

## Contact lens-related complications in austere conditions among military personnel

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## **Structured abstract:**

### **Introduction:**

Military service personnel are required to deploy to austere environments where they are exposed to harsh conditions. Many service personnel continue to wear contact lenses when deployed as they are an effective alternative to spectacles by affording superior ergonomic functionality, although they are associated with significant complications. We aimed to explore the prevalence and type of contact lens related complications amongst deployed service personnel worldwide.

### **Methods:**

A systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement. PubMed, Medline, CINAHL and EMBASE databases were searched for relevant articles published between 1950 and 2023. The keywords “contact lens” and “military” or “army” or “navy” or “air force” and “austere” or “deployed” or “adverse” were used.

### **Results:**

Five eligible articles were included. Excluded articles reported contact lens wear in the firm base, were not related to military personnel or did not involve the deployed setting. Major complications associated with contact lens wear included microbial keratitis and contact lens related discomfort. Excluding case reports, the overall incidence of contact lens related complications ranged from 0.35% to 25.4%. The 3 case reports included in this systematic review described acanthamoeba keratitis, nocardia keratitis and contact lens related discomfort as significant complications. These case reports also detailed time to initial presentation and type of contact lens worn when complications were encountered. Types of deployed conditions service personnel were exposed to included desert, temperate and underwater environments.

### **Conclusions:**

We highlight a scarcity of recent data regarding contact lens related complications in the deployed setting. While contact lens wearing service personnel are at risk of infectious keratitis and contact lens related discomfort, we recommend good quality data collection on contact lens wearing schedules and complication rates to steer guidance on contact lens wear in service personnel.

### **Key messages:**

#### **What is already known on this topic?**

- Deployed contact lens wearing service personnel are often subjected to harsh conditions in austere environments and are at risk of developing complications related to contact lens wear.

**What this study adds:**

- Complications seen in the deployed setting included contact lens related discomfort and microbial keratitis.
- A single report indicated that the incidence of infective complications is greater in the deployed environment compared to the firm base.

**How might this study affect research, practice or policy?**

- This systematic review highlights a scarcity of data related to contact lens wearing service personnel.
- Further research is required to gather high quality data on complication rates and thus compare the cost-effectiveness of alternatives such as refractive surgery.

## **Introduction:**

United Kingdom (UK) military service personnel are frequently required to deploy to austere environments, both on exercises and operations. They are invariably exposed to harsh conditions; examples include the jungle, desert and arctic. Service personnel with refractive errors manage their condition by either wearing spectacles or contact lenses. In the deployed setting, the use of contact lenses may be seen as a favourable option, owing to less physical restriction[1]. However, there are significant complications associated with contact lens wear, including microbial keratitis. Service personnel are exposed to more risk factors whilst deployed and wearing schedules under the intensive workload on deployment may affect the complication rate associated with contact lens wear[2]. For instance, van Norren described that 94-95% of contact lens wearers in the military “almost always” wear their lenses[3].

Treating infectious complications on deployments can present major challenges and places a significant strain on medical resources. Ophthalmic complaints have accounted for 5.3% of all presentations on recent deployments and contact lens wear is likely to contribute to this burden[4]. Those affected by complications of contact lens wear may require aeromedical evacuation and specialised treatment at role 4 facilities, thus limiting operational effectiveness.

The aim of this review is to explore the prevalence and type of contact lens-related complications amongst deployed service personnel worldwide. In particular, the specific pattern of contact lens related disease in austere environments is investigated.

## **Methods:**

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement[5]. Searches were originally conducted on 28<sup>th</sup> November 2022 and updated on 3<sup>rd</sup> March 2023. Modifications made to the search included widening inclusion criteria beyond only “austere” conditions.

## **Search strategy:**

PubMed, Medline, CINAHL and EMBASE databases were searched for relevant articles published between 1950 and 2023. Search strings are contained in Annex A.

## **Inclusion criteria:**

The keywords “contact lens” and “military” or “army” or “navy” or “air force” and “austere” or “deployed” or “adverse” were used. Only studies published in indexed medical journals were included. No limitations were placed on language or geographical area. Two independent reviewers individually reviewed all titles retrieved from the initial search. Duplicates were eliminated and each reviewer decided on article inclusion. Where there was any disagreement, eligibility was resolved by discussion.

## **Results:**

65 records were identified and 5 eligible articles were included after the screening process. Excluded articles reported contact lens wear in the firm base, were not related to military personnel or did not involve the deployed setting. Articles were also excluded on the basis that they described patterns of contact lens wear but not complications. A full outline of the search process is detailed in Figure 1.

### **Characteristics of included articles:**

Three of the articles were case reports, one was a retrospective case series and one was a questionnaire of 1400 serving contact lens and spectacle wearers. Included studies with population at risk (PAR) and estimated incidence rate are summarised in Table 1. Types of deployed conditions service personnel were exposed to included desert, temperate and underwater environments.

Musa et al identified a total of 27 cases of contact lens related microbial keratitis over a 6-year period in a desert environment, with 63% of these cases losing more than one line of best corrected visual acuity resulting in permanent downgrading[6]. Type of contact lens wear and time to treatment was also documented. Van Norren's survey from 1984 described the incidence of contact lens related discomfort in a population of army and air force personnel[3]. This mail survey was initiated by the Dutch directorate of Military Medical Services to all contact lens wearers at the time and had a response rate of 67%, collecting data on 355 personnel in total[3]. This study described the type of contact lens used, duration of wear and associated symptoms such as pain and irritation. Of the 3 included case reports, information on type of contact lens worn, time to initial presentation and type of complication was provided. 2 case reports were based on single patients, whereas the case report by Simon et al included 2 patients[7–9]. The mean age of patients across all case reports was 34.8.

