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An algorithm in ophthalmic emergencies to evaluate the necessity of physical consultation during COVID-19 lockdown in Paris: Experience of the first 100 patients

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Summary
Purpose. — This study aimed to evaluate the ability of a freely accessible internet algorithm to correctly identify the need for emergency ophthalmologic consultation for correct diagnosis and management.
Method. — This retrospective observational cohort study was based on the first 100 patients who requested recommendations on the necessity of breaking the lockdown for emergency ophthalmology consultation during the period from March to May 2020.
Results. — Ninety-one patients completed questionnaires. Forty-nine were directed to emergency consultation and 42 to differed scheduled visits or telemedicine visits. One patient sent for emergency consultation had an overestimated severity and could have been seen later, while two patients initially recommended for a scheduled visit were considered appropriate for emergency consultation. However, these patients’ management did not suffer as a consequence of the delay. The sensitivity of the algorithm, defined as the number of emergency consultations suggested by the algorithm divided by the total number of emergency consultations...
deemed appropriate by the practitioner’s final evaluation, was 96.0%. The specificity of the algorithm, defined as the number of patients recommended for delayed consultation by the algorithm divided by the number of patients deemed clinically appropriate for this approach, was 97.5%. The positive predictive value, defined as the number of appropriate emergency consultations divided by the total number of emergency consultations suggested by the algorithm, was 97.9%. Finally, the negative predictive value, defined as the number of appropriately deferred patients divided by the number of deferred patients recommended by the algorithm, was 95.2%.

Conclusion. — This study demonstrates the reliability of an algorithm based on patients’ past medical history and symptoms to classify patients and direct them to either emergency consultation or to a more appropriate deferred, scheduled appointment. This algorithm might allow reduction of walk-in visits by half and thus help control patient flow into ophthalmologic emergency departments.

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emergency consultations (EC), TC, or differed consultations (DC), an algorithm has been developed to properly indicate the emergency degree to patients and medical staff.

Our study aimed to assess the efficiency and security of an algorithm recommendation on the emergency degree following a 5 minutes long progressive survey filled by the patients on internet, focusing on their past medical history and symptoms. The main judgement criterion was defined as the ability of the algorithm to properly indicate an emergency consultation for fair diagnosis and treatment in eye emergencies.

**Method**

This study is a prospective observational cohort study conducted on the first 100 patients who filed the survey jointly developed by Eyeneed® and Quinze-Vingts National Eye hospital. It is available on the ‘‘Centre hospitalier national d'ophtalmologie des Quinze-Vingts (CHNO 15-20)’’ website (https://www.15-20.fr/) since the COVID-19 lockdown in Paris. The surveys were filed between April 19th and May 18th, 2020. The surveys included a progressive algorithm including patients age, sex, past medical history and symptoms. The aim of the algorithm was to assess the necessity of physical emergency consultation (EC) or a differed consultation (DC) with a practitioner. At the end of the survey the patient received the algorithm instructions with a summary of his symptoms and an evaluation of their potential severity. The patient was then invited to come to CHNO 15-20 emergency (EC) department the same day or to program a differed appointment.

**Analysis**

Patients characteristics were analyzed using Pvalue.io® software. The algorithm sensitivity was defined as the number of EC asked by the algorithm among the total of appropriate EC according to the practitioner final evaluation. Algorithm specificity was defined as the number of algorithm-only managed patients, among the patients with no need for EC. Positive predictive value was defined as the number of appropriate EC among the total of required EC. Negative predictive value was defined as the number of rightly algorithm-only managed patients among algorithm-only managed estimated patients.

**Results**

Among the 100 first surveys, 91 patients reached final decision and were included for final evaluation; 6 patients did not completely fill the form and were invited for a teleconsultation and 3 patients filled the form twice and were considered as duplicate. 54 patients (59%) were women, population mean age was 47.3 ± 20.4 years old, 53 (58%) patients filled the survey during the 24 hours following symptoms apparition, 71 (78%) never had consultation in CHNO department before and 91 (100%) lived in Paris & suburb. Population characteristics are presented in Table 1.

