuis Rotterdam. Oral presentation for iBMG-studenten visiting the Rotterdam Eye Hospital, Rotterdam.	2013	1.0
-	Zelftriage als hulpmiddel voor oogheelkundige triage op de SEH van algemene ziekenhuizen. Oral presentation during the "Cz zorgprijs".	2013	1.0

(Inter)national conferences

-	Symposium Klinisch Redeneren: not for dummies, Erasmus MC, Rotterdam.	2017	0.16
-	Symposium "Een enkeltje Rotterdam", Erasmus MC, Rotterdam.	2015	0.18
-	Symposium "Kwaliteit en implementatie: durf de uitdaging aan!". Erasmus MC, Rotterdam.	2013	0.14
-	International conference of Healthcare Systems, Ergonomics and Patient Safety. Oviedo, Spain.	2011	0.86
-	Nederlands Oogheelkundig Gezelschap 205e vergadering Maastricht.	2011	0.29
-	Symposium "In the Picture". Oogzorgnetwerk, Rotterdam	2011	0.29
-	Implementatiecongres Kennis Beter Delen, Nieuwegein.	2010	0.29
-	Nederlands Oogheelkundig Gezelschap 204e vergadering Maastricht.	2010	0.29
-	Wetenschapsdag Rotterdam Eye Hospital, Rotterdam.	2009	0.29

Other

-	BKO (expected)	2017	5.0

2. Teaching

	Year	Workload (ECTS)
Lecturing		
- Communication and professional development education in the medical curriculum. Erasmus MC, Rotterdam.	2010-2016	45
- Vaardigheidsonderwijs Rouwverwerking, Counseling bij geassisteerde voortplanting, Tuchtzaak, Slechtnieuwsgesprek, beslissingen rond aangeboren afwijkingen	2014-2016	1.0
- Keuzevak Interculturaliteit	2015-2016	2.0
- Vaardigheidsonderwijs Arts-Patient communicatie met simulatiepatienten	2015-2016	2.0
- Vaardigheidsonderwijs Samenwerken	2015-2016	2.0
Supervising practicals and excursions, Tutoring		
- Supervising 3 systematic reviews keuze-onderwijs BA2	2016	1.0
Supervising Master's theses		
- Supervising masterthesis Roel van Deventer, student of TU delft Industrial design: "Self-Triage System for Rotterdam Eye Hospital".	2013	1.0
- Supervising masterthesis Nidal Cossack, medical student of UMC Utrecht: "Macular involvement in rhegmatogenous retinal detachment: How to clarify the onset of macular symptoms"	2011	1.0
Other		
- Coaching medical students: 15 students	2015-2016	1.0
- Coordination medical curriculum	2015-2016	3.0

Curriculum Vitae

Eva Suzanne van Eijk was born on March 13th, 1981 in Rotterdam, the Netherlands. She received the Master's degree in Applied Cognitive Psychology at the University of Utrecht in 2008. For her Bachelor's thesis she conducted a study on multimodal sensory stimulation by affective auditive priming of the gustatory system. For her Master's thesis she conducted a study at the Technical University of Delft, department of Industrial Design, comparing location memory for four sensory modalities.

In March 2009, she began a research project in the Rotterdam Eye Hospital in the Netherlands, which was two years later the basis for the PhD study that is described in this thesis. She was supervised by Prof.dr. J.J. van Busschbach from the department of Medical Psychology and Psychotherapy at the Erasmus University Medical Centre in Rotterdam. The main focus of her research was the development of a self-triage instrument for the ophthalmic emergency department, enabling patients to categorize the urgency of their eye complaints themselves. In addition to this research, she teaches medical psychology and communication skills to medical students and residents of the Erasmus MC, Rotterdam. Since 2015 she has a coordinating role in the department and she develops course material, e.g. for the topics "Teamwork" and "The Cultural Sensitive Doctor". She aims to receive the Qualification for University Teaching in 2017.

Acknowledgement (dankwoord)

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Supplement 1:

Pen-and-paper ISET questionnaire

1

Self-triage Questionnaire

Initials:……...

