



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

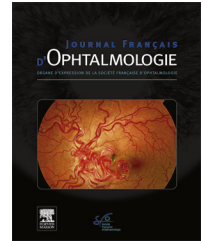


Disponible en ligne sur

**ScienceDirect**  
www.sciencedirect.com

Elsevier Masson France

**EM|consulte**  
www.em-consulte.com



ORIGINAL ARTICLE

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

*Utilisation d'un algorithme évaluant la nécessité d'une consultation ophtalmologique urgente durant le confinement à Paris : expérience des 100 premiers patients*

H. Bourdon<sup>a,\*</sup>, A. Herbaut<sup>a</sup>, L. Trinh<sup>a</sup>, E. Tuil<sup>b</sup>,  
J.F. Girmens<sup>b</sup>, C. Baudouin<sup>a</sup>

<sup>a</sup> Department of Ophthalmology III, CHNO des Quinze-Vingts, IHU FOReSIGHT, 28, rue de Charenton, 75012 Paris, France

<sup>b</sup> Department of Ophthalmology IV, CHNO des Quinze-Vingts, IHU FOReSIGHT, 28, rue de Charenton, 75012 Paris, France

Received 6 December 2020; accepted 10 December 2020

Available online 10 February 2021

## KEYWORDS

Teleophthalmology;  
Emergency  
ophthalmology;  
COVID-19;  
Lockdown;  
Social distancing

## 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

\* Corresponding author.

E-mail address: [bourdonhugo@gmail.com](mailto:bourdonhugo@gmail.com) (H. Bourdon).

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.

© 2021 Elsevier Masson SAS. All rights reserved.

## MOTS CLÉS

Téléophtalmologie ;  
Ophtalmologie  
d'urgence ;  
COVID-19 ;  
Confinement ;  
Distanciation sociale

## Résumé

**Objectif.** – L'objectif de cette étude était d'évaluer la capacité d'un algorithme en libre accès sur internet à indiquer correctement la nécessité d'une consultation ophtalmologique en urgence pour une prise en charge et un traitement approprié.

**Méthode.** – Il s'agit d'une étude observationnelle rétrospective reprenant les 100 premiers questionnaires patients évaluant la nécessité d'une consultation en service d'urgence ophtalmologiques durant le confinement de mars à mai 2020.

**Résultats.** – Au total, 91 patients ont rempli les questionnaire complètement. Quarante-neuf ont été orientés vers une consultation immédiate et 42 vers une consultation programmée ou une téléconsultation. Un patient, orienté aux urgences, avait une gravité surestimée et aurait pu être orienté en consultation différée et deux patients, orientés en consultation différée, relevaient d'une consultation d'urgence. Cependant, aucune perte de chance n'a été identifiée durant la prise en charge. La sensibilité de l'algorithme, définie comme le nombre de consultations en urgence recommandées par l'algorithme parmi les consultations en urgence appropriées dans l'évaluation finale était de 96,0 %. La spécificité, définie comme le nombre de patients orientés par l'algorithme en consultation différée, parmi les patients requérant en effet de cette prise en charge, était de 97,5 %. La valeur prédictive positive, définie comme le nombre de consultation en urgences appropriées parmi le nombre de consultations en urgence recommandées par l'algorithme était de 97,9 %. Finalement, la valeur prédictive négative, définie comme le nombre de consultations différées appropriées parmi le nombre de consultation différées recommandées par l'algorithme était de 95,2 %.

**Conclusion.** – Cette étude montre la fiabilité d'un algorithme basé sur les antécédents médicaux du patient, son histoire clinique et ses symptômes afin de classer et orienter les patients vers une consultation aux urgences ou programmée. Cet algorithme permet de réduire de moitié les consultations non programmées et ainsi réguler la fréquentation des services d'urgences ophtalmologiques.

© 2021 Elsevier Masson SAS. Tous droits réservés.

## Introduction

COVID-19 pandemic urges ophthalmology departments especially the one providing emergency care to change their practice and manage their frequentation. Crowded waiting rooms and close physical examination despite clear protective measures [1] endanger patients and practitioners especially in emergency departments, having highly fluctuating frequentation. Teleophthalmology development is forced in the midst of the pandemic and benefits from prior

applications experience in age-related macular degeneration [2,3] and diabetic retinopathy [4–6] requiring fundus cameras and/or optical coherence tomography apparatus. Emergency teleophthalmology can use remote slit lamp and camera systems [7–9] or differed tele-expertise with photos for military [10] or remote slit lamp in poor areas [11].

Teleconsultation (TC) is proposed as a solution to maintain healthcare access and manage the emergency departments frequentation in ophthalmology [12], but its organization remains time-consuming. To help organize

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 tele-consultation and 3 patients filled the form twice and were considered as duplicate. 54 patients (59%) were women, population mean age was  $47.3 \pm 20.4$  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	
Female	54 (59%)
Male	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 lases	1 (1.1%)
Recent surgery	4 (4.4%)