**Table 1** Population characteristics.

| Sex       | 54 (59%) | 37 (41%) |
|-----------|----------|----------|
| Age       | 47.3 (20.4) |
| Age repartition |
| <25       | 9 (10%)  |
| 25–45     | 32 (35%) |
| 46–65     | 31 (32%) |
| >65       | 22 (24%) |
| Time to consultation |
| Same day  | 9 (10%)  |
| 1 day     | 44 (48%) |
| 2–7 days  | 16 (18%) |
| >7 days   | 22 (24%) |
| New patients | 71 (78%) |
| Location  |
| Paris & suburb | 91 (100%) |
| Past medical history |
| None      | 64 (70%) |
| Uveitis   | 1 (1.1%) |
| Herpes    | 2 (2.1%) |
| Glaucoma  | 5 (5.5%) |
| Refractive surgery | 1 (1.1%) |
| Vitreoretinal disorder | 12 (13%) |
| Contact leses | 1 (1.1%) |
| Recent surgery | 4 (4.4%) |

**Emergency consultation**

The algorithm estimated a consultation was required for 49 (54%) patients, but 11 patients did not present and were called by phone, whereas 10 (11%) patients presented for emergency consultation despite the algorithm recommendations. Patients consultation repartition is described in Fig. 1.

A total of 48 (53%) physic consultations were performed in CHNO emergency department (38 required by the algorithm and 10 spontaneous consultation despite the algorithm recommendations). The most relevant confirmed diagnoses in consultation were: 10 posterior vitreous detachments, 2 retinal detachments, 2 acute angle closure, 2 uveitis and 3 postoperative complications: IOL subluxation or post-operative inflammation. All the clinically confirmed diagnoses are detailed in Table 2.

**Algorithm predictability**

Among the 49 EC required, 48 seemed appropriate and only 1 patient had overestimated severity diagnosis: a conjunctivitis complaining of acute visual loss. Thirty-eight were performed in CHNO emergency department and the 11 other patients were called retrospectively by phone: 6 (7%) consulted in other emergency departments (2 acute vision loss, 2 traumas, 1 uveitis, 1 posterior vitreous detachment) and 5 (6%) declined despite the algorithm recommendations (2 minor traumas and 3 complaining of symptoms compatible with posterior vitreous detachment). Forty-two patients were initially oriented to non-emergency consultations but 10 decided to consult in emergency department despite algorithm recommendations: 7 were conjunctivitis among
Figure 1. Algorithm decisions and practitioner appreciations (*: two conjunctivitis were considered as appropriate consultation considering patients characteristics: a newborn child and a patient with retinitis pigmentosa).

Table 2  Repartition of patients’ consultations and diagnoses.

| Diagnoses                              | Total | Consultation in CHNO | Consultation in other departments | Did not consult |
|----------------------------------------|-------|----------------------|-----------------------------------|-----------------|
|                                        |       | Asked by the algorithm | Inappropriate show up             |                 |
| Posterior vitreous detachment          | 13    | 9                    | 1                                 | 3               |
| Trauma or foreign body                 | 13    | 9                    | 2                                 | 2               |
| Conjunctivitis                         | 8     | 1<sup>a</sup>        | 5 + 2<sup>b</sup>                 |                 |
| Uveitis                                | 3     | 2                    |                                   | 1               |
| Postoperative complications            | 3     | 3                    |                                   |                 |
| Ophthalmic migraine (1st episode)      | 3     | 3                    |                                   |                 |
| Retinal detachment                     | 2     | 2                    |                                   |                 |
| Acute angle closure                    | 2     | 2                    |                                   |                 |
| Acute vision loss                      | 2     | 0                    | 2                                 |                 |
| Central serous chorioretinopathy       | 1     | 1                    |                                   |                 |
| Retinal vein occlusion                 | 1     | 1                    |                                   |                 |
| Diabetic macular oedema                | 1     | 1                    |                                   |                 |
| Cerebral aneurism                      | 1     | 1                    |                                   |                 |
| Herpes Zoster                          | 1     | 1                    |                                   |                 |
| Scleritis                              | 1     | 1                    |                                   |                 |
| Recurrent keratalgia                   | 1     | 1                    |                                   |                 |
| Chronic blepharitis                    | 2     | 2                    |                                   |                 |
| Hordeolum                              | 1     | 1                    |                                   |                 |
| Total                                  | 59    | 38 (37 + 1<sup>a</sup>) | 10                                | 6               |

