
# Forward Operating Base Ocular Trauma Telemedicine Triage and Stabilization (FOBOT3S)

**MAJ William Gensheimer, MD, USAF, MC**

**FINAL REPORT**

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**59th Medical Wing**
**Office of the Chief Scientist**
**1100 Wilford Hall Loop, BLDG. 4554**
**JBSA Lackland AFB, TX 78236-7517**



***DECLARATION OF INTEREST***

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FORWARD OPERATING BASE OCULAR TRAUMA TELEMEDICINE TRIAGE AND STABILIZATION (FOBOT3S).

Michele F. Tavish

Michele Tavish, DAF
Medical Modernization Program Analyst
Office of the Chief Scientist, 59 MDW

Diana del Monaco

Diana del Monaco, Ph.D., DAF
Senior Scientist, 59th Medical Wing

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WILLIAM G GENSHEIMER, MD, Maj, USAF, MC, FS
Email: william.g.gensheimer.mil@mail.mil

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**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
William G. Gensheimer, MD, Warfighter Eye Center, Malcolm Grow Medical Clinics and Surgery Center,
1060 W Perimeter Rd, Joint Base Andrews, MD 20762

**8. PERFORMING ORGANIZATION REPORT NUMBER**
Phone: (240) 612-1730

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**14. ABSTRACT-**
The Forward Operating Base Expert Telemedicine Resource Utilizing Mobile Application for Trauma (FOXTROT) was successfully beta tested in Afghanistan during 6 weeks from September to November 2019. To our knowledge, this is the first use of an approved mobile phone application for teleophthalmology in the US military in a combat zone. Objective: To beta test a secure teleophthalmology mobile application (mApp) called Forward Operating Base Expert Telemedicine Resource Utilizing Mobile Application for Trauma (FOXTROT) in Afghanistan
Participants: Thirty users at 16 locations in OCONUS and one location outside of this site.
Methods: Point of care (POC) medical providers placed teleophthalmology consults on their mobile phone using the FOXTROT mApp and an expeditionary ophthalmologist stationed at a military hospital in Afghanistan responded using a secure computer portal directly linked to the POC user mApp. Users graded their satisfaction with FOXTROT in 4 categories using a 1 to 5 rating scale, with 1 being very dissatisfied and 5 being very satisfied.
Main Outcome Measures: Mean initial response time, agreement between the teleophthalmology diagnosis and final diagnosis, treatment and management following recommendations outlined in the Joint Trauma System (JTS) Clinical Practice Guidelines (CPG), prevention of the need for aeromedical evacuation, user satisfaction, and security and HIPAA compliance of consult.
Results: There were 29 consults placed over 6 weeks by 18 different users. One consult did not synchronize due to connectivity so there were 28 consults that were received by the expeditionary ophthalmologist. All consults received were responded to with a mean initial response time of 3 minutes 58 seconds ± 3 minutes 48 seconds. There was agreement between the teleophthalmology diagnosis and final diagnosis in 24 (86%) consults. The treatment and management followed recommendations outlined in the JTS CPG for Eye Trauma: Initial Care in 28 (100%) consults. Teleophthalmology consultation prevented the need for aeromedical evacuation in 4 (14%) consults and downgraded the category of precedence from urgent or priority to routine in 4 (14%) consults. The patient returned to duty in 15 (54%) consults. Overall satisfaction was 4.79 ± 0.56, satisfaction with ease of use was 4.75 ± 0.51, satisfaction with the treatment and management plan was 4.96 ± 0.19, and satisfaction compared with other teleophthalmology methods was 4.70 ± 0.66. All 28 (100%) consults were secure and HIPAA compliant.
Conclusions: This project demonstrates that teleophthalmology mobile phone applications can improve and extend ophthalmic care in operational environments. Telemedicine is complex and future development should engineer solutions that are secure, simple, reliable, and human.

