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# Testing the reliability of an eye-dedicated triaging system: The RESCUE

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PURPOSE. *To calculate the reliability of an eye-dedicated triaging system named Rome Eye Scoring System for Urgency and Emergency (RESCUE).*
METHODS. *There were four coding parameters: pain, redness, loss of vision, and risk of open globe. Each parameter is assigned a score, the sum of which allows color coding. There were 1000 consecutive patients divided into urgent (U) or non-urgent (NU) based upon diagnosis, need for treatment, hospitalization, and/or follow-up visit. Correlation between RESCUE triage scoring as assigned by the nurse on presentation and urgency as estimated retrospectively was calculated. Accuracy, sensitivity, and specificity have been calculated. False positives (FP) have been defined as patients assigned a RESCUE green or yellow code while retrospectively judged NU and false negatives (FN) have been defined as patients assigned a white code despite being considered U.*
RESULTS. *Of 1000 patients, 332 (33.2%) were classified as U and 668 (66.8%) NU. The difference in RESCUE scoring between U and NU patients was significant ($p<0.001$), as well as the correlation between RESCUE scoring and urgency status. Accuracy was 95% with 9.3% FP and 2.7% FN. Sensitivity was 90.7% and specificity 97.2%. Positive predictive value was 94.6%, and negative predictive value was 95.2%. All 32 hospitalized patients and 147/198 (74.2%) patients given a return appointment properly received a yellow or green code.*
CONCLUSIONS. *RESCUE accuracy, sensitivity, and specificity yield encouraging results, confirming the system's ability to properly spot the most urgent cases. The concept of urgency in ophthalmology can be difficult to establish; nonetheless, an eye-dedicated triage can help in properly prioritizing urgent patients. (Eur J Ophthalmol 2008; 18: 445-9)*

KEY WORDS. *Emergency room, Coding, Ophthalmic emergency, Triage, Ocular Trauma, Urgency*

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## INTRODUCTION

The need for priority assignment in ophthalmic urgency is a function of the volume of patients seen by emergency departments (EDs). A few institutions worldwide have an eye-dedicated ED (1) and are mostly located in those countries where the existence of a National Healthcare System (NHS) tends to concentrate patients in a limited number of tertiary referral centers. Elsewhere, patients are generally scattered throughout a larger variety of institutions and seen on a first come first served basis. Whenever a disproportion between care need and offer arises, a prioritization system can be usefully enforced (2).
In a previous article, the authors introduced a triaging tool exclusively dedicated to ophthalmology named Rome Eye Scoring System for Urgency and Emergency (RESCUE)

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and found a significant correlation between nurse triage coding and the diagnosis made by the ophthalmologist (3). The purpose of the present article is to test RESCUE accuracy, sensitivity, and specificity over a 1000 emergency room (ER) patients sample population.

## METHODS

The RESCUE system, previously described, relies on values attributed to four coding parameters (Tab. I) by the triage nurse (3). Adding values attributed to each parameter yields a score ranging between 0 and 12, similarly to the Apgar index or the Glasgow Coma Scale. RESCUE scoring can eventually be converted into color coding attributed based upon the sum of coding parameters values: white code (scoring 0–3), green code (scoring 4–7), and yellow code (scoring 8–12).

The authors reviewed all data collected for the previous study including 1000 consecutive patients referred to the ED of the Eye Hospital of Rome, a tertiary care referral center exclusively dedicated to ophthalmology, seeing over 70,000 patients a year in the ER.

A panel of three authors (T.R., M.I., and P.A.M.) retrospectively reviewed all medical records of enrolled patients and divided them into urgent (U) or non-urgent (NU) based upon diagnosis, need for medical and/or surgical treatment, hospitalization, and/or need for follow-up.

Correlation between RESCUE triage scoring as assigned by the nurse on presentation and the definition of urgency as above described was calculated.

Accuracy was defined as the probability of giving the correct prioritization and calculated as (true positives + true negatives)/(all patients observed). False positives (FP) have been defined as patients assigned a RESCUE code green or yellow (that is, with a RESCUE score higher than 4 points) while judged NU once the diagnosis was made and false negatives (FN) have been defined as patients assigned a white code (RESCUE score less than 4 points) despite being considered U retrospectively. Sensitivity has been calculated as the ratio (true positives)/(all positive patients); that is, the probability of properly identifying all U patients, coding them as green or yellow. Specificity has been calculated as the ratio [true negatives (RESCUE < 4)]/[all negative patients] defined as the probability of being NU once assigned a white code (Tab. II).