**Table 1:** Summary of included articles.

Article title	Year	Type of study	Number of cases	Population at risk (PAR)	Estimated incidence rate	Environment	Complications
Contact lens-related microbial keratitis in deployed British military personnel[6]	2010	Retrospective case series	27	7714	35 per 10,000	Desert	Bacterial keratitis Fungal keratitis
Contact lenses in the military service[3]	1984	Questionnaire	355	1400	2,536 per 10,000	Temperate	Contact lens related discomfort (CLD)
Acanthamoeba keratitis in a U.S. Army soldier after unauthorized use of contact lenses in the combat theatre[8]	2006	Case report	1	Unknown	Unknown	Desert	Acanthamoeba keratitis
Nocardia Arthritis Keratitis: Case Report and Review of the Literature[9]	2017	Case report	1	Unknown	Unknown	Temperate	Bacterial keratitis
Corneal edema in divers wearing hard contact lenses[7]	1978	Case report	2	Unknown	Unknown	Underwater	CLD

## **Discussion:**

Contact lens associated complications have been well described amongst the general population, but not in deployed military personnel[1]. The most frequently reported complications include contact lens discomfort (CLD), infective keratitis and conjunctivitis[8]. Our review of articles including deployed service personnel have highlighted cases of infective keratitis and CLD.

### **Infective keratitis:**

Cases of infectious keratitis were associated with long-term complications and had implications for future deployability[6]. The incidence of infective keratitis in the general population is approximately 2 to 5 per 10,000 people, which compares to the incidence of 35 per 10,000 described by Musa et al[6]. Infective keratitis secondary to contact lens wear, termed contact lens induced keratitis (CLIK), may be associated with any type of contact lens but most frequently occurs with soft contact lens wear[10]. Risk factors for the development of CLIK include poor personal hygiene, contamination of cleaning solution, inadequate lens cleaning, dry eyes, blepharitis and extended wear[10]. Service personnel deploying in austere conditions are likely to satisfy many of these risk factors.

Acanthamoeba keratitis (AK) is a sight threatening complication of contact lens wear and has been documented in a US service person[8]. Diagnosis is notoriously difficult and risk of long-term complications such as corneal scarring is linked to delayed treatment, as cases are easily confused with herpes simplex keratitis.

Our review also highlighted a rare case of Nocardia arthritidis keratitis (NK) in a fit and well male[9]. As with AK, this case report describes difficulty diagnosing a rare form of infective keratitis. Many such cases are treated empirically with corticosteroids and antibiotics with little improvement in symptoms, whilst corticosteroids may greatly worsen outcomes, especially in cases of AK. Fortunately this patient had only suffered mild anterior stromal scarring with no loss in visual acuity, although this may have been prevented with earlier diagnosis[9].

### **Contact lens related discomfort (CLD):**

The incidence of CLD in the military population was 2,536 per 10,000. While it is hoped that service personnel deploying will have been sufficiently educated and had a symptom free period prior to deploying, environmental factors can increase the risk of CLD. Some examples of this include relative increases (or decreases) in humidity, wind and temperature[11]. Our review has also found that divers are particularly susceptible to CLD, although this only appears to be associated with hard contact lens wear[7] and contact lens wear is not recommended in divers as a result of the risk of contamination with organisms such as Acanthamoeba.

### **Alternatives to contact lens wear:**

UK service personnel can self-fund refractive surgery, but in doing so there is a 3–6-month downgrade applied to their deployability status. This is in contrast with other NATO colleagues who fund in-service refractive surgery. For example, the United States Military has pioneered the Warfighter Refractive Eye Surgery Programme (WRESP), which offers refractive eye surgery to service personnel fulfilling certain criteria[12].

Current UK military policy advises against contact lens wear on operations due to the increased risk of complications. Service personnel must therefore resort to spectacle wear which can be cumbersome, especially when coupled with other forms of eye protection. Furthermore, many service personnel continue to wear contact lenses on exercise and deployment because of the enhanced functionality they afford. Spectacles can sometimes be incompatible with other adjuncts such as specialised combat goggles, hence the desire for service personnel to either continue to use contact lenses whilst deployed or seek refractive surgery.

### **Limitations:**

Although deployed environments share common themes such as increased evacuation timelines and limited medical resources, we appreciate the considerable clinical heterogeneity in this systematic review because of subsets of military personnel operating in different conditions. In addition, two of the studies included date prior to 1990 and there have been improvements in how service personnel are educated on modern day contact lens wear. These studies may therefore not be an accurate reflection of service personnel wearing contact lenses in current deployed conditions. Estimated incidence rates have been either extracted from the studies or calculated based on the PAR. Since the data has been survey based, the samples may not be a true reflection of the proportion of service personnel wearing contact lenses whilst deployed. Finally, we acknowledge that accurate comparison to service personnel wearing contact lenses in the firm base is not available and it is necessary to acknowledge that the included studies are either describing trends or are case reports from military deployments.

### **Conclusion:**

This systematic review has highlighted a scarcity of data with regards to contact lens-related complications in the deployed setting and many questions remained unanswered. We are unaware of any differences in complication rate and type of contact lens depending on the type of environment. Areas lacking complication data are in humid or extreme cold weather environments. Given that service personnel will continue to operate in such locations, it would be worthwhile to collect data to guide recommendations with respect to the relative risks and benefits of contact lens wear and refractive surgery.

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