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Teleophthalmology, Telemedicine, Ocular trauma, Ocular disease, Ophthalmology, Forward operating base (FOB), Secure mobile application (App), Mobile health care environment (MHCE), iPhone, Nett Warrior device

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| U | U | U | UU | 16 | 19b. TELEPHONE NUMBER *(include area code)* (240) 612-1730 |

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## 1.0 EXECUTIVE SUMMARY

The Forward Operating Base Expert Telemedicine Resource Utilizing Mobile Application for Trauma (FOXTROT) was successfully beta tested in Afghanistan during 6 weeks from September to November 2019. To our knowledge, this is the first use of an approved mobile phone application for teleophthalmology in the US military in a combat zone. Objective: To beta test a secure teleophthalmology mobile application (mApp) called Forward Operating Base Expert Telemedicine Resource Utilizing Mobile Application for Trauma (FOXTROT) in Afghanistan.

Design: Prospective case series.

Participants: Thirty users at 16 locations in Afghanistan and one location outside of Afghanistan.

Methods: Point of care (POC) medical providers placed teleophthalmology consults on their mobile phone using the FOXTROT mApp and an expeditionary ophthalmologist stationed at a military hospital in Afghanistan responded using a secure computer portal directly linked to the POC user mApp. Users graded their satisfaction with FOXTROT in 4 categories using a 1 to 5 rating scale, with 1 being very dissatisfied and 5 being very satisfied.

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Conclusions: This project demonstrates that teleophthalmology mobile phone applications can improve and extend ophthalmic care in operational environments. Telemedicine is complex and future development should engineer solutions that are secure, simple, reliable, and human.

## 2.0 INTRODUCTION

During Operation Iraqi Freedom and Operation Enduring Freedom, 10-15% of combat-related trauma injuries involved the eye. There were 170 ocular trauma cases reported in FY17 in deployed locations. The military ophthalmologist's primary mission is to be prepared to manage ocular trauma especially in an austere environment, however with deployments across the globe, access to ophthalmic care is not easily accessible. The primary purpose of our research is to determine the best method to provide ophthalmic care to any remote location through teleophthalmology.

In December 2017, the current state of teleophthalmology in the United States was detailed in an article in the journal Ophthalmology. The article references the past success of the Army's teleophthalmology service and highlights the continued growth of the practice. In February 2018, the American Academy of Ophthalmology Task Force on Telemedicine for Ophthalmology provided an information paper with an overview of teleophthalmology and the future that is coming soon. In April 2018, Columbia University hosted the first Teleophthalmology Conference to highlight novel ways for using teleophthalmology and the numerous devices that are available.

Currently in the military, there are three primary methods for teleophthalmology. In ocular emergencies or time sensitive cases, first responders and point of care providers at Role 1 or 2 call and speak directly with physicians at Role 3, which may include an ophthalmologist. Communication with an ophthalmologist may be available using a non-secure or secure Defense Switched Network (DSN) phone, satellite phone, or cellular phone if Wi-Fi is available. Typically, the ophthalmologist is reached by calling the hospital command post at Role 3. The ophthalmologist is then paged or called and is able to speak with the first responders or point of care provider to provide a consultation that includes an assessment and plan of care. If video teleconferencing (VTC) or Wi-Fi is available at Role 1 or Role 2, it may be possible to send pictures, video, or live video. Deployed members report using WhatsApp and encrypted e-mail to send pictures and video.

In less time sensitive cases, the web-based secure teleconsultation systems developed by the Navy called Health Experts Online Portal (HELP) or Pacific Asynchronous TeleHealth (PATH) are available. The PATH and HELP systems allow users to ask consult questions and upload media including images. Another teleophthalmology method is to send an encrypted e-mail to a listserve (eye.consult.army@mail.mil) with a question or image and the consult usually receives a response in less than eight hours. With the growth of teleophthalmology and advancements in technology there is an opportunity to improve the capabilities of teleophthalmology in a remote location.