The cutoff value of 4 RESCUE points was arbitrarily chosen on the basis of the authors' ER experience and analysis of the RESCUE parameters (Tab. I). Severe loss of vision or high risk of globe penetration, in fact, account for 4 RESCUE points even in the absence of other signs and definitely deserve prompt examination.

Positive predictive value (PPV) has been defined the probability of really being U while coded green or yellow, calculated as the ratio (true positives)/(all U patients). Negative predictive value (NPV) has been defined as the probability of truly being NU when given a white code and calculated as the ratio (true negatives)/(all NU patients).

Records of all FP and FN patients have been reviewed in

**TABLE I -** RESCUE CODING PARAMETERS AND SCORING

| Parameter | Scoring | | |
|---|---|---|---|
| | **None** | **Moderate** | **Severe** |
| Redness | 0 | 1 | 2 |
| Pain | 0 | 1 | 2 |
| Loss of vision | 0 | 2 | 4 |
| Open eye risk | 0 | 2 | 4 |

**TABLE II -** DISTRIBUTION OF URGENT AND NON-URGENT PATIENTS ACCORDING TO RESCUE SCORING

| | | **RESCUE scoring** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| | **No.** | **White code** | | | | **Green code** | | | | **Yellow code** | | | | |
| Urgent | 332 | 0 | 1 | 12 | 5 | 210 | 40 | 42 | 0 | 16 | 2 | 2 | 0 | 2 |
| Non-urgent | 668 | 32 | 107 | 339 | 158 | 23 | 5 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 1000 | 32 | 108 | 351 | 163 | 233 | 45 | 46 | 0 | 16 | 2 | 2 | 0 | 2 |

False negatives are in the grey-shaded area on the urgent row; false positives are in the grey-shaded area on the non-urgent row

order to evaluate the reason why RESCUE miscoded them and evaluate their clinical significance. All records of patients hospitalized or given a return appointment have also been reviewed separately in order to see if and to what extent the RESCUE coding properly identified them as being more urgent than the dismissed patients.

### *Statistical analysis*

Statistical analysis used SPSS software (v 12, SPSS, Chicago, IL, USA). Urgency and RESCUE scoring comparison has been calculated both with parametric and nonparametric algorithm. Correlation between RESCUE scoring and urgency has been calculated by means of Pearson and Kendall tau b correlation coefficients. Chi-square has been calculated as well; p values less than 0.05 have been considered significant.

## RESULTS

After retrospective evaluation 332/1000 patients (33.2%) were classified as U and 668/1000 (66.8%) NU (Tab. III).

**TABLE III -** PATIENTS' PRIORITIZATION ACCORDING TO PROSPECTIVE RESCUE COLOR CODING AND RETROSPECTIVE URGENT/NON-URGENT ASSESSMENT

| | Yellow/green codes | White code | Total codes |
|---|---|---|---|
| Urgent | 314* | 18† | 332 |
| Non-urgent | 32‡ | 636§ | 668 |
| Total | 346 | 654 | 1000 |

*True positives; †False negatives; ‡False positives; §True negatives

The difference in RESCUE scoring between U and NU patients was statistically significant ($p<0.001$). Correlation between RESCUE scoring and urgency status was highly significant as well (Pearson R correlation coefficient –0.723; $p<0.001$; Kendall tau b correlation coefficient –0.686; $p<0.001$). Accuracy was 95% ([314 + 636]/1000) with 9.3% FP (32/346) and 2.7% FN (18/654). Sensitivity was therefore 90.7% (314/346) and specificity 97.2% (636/654). PPV was 94.6% (314/332) while NPV was 95.2% (636/668).

Table II reports the overall distribution of U and NU patients per RESCUE score. Note that 18 U patients (1+12+5 =18) fell into the white code area and therefore are FN (grey-shaded area on the U row) while 32 NU patients (23+5+4=32) fell into the green code area and are therefore FP (grey-shaded area in the NU row). All 32 hospitalized patients and 147/198 (74.2%) patients were given a return appointment received a RESCUE scoring greater than 4.

Table IV reports the diagnosis of all FN and FP patients in order of frequency. Acute diplopia, corneal foreign bodies (FB), and macula on retinal detachment (RD) were the main cause of FN, whereas epidemic conjunctivitis, corneal abrasion, and ophthalmic migraine were the main causes of FP.