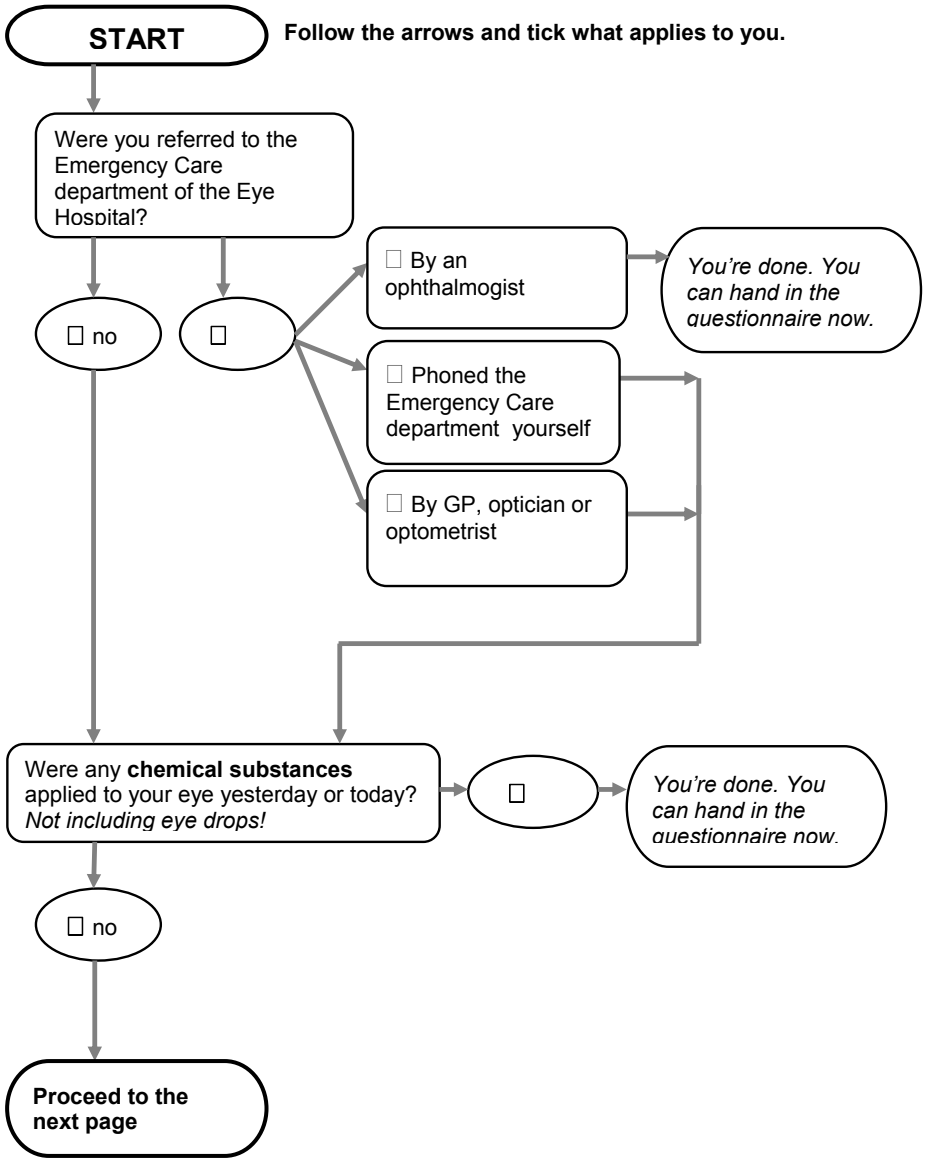
Birth date:..... ……

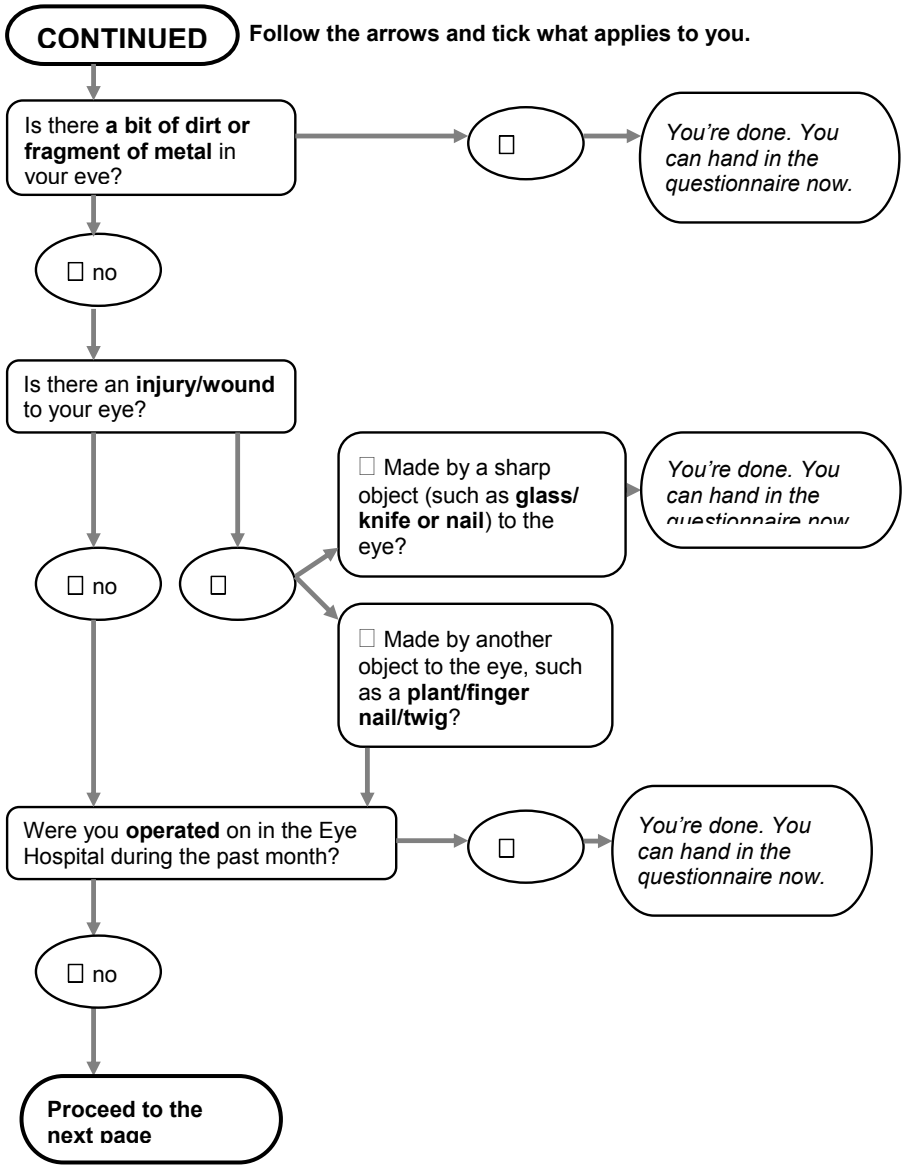
Study number: 2009-03

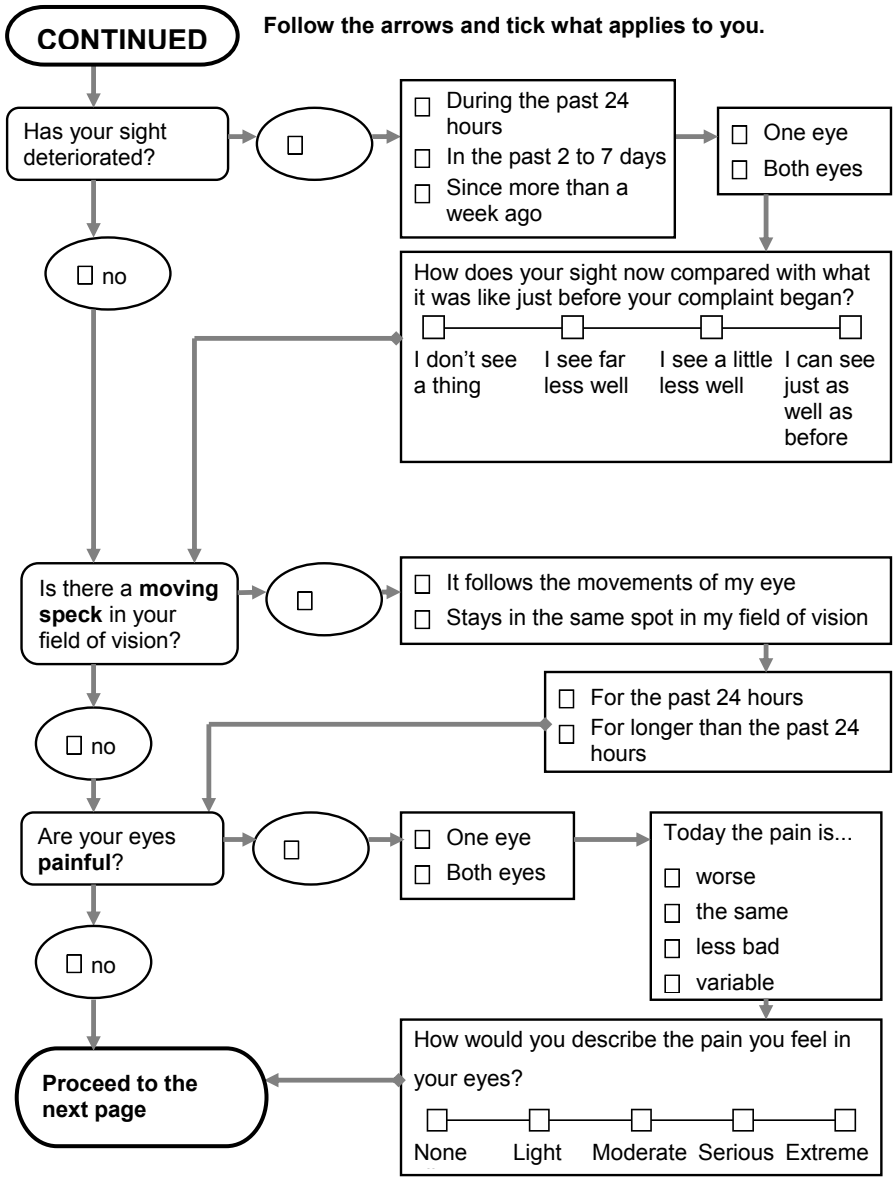
Date: …..-….-2010