This study will determine the best method for acquiring images using the most commonly used devices the iPhone, iPhone with PEEK adapter, Nett Warrior device, Android phone, Volk Pictor Plus, and GlobalMed Transportable Exam Station (TES) Extreme in an austere environment. In this process a grading system will be developed that can be used to grade any future ophthalmic imaging device for military teleophthalmology. In addition, this study will identify the best method for transmitting the data and reviewing the consult which will be accomplished by comparing phone (DSN, satellite, iPhone, Nett Warrior device, Android phone), PATH/HELP, encrypted e-mail (eye.consult.army@mail.mil), WhatsApp, and a new secure mobile application. This study will include development of a new secure mobile teleophthalmology application (App) for use in remote deployed locations to improve upon existing image acquisition and communication devices. The App will utilize the Mobile Health Care Environment (MHCE) which was developed by the US Army Medical Research and Materiel Command (USAMRMC) Telemedicine and Advanced Technology Research Center (TATRC). Features of the App will include triage surveys, image capture, chat, secure messaging, video chat, reports, and user management. The App will be designed to provide complete and comprehensive teleophthalmology capabilities to downrange service members. Development of the App will include a comprehensive review of current ophthalmology Apps including the Wills Eye Manual, Eye Handbook (EHB), EyesHaveIt, Ullman Indirect, and EyeTube. In the future, the app could integrate with ocular diagnostic Apps including a stereo-photo ophthalmic slitlamp system and optical coherence tomography for mobile devices.

## 3.0 METHODS, ASSUMPTIONS AND PROCEDURES

Teleophthalmology image acquisition devices (iPhone, iPhone with PEEK adapter, Nett Warrior device, Android phone, Volk Pictor Plus, and GlobalMed Transportable Exam Station Extreme) and communications devices (phone [DSN, satellite, iPhone, Nett Warrior device, Android phone], PATH/HELP, encrypted e-mail [eye.consult.army@mail.mil], Whatsapp, and a new teleophthalmology App) will first be tested on ocular trauma cases at CONUS military treatment facilities. A new secure mobile teleophthalmology application (App) will be developed in collaboration with USAMRMC and TATRC. These models will then be tested at selected forward operating bases (FOB) in Afghanistan. The suitability of devices for teleophthalmology in remote deployed settings will be assessed using a standardized grading system. The cyber and data security of the devices will be evaluated and monitored during testing. Results will be utilized to develop standardized operating procedures for teleophthalmology and a training program for active duty military ophthalmologists. Upon completion of the training program, ophthalmologists will become a part of a teleophthalmology consult service that will respond to consults from deployed service members all over the world. The FOBOT3S study is designed to extend advanced ophthalmic consultation capabilities to any member in a deployed setting including but not limited to medics, corpsmen, nurses, nurse practitioners, physicians' assistants, optometrists, physicians, surgeons, and ophthalmologists.

**Hypothesis/Objectives:**

Our hypothesis is that teleophthalmology will improve and extend ophthalmic trauma care in remote deployed environments. The objectives of this study are the following:

1. Evaluate and test image acquisition devices (iPhone, iPhone with PEEK adapter, Nett Warrior device, Android phone, Volk Pictor Plus, and GlobalMed Transportable Exam Station Extreme) and communications devices (phone [DSN, satellite, iPhone, Nett Warrior device, Android phone], PATH/HELP, encrypted e-mail [eye.consult.army@mail.mil], Whatsapp, and a new teleophthalmology App) for use in military teleophthalmology

2. Develop a new secure mobile teleophthalmology application (App) for use in remote deployed locations utilizing the Mobile Health Care Environment (MHCE)
3. Develop a standardized and reproducible protocol for utilizing teleophthalmology
4. Assess the cyber and data security of teleophthalmology acquisition devices and communications devices
5. Create a teleophthalmology training program for military ophthalmologists

Participants: Thirty users at 16 locations in Afghanistan and one location outside of Afghanistan.

Methods: Point of care (POC) medical providers placed teleophthalmology consults on their mobile phone using the FOXTROT mApp and an expeditionary ophthalmologist stationed at a military hospital in Afghanistan responded using a secure computer portal directly linked to the POC user mApp. Users graded their satisfaction with FOXTROT in 4 categories using a 1 to 5 rating scale, with 1 being very dissatisfied and 5 being very satisfied.

Main Outcome Measures: Mean initial response time, agreement between the teleophthalmology diagnosis and final diagnosis, treatment and management following recommendations outlined in the Joint Trauma System (JTS) Clinical Practice Guidelines (CPG), prevention of the need for aeromedical evacuation, user satisfaction, and security and HIPAA compliance of consult.