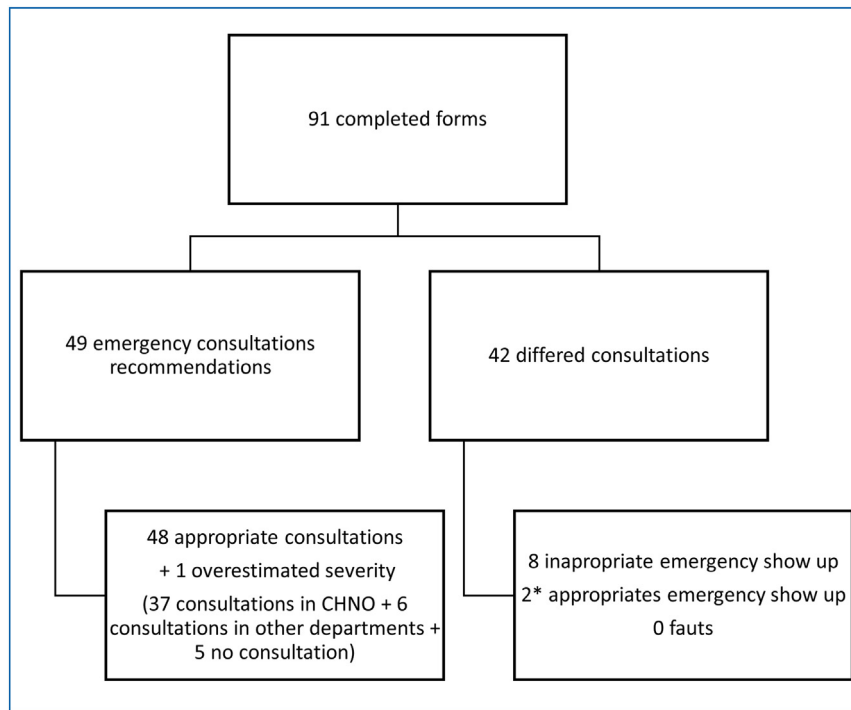
## Emergency consultation

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		
<b>Total</b>	<b>59</b>	<b>38 (37 + 1<sup>a</sup>)</b>	<b>10</b>	<b>6</b>	<b>5</b>

<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 SCORÉ [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 Œil" department teleophthalmology experience leaded 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% predictive positive 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.

## References

- [1] Li J-PO, Shantha J, Wong TY, Wong EY, Mehta J, Lin H, et al. Preparedness among ophthalmologists: during and beyond the COVID-19 pandemic. *Ophthalmology* 2020;0, <http://dx.doi.org/10.1016/j.ophtha.2020.03.037>.
- [2] Li B, Powell A-M, Hooper PL, Sheidow TG. Prospective evaluation of teleophthalmology in screening and recurrence monitoring of neovascular age-related macular degeneration: a randomized clinical trial. *JAMA Ophthalmol* 2015;133:276–82, <http://dx.doi.org/10.1001/jamaophthalmol.2014.5014>.
- [3] Ulrich JN, Poudyal G, Marks SJ, Vrabec TR, Marks B, Thapa ABS, et al. Ocular telemedicine between Nepal and the USA: prevalence of vitreoretinal disease in rural Nepal. *Br J Ophthalmol* 2009;93:698–9, <http://dx.doi.org/10.1136/bjo.2008.151357>.
- [4] Carroll M, Cullen T, Ferguson S, Hogge N, Horton M, Kokesh J. Innovation in Indian healthcare: using health information technology to achieve health equity for American Indian and Alaska Native populations. *Perspect Health Inf Manag* 2011;8:1d.
- [5] Massin P, Chabouis A, Erginay A, Viens-Bitker C, Lecleire-Collet A, Meas T, et al. OPHDIAT: a telemedical network screening system for diabetic retinopathy in the Ile-de-France. *Diabetes Metab* 2008;34:227–34, <http://dx.doi.org/10.1016/j.diabet.2007.12.006>.
- [6] Chasan JE, Delaune B, Maa AY, Lynch MG. Effect of a teleretinal screening program on eye care use and resources. *JAMA Ophthalmol* 2014;132:1045–51, <http://dx.doi.org/10.1001/jamaophthalmol.2014.1051>.
- [7] Blackwell NA, Kelly GJ, Lenton LM. Telemedicine ophthalmology consultation in remote Queensland. *Med J Aust* 1997;167:583–6.
- [8] Kumar S, Yogesan K, Hudson B, Tay-Kearney M-L, Constable IJ. Emergency eye care in rural Australia: role of internet. *Eye (Lond)* 2006;20:1342–4, <http://dx.doi.org/10.1038/sj.eye.6702104>.
- [9] Bar-Sela SM, Glovinsky Y. A feasibility study of an Internet-based telemedicine system for consultation in an ophthalmic emergency room. *J Telemed Telecare* 2007;13:119–24, <http://dx.doi.org/10.1258/135763307780677640>.
- [10] Mines MJ, Bower KS, Lappan CM, Mazzoli RA, Poropatich RK. The United States Army Ocular Teleconsultation program 2004 through 2009. *Am J Ophthalmol* 2011;152:126e2–32e2, <http://dx.doi.org/10.1016/j.ajo.2011.01.028>.
- [11] Ribeiro AG, Rodrigues RAM, Guerreiro AM, Regatieri CVS. A teleophthalmology system for the diagnosis of ocular urgency in remote areas of Brazil. *Arq Bras Oftalmol* 2014;77:214–8, <http://dx.doi.org/10.5935/0004-2749.20140055>.

- [12] Bourdon H, Jaillant R, Ballino A, El Kaim P, Debillon L, Bodin S, et al. Teleconsultation in primary ophthalmic emergencies during the COVID-19 lockdown in Paris: experience with 500 patients in March and April 2020. *J Fr Ophtalmol* 2020, <http://dx.doi.org/10.1016/j.jfo.2020.05.005>.
- [13] Bourges PJ-L. *Urgences en ophtalmologie: rapport SFO 2018*. Elsevier Masson, Paris; 2018.
- [14] Bourges J-L, Boutron I, Monnet D, Brézin AP. Consensus on severity for ocular emergency: the BAsic SEverity Score for Common Ocular Emergencies [BaSe SCOrE]. *J Ophthalmol* 2015;2015:576983, <http://dx.doi.org/10.1155/2015/576983>.