WORLD EXTREME MEDICINE CONFERENCE

# Teleophthalmology in remote environments

*A practical framework for remote eye assessment and evacuation decision-making*

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## BACKGROUND

### Often eye problem = end of expedition

Eye complaints are frequently encountered in the remote, conflict and expedition settings, where ophthalmic input is usually unavailable. Whilst most eye conditions are not immediately sight-threatening, differentiating these in the field, with limited resources and training, can be challenging for non-specialist clinicians. This challenge can be exacerbated in very remote environments, such as the high latitudes, where evacuation can be very expensive or impossible.

## AIMS

To develop an evidence-based framework enabling non-specialist clinicians to perform and transmit a structured remote eye assessment to facilitate specialist review and evacuation decision-making.

## METHODS

This protocol was developed from a literature search, field experience and expert ophthalmology consultation, then structured around the tools a remote kit realistically holds:

Arclight ophthalmoscope






Pocket visual acuity chart

Smartphone






Fluorescein strips

## LITERATURE SEARCH

### Databases

PubMed | Google Scholar | Cochrane Library

### Search criteria

PAPERS 2005 – 2026

(teleophthalmology OR telemedicine)
AND
(ophthalmology OR eye)
AND
(remote OR rural OR expedition OR wilderness OR austere OR military OR humanitarian)

### Key findings

- Teleophthalmology may support treatment and evacuation decision making
- High agreement between teleophthalmic and in-person assessment, particularly for anterior segment disease
- Multiple novel ophthalmic imaging devices designed for smartphone compatibility

## Teleophthalmology capture protocol

STEP 1 – OCULAR EXAM

**History**
- Pain
- Visual change
- Flashes/floaters
- Photophobia
- Foreign body
- Trauma

**Examination**
- Visual acuity
- Eye movements
- Pupils
- Conjunctiva
- Cornea
- Fluorescein staining

STEP 2 – VISUAL ACUITY

**Assess and document visual acuity**

Formal VA chart / Pocket VA chart / Digital VA chart / Count fingers → Check each eye independently (with and without glasses) → If unable to see, halve distance → If still unable to see, count fingers → If still unable to see, check light perception → DOCUMENT VISUAL ACUITY e.g. VA R 6/6

STEP 3 – TELEOPHTHALMIC EXAM

INCLUDE: Laterality (left-OS/right-OD) and timestamp

| | EXTERNAL / ADNEXAL | ANTERIOR SEGMENT | PUPILS / FUNDAL REFLEX | POSTERIOR SEGMENT | OCULAR ULTRASOUND |
|---|---|---|---|---|---|
| **Image capture views** | | | | | |
| **Method** | Well-lit image of both eyes | 1. Ambient light<br>2. Oblique light<br>3. Fluorescein + blue light | Bilateral flash photo, fixation at distance | Phone video + pocket ophthalmoscope / 20D lens | Linear probe over closed eyelid, gaze side-to-side |
| **Finding** | *Lids, conjunctiva, trauma + eye position* | *Cornea, hyphema/hypopyon and fluorescein uptake/Leak* | *Pupil size, shape, symmetry + fundal reflex* | *Disc, vessels, haemorrhage + retina* | *Vitreous + retina* |

STEP 4 – RED FLAG IMAGE FINDINGS – SEE IMAGES FOR EXAMPLES

**1. External / adnexal**
- Proptosis
- Eyelid laceration
- Peri-orbital swelling
- Globe irregularity

**2. Anterior segment**
- Corneal opacity or trauma
- Fluorescein flow (Seidel's sign)
- Hyphema or hypopyon

**3. Pupils / red-reflex**
- Unequal pupils (RAPD/fixed pupil)
- Absent fundal reflex
- Irregular pupillary shape

**4. Posterior segment**
- Optic disc swelling
- Retinal/vitreous haemorrhages
- Retinal discolouration or folds

**5. Ocular ultrasound**
- Hyperechoic vitreous
- Mobile membrane tethered to the retina

TRIAGE - ANY RED FLAG PRESENT?

**Escalate immediately**

Trigger teleconsult regardless of connectivity tier - treat as time-critical.

NO RED FLAG PRESENT

**Send images for remote review**

Send structured findings and images through the best available channel, often via 'Store and Forward' means.