## 4.0 MAJOR EVENTS/MILESTONES/SUCCESS

- Kick Off Meeting – Dec 2018
- IRB Approval – Sept 2019
- All experimental procedures completed – Sept 2021
- Data Analysis – Sept 2021
- Dissemination of Results – November 2021

## 5.0 RISK ASSESSMENT

### 5.1 Risk Analysis

None.

### 5.2 Technical Challenges

None.

## 6.0 TRANSITION PLAN

### 6.1 Military Relevance

Better Health, Better Care

SGROC priority #4 Telemedicine, AFMS priority #54, Tele-Mentoring/Medicine/Monitoring (TM3), ACC and AFMS priority # 168, Telemedicine, PACAF. The FOBOT3S project also meets SGROC priority #6: AFMS priority # 51, Automated/Autonomous Intervention for Patient Care, ACC, AFMS priorities #60 - AFDS, #197 - ACC, and #267 - USAFE.

### 6.2 Transition Strategy

The transition plan for the FOBOT3S project includes broadening the mobile App platform to include other surgical and medical specialties. Because the FOBOT3S App is built on the MHCE platform, other specialties such as orthopedics, general surgery, and dermatology could easily be added to create a "one stop shop" for telemedicine. Members deploying to a remote location would have a single resource to utilize for any medical consultations. FOBOT3S would leverage decision support with digital consultation capability. In addition, there are many civilian applications for the FOBOT3S project and App. The FOBOT3S App could be utilized in any remote setting such as cruise ships, ski resorts, wilderness trips, or international travel. It could also be utilized in any civilian outpatient medical clinic, hospital, urgent care clinic, optometrist office, or emergency department without an in-house ophthalmologist.

## 7.0 RESULTS

There were 29 consults placed over 6 weeks by 18 different users. One consult did not synchronize due to connectivity so there were 28 consults that were received by the expeditionary ophthalmologist. All consults received were responded to with a mean initial response time of 3 minutes 58 seconds ± 3 minutes 48 seconds. There was agreement between the teleophthalmology diagnosis and final diagnosis in 24 (86%) consults. The treatment and management followed recommendations outlined in the JTS CPG for Eye Trauma: Initial Care in 28 (100%) consults. Teleophthalmology consultation prevented the need for aeromedical evacuation in 4 (14%) consults and downgraded the category of precedence from urgent or priority to routine in 4 (14%) consults. The patient returned to duty in 15 (54%) consults. Overall satisfaction was 4.79 ± 0.56, satisfaction with ease of use was 4.75 ± 0.51, satisfaction with the treatment and management plan was 4.96 ± 0.19, and satisfaction compared with other teleophthalmology methods was 4.70 ± 0.66. All 28 (100%) consults were secure and HIPAA compliant.

## 8.0 CONCLUSION/DISCUSSION

Teleophthalmology has advanced for diabetic retinopathy screening and macular degeneration, but the literature is limited for its applications in trauma and emergency medicine.7,10-13 The focus of this mobile app on trauma and disease and nonbattle injury is novel, to our knowledge, in teleophthalmology. This project demonstrated that a teleophthalmology mobile app was associated with improved and extended ophthalmic care in an operational environment. Use of a mobile app was associated with agreement between the teleophthalmology diagnosis and final diagnosis in 86% (95% CI, 72%-100%) of consults. The treatment and management followed recommendations outlined in the Joint Trauma System clinical practice guidelines in all consults. User satisfaction with a nonvalidated survey was relatively high, with the median overall score of 5 (minimum, 3; maximum, 5). The positive return on investment and cost savings from prevented aeromedical evacuation has previously been reported in military telemedicine.14 The mobile eye care app prevented the need for aeromedical evacuation in 4 consults (14%; 95% CI, 0.7%-28%) and downgraded the category of precedence from urgent or priority to routine in 4 consults (14%; 95% CI, 0.7%-28%).

A mobile app has potential advantages in convenience and response time over other asynchronous telemedicine options such as email or a web-based portal. The reported average response times for military telemedicine programs using email, which have been retired because they could not transmit identifiable patient health information, were 5 hours and 41 minutes for ophthalmology and 7 hours 32 minutes for orthopaedics.15,16 The mobile eye care app immediately sent out an alert to the expeditionary ophthalmologist's cell phone when a new consult was placed, allowing for a more timely response of 3 minutes and 58 seconds (95% CI, 2 minutes 30 seconds to 5 minutes 26 seconds).