## DISCUSSION

Urgency is a condition characterized by damage to a biological function in case of care delay; it should be emphasized that urgency and gravity may not correspond since the need for a quick symptom relief and a severe long-term prognosis does not always overlap. Whenever care cannot be granted in real time prioritization is advisable:

**TABLE IV -** POST-ASSESSMENT DIAGNOSIS OF PATIENTS MISCODED AS FALSE NEGATIVES AND FALSE POSITIVES

| False negatives | | | False positives | | |
|---|---|---|---|---|---|
| **Diagnosis** | **No.** | **%** | **Diagnosis** | **No.** | **%** |
| Acute diplopia | 5 | 27.8 | Epidemic conjunctivitis | 8 | 25.0 |
| Corneal foreign body | 4 | 22.2 | Corneal abrasion | 8 | 25.0 |
| Macula on retinal detachment | 3 | 16.7 | Ophthalmic migraine | 6 | 18.8 |
| Conjunctival wound | 2 | 11.1 | Post-PRK pain | 4 | 12.5 |
| Cheratitis | 2 | 11.1 | Minor contusion | 2 | 6.3 |
| Papilledema | 1 | 5.6 | Cataract (senile) | 2 | 6.3 |
| PK acute rejection | 1 | 5.6 | Iridocyclitis | 2 | 6.3 |
| Total | 18 | 100.0 | Total | 32 | 100.0 |

both Banerjee et al (2) and Buchan et al (4), in fact, concluded that ophthalmic triage improves appropriateness and speed of care in an ED scenario.

An eye-dedicated triaging system can be useful both in a crowded eye-only ED and in a general hospital ER where the decision to call an ophthalmologist or delay the patient to ambulatory care must be made by the general practitioner or by the triaging nurse.

The RESCUE system proved capable of identifying patients at risk: overall, U patients received a scoring significantly higher than NU ones and the correlation between scoring and urgency was highly significant. All hospitalized patients have also been properly coded green or yellow as well as three-quarters of the patients asked to return for follow-up.

Accuracy, sensitivity, and specificity yield high figures with, respectively, 95%, 90.7%, and 97.2%. The higher value of specificity compared to sensitivity makes the RESCUE somewhat safer since it tends to overestimate simpler cases, rather than underestimating the more complex ones.

We believe 2.7% FN and 9.3% FP represent an interesting result both from a statistical and clinical standpoint. FN patients are possibly the most critical subset of patients in our study: they are urgent cases whose diagnosis has been missed on presentation. All FN patients have in common a relative scarcity of signs and symptoms and this is why the RESCUE failed to recognize them. On the other hand, we are reassured that none of the most emergent diagnoses (ruptures, penetrations [5], endophthalmitis, acute glaucoma, artery occlusion) is present in the FN list, having been properly prioritized.

The opposite is true for FP patients, all with minor ailments with tedious symptoms and macroscopic signs, whose clinical significance has been erroneously overestimated by the RESCUE. This is one common feature to all EDs due to the overcrowding of health care facilities. Fenton et al (6) found that up to 70% of patients referring to an ED do not represent urgent pathology and might have been treated in an ambulatory setting.

Interestingly, virtually all miscoded patients, respectively, 17/18 (94.4%) FN and 32/32 (100%) FP, fell within 2 RESCUE points from the watershed of 4 points, boundary between white and green codes (Tab. II). This means that no FP totaled a score higher than 6 and only 1 FN lower than 2 (a macula-on retinal detachment with full vision complaining of mild floaters). In other words, uncertain cases tend to cluster around 4 RESCUE points while at the two ends of the scale the chance of an error is much lower: all patients scoring over 6 turned out to be urgent.

Among the pitfalls of present study stand the relatively low number of included patients, the long-standing experience in the field of ophthalmology of the involved triaging nurses, and the concept of urgency itself.

Except for a few indisputable diagnoses, in fact, the level of urgency can be largely debatable and priority assignment uncertain. For example, deciding whether a suspect corneal foreign body should be seen before a patient seeing flashes and floaters can be troublesome. The first, in fact, is in a lot of pain although suffering from a minor ailment that can be easily relieved while the second could have both a negative fundus and a retinal detachment which is a much more severe condition. The key to efficient triaging is to keep in mind which patient benefits the most from a prompt treatment; in this case, the removal of a corneal foreign body solves the problem and the patient's pain while a few minutes deferral of a possible retinal detachment does not change its prognosis.

While acknowledging the limitations of our system, the RESCUE can usefully help in the discrimination of urgent cases and the prioritization of patients in the ER. Its simplicity and immediacy can encourage its use even and possibly especially by personnel with limited experience in the field of ophthalmology although further testing on higher numbers and several institutions is warranted.

*None of the authors has any proprietary interest in the subject matter.*

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