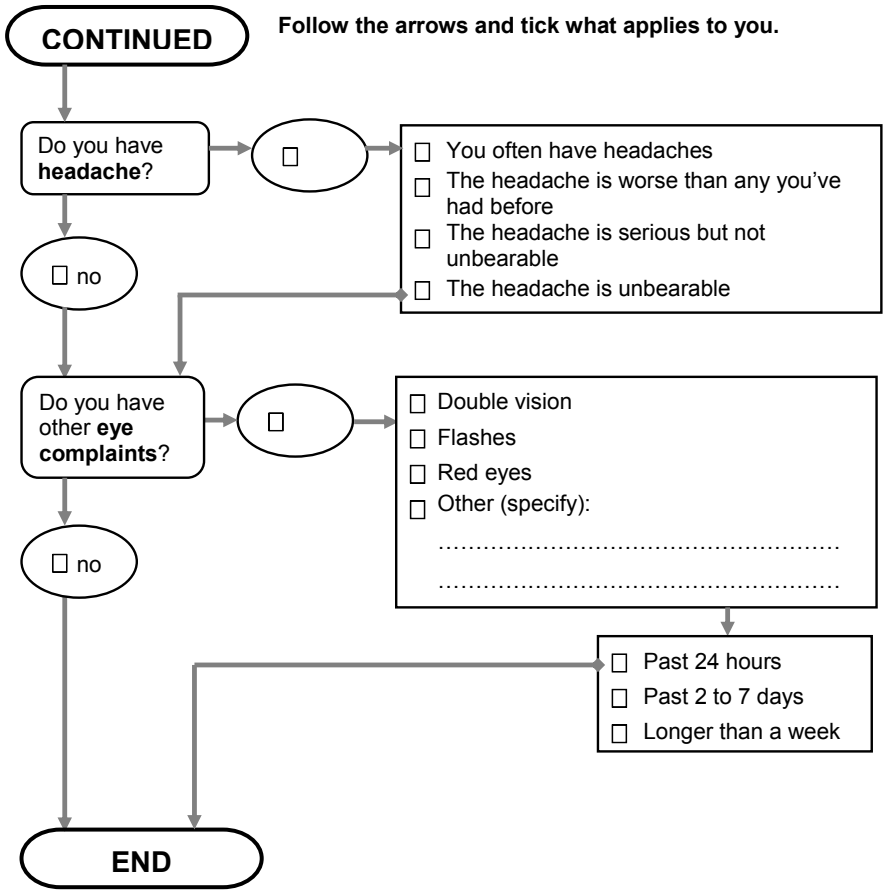
I give permission for this form to be used for scientific purposes…….
……....**YES / NO***
Who is the questionnaire being completed by? .....**…**
…….....…….……**PATIENT / COMPANION***
How good is your Dutch?.....
……...**VERY POOR /POOR / AVERAGE / GOOD / VERY GOOD***

*** Indicate which answer applies to you.**









Thank you very much for completing this questionnaire!