To guide the future development of mobile apps for operational telemedicine and teleophthalmology in the military, we propose 4 development principles based on the results of the mobile eye care app beta testing: new technology should be secure, simple, reliable, and human (Table 4). This mobile eye care app was secure and HIPAA compliant in all consults. Future mobile apps should also provide data security, end-to-end encryption, and HIPAA compliance. Photographs with identifiable patient health information taken on a cell phone and stored in an unsecure location such as a photo album or cloud without additional security are not HIPAA compliant.17 This mobile eye care app allowed images to be captured and encrypted within the mobile software application directly and was HIPAA compliant.

Operational telemedicine technology should be simple and easy to set up and use. Input of demographic information could be automated using identification card scanning. Anterior and posterior segment photographs could be automated using focusing technology integrated into a mobile device or adaptors attached to a mobile device. An integrated examination toolbox could provide users with routine or advanced examination or diagnostic testing. Artificial intelligence including image processing tools could check the accuracy of data input and provide users with diagnostic support and treatment recommendations.

Reliability of teleophthalmology devices is perceived by the authors to be important, and one of the greatest obstacles for expeditionary mobile phone application technology is connectivity and firewalls in the operational environment. In this project, there were 12 potential users who were unable to use this mobile eye care app because of limited or no connectivity and/or firewalls. Future mobile app development might consider engineering technology with firewall solutions that maintain security and are recognized by the entire US Department of Defense network spectrum. Denied, degraded, or disrupted communication environments are likely in future conflicts and therefore apps need to consider engineering to meet anti-access and area denial challenges. In some instances, especially at remote forward operating bases or ships at sea, there is no wireless connectivity or synchronous capability. Therefore, asynchronous solutions that use minimal bandwidth when it is available are needed. It is also possible that mobile apps could integrate with existing military communication systems such as nonsecure or secure telephone, satellite telephone, or tactical chat.

Beta testing for this mobile eye care app demonstrated that telemedicine is complex, and it may not always be possible to make the correct diagnosis or guide management through remote communication alone. There was agreement between the teleophthalmology diagnosis and final diagnosis in 86% (95% CI, 72%-100%) of consults but ophthalmology evaluation was required in 61% (95% CI, 42%-80%) of consults. The history and examination gathered through a teleophthalmology consult may not be as accurate, detailed, or comprehensive as that obtained

from an ophthalmology evaluation. There are certain examination or diagnostic tests unavailable to POC users that can only be provided by a subspecialty evaluation. Therefore, direct follow-up with a clinician ideally should be possible with pathways to arrange referrals that are built into mobile apps. There were several limitations to this study. It occurred during a limited period of time in a deployed military setting on a proprietary military teleophthalmology platform with 1 expeditionary ophthalmologist responding to a limited number of consults. The results of this project may not be generalizable to how this mobile eye care app would perform in a larger population of military or civilian patients, users, and ophthalmologists. Ophthalmology evaluation was not recommended in 39% (95% CI, 20%-58%) of consults, so the final diagnosis determined from a review of all follow-up telephone calls and patient records may not be as accurate as a diagnosis from an in-person examination. The user satisfaction survey was non-validated, which may limit the interpretation of user satisfaction scores.

There may be other potential military and civilian applications for this technology and the current coronavirus disease 2019 pandemic has highlighted the need to expand telemedicine solutions. Teleophthalmology mobile phone apps can be used for virtual screening, examination, and treatment of patients during an infectious disease outbreak. Remote consultations might help patients access care while decreasing in-person visits to protect patients and health care workers. This technology might also have applications in other remote settings with limited connectivity such as cruise ships, ski resorts, wilderness trips, or international travel. It could also be used to extend ophthalmic coverage to any hospital, emergency department, urgent care clinic, outpatient medical clinic, or optometry office without an in-house ophthalmologist. The future of teleophthalmology appears to have the potential to improve and extend care in many military and civilian environments.