OUTCOME A

**Evacuate**
- High-risk image triage
- Sight or life-threatening findings that exceed field treatment capability.

OUTCOME B

**Treat & reassess**
- Working diagnosis confirmed from image triage
- Field-manageable condition, treat per protocol and set a defined reassessment point.

OUTCOME C

**Monitor in field**
- Low-risk image triage
- Observe, document and continue activity with safety-netting.

TIERS OF CONNECTIVITY

**Real-time video**
Live specialist exam guidance where satellite bandwidth allows.

**Store & forward**
Images and notes sent for asynchronous specialist review.

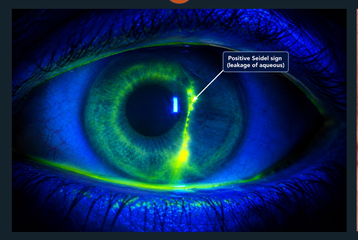
**Voice only**
Verbal description against a structured exam script.

**No contact**
Standalone use against red-flag criteria until contact restored.

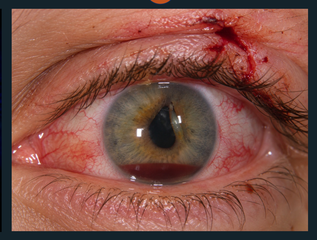
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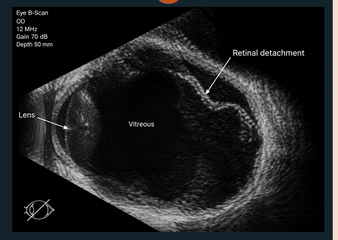

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## FIELD LOG

### Example cases

**Case 01 · Jungle expedition** — Evacuated

**Presentation:** A member of the team complains of eye pain, redness and watering after clearing a path through dense foliage. VA preserved, eye appears red and watering with no evidence of foreign body. Fluorescein dye instilled and Seidel's sign observed. Urgent teleophthalmic review sought.

**Decision:** Met red-flag criteria; urgent store-and-forward consult confirmed penetrating trauma, patient evacuated urgently.

**Case 02 · Helicopter down-draft injury** — Treated in field

**Presentation:** Foreign body sensation after exposure to a down-draft of a landing helicopter. Small FB noted at lid margin, so eye irrigated with normal saline. Fluorescein stain revealed small corneal abrasion, but no leakage of stain and no red flag features.

**Decision:** No need for urgent evacuation. Images sent for non-urgent review. Safety-netting provided.

**Case 03 · Flashing lights** — Evacuated

**Presentation:** Member of scientific team at Antarctic station attends your clinic following sudden onset, painless flashing lights in their right eye. Reduced VA and RAPD noticed on examination. Ultrasound examination reveals a freely mobile structure tethered to the posterior aspect of the eye.

**Decision:** Ultrasound images sent for urgent review. Urgent evacuation due to confirmed retinal detachment.

**Case 04 · Chemical splash** — Treated & reassess

**Presentation**: Expedition member sustains an accidental chemical splash to one eye. Immediate copious irrigation performed. VA preserved following irrigation, with mild conjunctival injection and no corneal opacity or limbal ischaemia. Images obtained following fluorescein staining.

**Decision**: Urgent teleophthalmic review supported continued field management with further irrigation, treatment and defined reassessment. No immediate evacuation required.

**Case 05 · Red eye** — Monitor in field

**Presentation**: Expedition member notices a painless, well-demarcated red patch over the sclera after strenuous activity. No significant medical history. VA normal, with no pain, photophobia, trauma or visual disturbance. Smartphone images sent for remote review.

**Decision**: Teleophthalmic review consistent with uncomplicated subconjunctival haemorrhage. Reassurance and observation advised; no evacuation required.

## DISCUSSION

- Some parts of the eye are easier to assess remotely than others, with anterior-segment images being generally more reliable. Retinal assessment is more difficult, and a single retinal photograph may miss disease and therefore should not provide false reassurance.
- Advances in low-Earth-orbit satellite technology, enabling high-bandwidth, low-latency communication, may facilitate live teleconsultation and telementoring, allowing specialists to remotely guide image acquisition, examination and ocular ultrasound.
- Although teleophthalmology remains operator-dependent, it offers a valuable tool to support field management and evacuation decisions, particularly when combined with appropriate training, equipment and clear escalation protocols.

## CONCLUSION

Teleophthalmology can extend specialist ophthalmic expertise into austere environments, supporting safe field management and timely evacuation.

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