<sup>a</sup> One conjunctivitis complaining with acute vision loss had emergency consultation recommendation.

<sup>b</sup> Two conjunctivitis were considered as appropriate consultation considering patients characteristics: a new born child and a patient with retinitis pigmentosa.
them 1 newborn child and 1 patient followed for retinitis pigmentosa (the two were considered as appropriate consultation due to patients’ rare past medical history), 2 patients had chronic blepharitis and 1 hordeolum.

At this point, the algorithm evaluation had 96.0% sensitivity and 97.5% specificity. Algorithm evaluation had 97.9% positive predictive value and 95.2% negative predictive value.

Discussion

Social distancing was a major issue during COVID-19 lockdown in Paris and emergency consultation frequentation regulation remains a major challenge as hospital frequentation rises again. This study is the first to assess the reliability of an algorithm depending on patients past medical history and symptoms to classify patients and differ their emergency consultation to a more appropriate programmed appointment. This organization permitted to cut by half emergency consultation, orient patients to a nearer practitioner if needed or program a differed appointment.

Our cohort does correspond to a connected population, but its demography seems similar to the Parisian’s ophthalmology emergency departments [13]. The population mean age was 45 years, similar to that in our cohort (47.3 y.o.), with a slightly differing men/women ratio: 52/48% compared to 40/60% in our cohort. Low BaSe SCOrE [14] pathologies, mostly hordeolum, conjunctivitis, progressive visual loss, represent nearly half of the consultations, this ratio seems steady compared to classical emergency departments frequentation.

Considering the algorithm constitution, the survey formulation is similar to the “French Society of Ophthalmology” emergency triage survey developed in 2018 guidelines for secretary in charge of appointments [13] but it requires no medical or paramedical workforce. The legal responsibility of an algorithm decision remains unclear; however, the algorithm enlightens its final recommendation is non-binding and patient own appreciation to consult would be respected. This disposition could explain the 9 patients making the decision to come for EC despite the algorithm recommendation.

Teleconsultation in primary ophthalmic emergencies was a new exercise developed during the French lockdown. The algorithm showed similar sensitivity (96 vs. 96%), specificity (97.5% vs. 95%), and negative predictive value (95.2% vs. 98.6%) compared to “SOS CEI” department teleophthalmology experience led during the same period. The algorithm showed higher positive predictive value (97.9% vs. 87.6%) compared to teleconsultation, this result could be explained by the absence of interaction with the patients. Relying only on facts, the algorithm is independent from patient anxiety and does not influence the final decision to EC compared to teleconsultation.

Contrary to teleconsultation, the algorithm triage does not permit prescription deliverance to treat the patient. At this point, the algorithm does not relieve the patient from EC or teleconsultation but provides interesting information to regulate emergency departments frequentation and might accelerate EC or teleconsultation with a systematic pre-consultation.

Conclusion

This study assesses the reliability of an algorithm depending on patients past medical history and symptoms to classify patients and orient them to emergency consultation or to a more appropriate programmed appointment. With 96% sensitivity, 97.5% specificity, 97.9% positive predictive value and 95.2% negative predictive value, the algorithm provides pretty accurate recommendations to patients and ophthalmology departments on the necessity of an emergency consultation or a differed programmed physic or teleconsultation.

Disclosure of interest

The authors declare that they have no competing interest.

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