This project demonstrates that teleophthalmology mobile phone applications can improve and extend ophthalmic care in operational environments. Telemedicine is complex and future development should engineer solutions that are secure, simple, reliable, and human.

## 9.0 DELIVERABLES

### 9.1 Publications:

Gensheimer WG, Miller KE, Stowe J, Little J, Legault GL. Military Teleophthalmology in Afghanistan Using Mobile Phone Application. *JAMA Ophthalmol.* 2020;138(10):1053–1060. doi:10.1001/jamaophthalmol.2020.3090

### 9.2 Presentations:

American Telemedicine Association Virtual Conference; June 23, 2020

## 10.0 COST

This work was funded by 59MDW EC19EM04 where $516K was received and all funds were expended at the completion of the study.

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## FIGURES AND TABLES


**Figure 1. Military Teleophthalmology in Afghanistan Using a Mobile Phone App**

Medical professionals at the point of care placed consults using the mobile eye care application on their telephone, and an expeditionary ophthalmologist at a military hospital in Afghanistan responded by logging into a computer-based portal.

**Table 1. Demographics and Characteristics of the 28 Consults Received by the Expeditionary Ophthalmologist**

Table 1. Demographics and Characteristics of the 28 Consults Received by the Expeditionary Ophthalmologist

| Patient and consult characteristic | No. (%) |
|---|---|
| Age, mean (SD), y | 30.3 (9.8) |
| Sex | |
| Male | 26 (93) |
| Female | 2 (7) |
| Country | |
| US | 25 (89) |
| Coalition | 1 (4) |
| Afghanistan | 2 (7) |
| Category | |
| US military: active duty | |
| Not aviation or special duty | 13 (46) |
| Aviation | 6 (21) |
| Special duty | 3 (11) |
| US government or contractor | 3 (11) |
| Coalition military | 1 (4) |
| Afghanistan military | 1 (4) |
| Afghanistan civilian | 1 (4) |
| Response time requested | |
| Routine (response, <24 h) | 16 (57) |
| Priority (response, <4 h) | 4 (14) |
| Urgent (response, <1 h) | 8 (29) |
| Eye trauma | |
| Yes | 5 (18) |
| No | 23 (82) |
| Role of care | |
| 1 | 7 (24) |
| 2 | 8 (28) |
| 3 | 14 (48) |

# Table 2. Summary of Mobile Eye Care Teleophthalmology Consultations

Table 2. Summary of Mobile Eye Care Teleophthalmology Consultations

| Consult No. | Chief complaint | Cause[a] | Teleophthalmology diagnosis[b] | Ophthalmology evaluation recommended | Aeromedical evacuation[c] | Final diagnosis[d] | Outcome[e] |
|---|---|---|---|---|---|---|---|
| 1 | Eye pain/discomfort | DNBI | Dry eye disease | No | No | Dry eye disease | Return to duty |
| 2 | Vision loss | DNBI | Migraine with aura | Yes | No | Migraine with aura | Return to duty |
| 3 | Red eye (with pain) | DNBI | Conjunctivitis | No | No | Conjunctivitis | Return to duty |
| 4 | Trauma | DNBI | Orbital wall fracture | Yes | Downgraded to routine | Orbital wall fracture | Restricted duties |
| 5 | Eye lesion | DNBI | Pinguecula | No | No | Pinguecula | Return to duty |
| 6 | Red eye (with pain) | DNBI | Conjunctivitis | No | Prevented | Conjunctivitis | Restricted duties |
| 7 | Trauma | BI | Corneal abrasion | No | No | Corneal abrasion | Quarters |
| 8 | Vision loss | DNBI | Migraine with aura | Yes | No | Migraine with aura | Medical redeployment |
| 9 | Eye drifting | DNBI | Intermittent exotropia | Yes | Prevented | Intermittent exotropia | Redeployment as scheduled <1 mo |
| 10 | Red eye (with pain) | DNBI | Corneal abrasion | No | Prevented | Corneal abrasion | Restricted duties |
| 11 | Eyelid pain/swelling | DNBI | Chalazion | No | No | Chalazion | Return to duty |
| 12 | Red eye (with pain) | DNBI | Corneal abrasion | No | No | Corneal abrasion | Return to duty |
| 13 | Red eye (with pain) | DNBI | Herpetic keratitis | Yes | No | Iritis | Quarters |
| 14 | Foreign body in eye | DNBI | Conjunctival foreign body | Yes | No | Conjunctival foreign body | Return to duty |
| 15 | Red eye (with pain) | DNBI | Corneal abrasion | Yes | No | Corneal abrasion | Return to duty |
| 16 | Red eye (with pain) | DNBI | Episcleritis | Yes | No | Episcleritis | Return to duty |
| 17 | Floaters | DNBI | Vitreous opacities | Yes | Downgraded to routine | Intermediate uveitis | Redeployment as scheduled <1 mo |
| 18 | Discharge and itching | DNBI | Conjunctivitis | Yes | Downgraded to routine | CSR | Return to duty |
| 19 | Trauma | BI | Eyelid contusion | No | Prevented | Eyelid contusion | Admitted |
| 20 | Optic disc drusen | DNBI | Optic disc drusen | No | No | Optic disc drusen | Return to duty |
| 21 | Trauma | BI | Eyelid laceration | Yes | Downgraded to routine | Eyelid laceration | Surgery |
| 22 | Red eye (no pain) | DNBI | Conjunctivitis | No | No | Iritis | Quarters |
| 23 | Blind spot | DNBI | CSR | Yes | No | CSR | Return to duty |
| 24 | Trauma | BI | Open globe | Yes | Urgent | Open globe | Surgery |
| 25 | Red eye (with pain) | DNBI | Iritis | Yes | No | Iritis | Quarters |
| 26 | Red eye (no pain) | DNBI | Dry eye disease | Yes | No | Dry eye disease | Return to duty |
| 27 | Laser exposure | BI | Laser exposure | Yes | No | Laser exposure | Return to duty |
| 28 | Laser exposure | BI | Laser retinal injury | Yes | No | Laser retinal injury | Return to duty |

Abbreviations: BI, battle injury; CSR, central serous chorioretinopathy; DNBI, disease and nonbattle injury; POC, point of care.

[a] Cause of injury was categorized as BI or DNBI.

[b] Teleophthalmology diagnosis was determined by the expeditionary ophthalmologist at the time of response to the consultation.

[c] In-theater aeromedical evacuation for ophthalmology evaluation was required for some consults when the patient was located at another base. It was determined that teleophthalmology consultation prevented aeromedical evacuation if the POC user initially considered aeromedical evacuation for in-person ophthalmology evaluation but the expeditionary ophthalmologist did not recommend aeromedical evacuation and the patient was treated at their current role of care. It was determined that teleophthalmology consultation downgraded the category of aeromedical evacuation precedence if the POC user initially considered either urgent or priority aeromedical evacuation for in-person ophthalmology evaluation but the expeditionary ophthalmologist recommended routine aeromedical evacuation.

[d] If ophthalmology evaluation was recommended, the final diagnosis was determined at the time of an in-person ophthalmic examination. If ophthalmology evaluation was not recommended, the final diagnosis was determined by the expeditionary ophthalmologist based on a review of all follow-up telephone calls with the POC user and/or medical record review using the Theater Medical Data Store and Joint Legacy Viewer during the 30-day period after a consult was closed.

[e] Outcome determined after teleophthalmology mobile phone consultation and ophthalmology evaluation if recommended. Return to duty indicates no restrictions. Restricted duty indicates restrictions from performing certain duties or activities due to an illness or injury. Quarters indicates excusal from duty for a period of more than 24 hours to a maximum of 14 days due to an illness or injury that did not require hospitalization. Medical redeployment indicates redeployment to home station due to illness or injury. Redeployment in less than 1 month indicates member already scheduled to redeploy to home station so medical redeployment not recommended and the patient will follow-up as recommended when returns home. Admission indicates admission to a hospital and surgery indicates that a surgical procedure was performed.

**Table 3. Performance Indicators and Quality Benchmarks for Teleophthalmology Mobile Eye Care Consultations**

Table 3. Performance Indicators and Quality Benchmarks for Teleophthalmology Mobile Eye Care Consultations

| Performance indicator or quality benchmark[a] | No. (%) [95% CI] |
|---|---|
| Initial response time, mean (95% CI), min:s | 3:58 (2:30-5:26) |
| Response within requested time, No. (%) | 28 (100) |
| Visual acuity tested in both eyes | 18 (64) [46-83] |
| Agreement teleophthalmology diagnosis and final diagnosis[b] | 24 (86) [72-99] |
| Treatment and management followed JTS CPG, No. (%)[c] | 28 (100) |
| Prevented need for aeromedical evacuation | 4 (14) [0.7-28] |
| Downgraded category of aeromedical evacuation precedence | 4 (14) [0.7-28] |
| Return to duty | 15 (54) [34-73] |
| Consult record uploaded to medical record[d] | 27 (96) [89-100] |
| Consult secure and HIPAA compliant, No. (%) | 28 (100) |
| User satisfaction, median (range)[e] | |
| Overall | 5 (3-5) |
| With ease of use | 5 (3-5) |
| With the treatment and management plan | 5 (4-5) |
| Compared with other teleophthalmology methods[f] | 5 (3-5) |

Abbreviations: CPG, clinical practice guidelines; HIPAA, Health Insurance Portability and Accountability Act; JTS, Joint Trauma System.

[a] Analysis based on total of 28 new consults received by the expeditionary ophthalmologist.

[b] There were 4 cases with disagreement between the teleophthalmology diagnosis and final diagnosis. In 3 of those cases, an ophthalmology evaluation was recommended because the diagnosis was uncertain based on teleophthalmology consultation alone.

[c] For each consult, it was determined if treatment and management followed recommendations outlined in the JTS CPG Eye Trauma: Initial Care.

[d] In 1 consult, the patient was not able to be located in the medical record using name, date of birth, or Department of Defense Identification Number so the mobile eye care app consultation could not be uploaded to the medical record.

[e] Users graded their satisfaction with the mobile eye care app using a rating scale of 1 to 5, with 1 being very dissatisfied and 5 being very satisfied. The survey was completed for 28 of 28 consults.

[f] Satisfaction with the mobile eye care app compared with previous ophthalmology consults user has placed using other methods such as telephone, email, or pager.

**Table 4. Proposed Development Principles and Potential Solutions for Mobile Phone Apps Engineered for Military Teleophthalmology**

Table 4. Proposed Development Principles and Potential Solutions for Mobile Phone Apps Engineered for Military Teleophthalmology

| Development principle | Potential solutions |
|---|---|
| Secure | • Data security<br>• HIPAA compliance<br>• End-to-end encryption<br>• Camera functionality and photograph storage solutions |
| Simple | • Easy to set up and use with no training required<br>• Integrates functionality familiar to users: text, call, video<br>• Minimize required data fields<br>• Automated demographic information entry using identification card scanning<br>• Automated focusing for image capture<br>• Integrated toolbox with examination and diagnostic testing<br>• Artificial intelligence diagnostic support and treatment recommendations<br>• Functionality for both ocular and systemic trauma and disease |
| Reliable | • Engineer solutions for firewalls that maintain security<br>• Asynchronous and synchronous modes<br>• Integrate with existing communication systems<br>• Ensure functionality in denied, degraded, or disrupted communication environments<br>• Multiple rounds of development and testing to eliminate bugs<br>• High speed<br>• Automated routing of consultations with back-up on-call professionals |
| Human | • Direct communication with clinician available if needed<br>• Follow-up with clinician can be arranged if needed |

Abbreviation: HIPAA, Health Insurance Portability and Accountability Act.

## 12.0 LIST OF SYMBOLS, ABBREVIATIONS AND ACRONYMS

Clinical Practice Guidelines (CPG)

Eye Handbook (EHB)

Forward Operating Base Expert Telemedicine Resource Utilizing Mobile Application for Trauma (FOXTROT)

Joint Trauma System (JTS)

mobile application (mApp)

Mobile Health Care Environment (MHCE)

Point of care (POC)

video teleconferencing (VTC)

Transportable Exam Station (TES)

Tele-Mentoring/Medicine/Monitoring (TM3)

US Army Medical Research and Materiel Command (USAMRMC)