

# Tonometer disinfection practice in the United Kingdom: A national survey

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CLINICAL STUDY

## Abstract

**Purpose:** To assess current tonometer disinfection practice in the UK, and compare with published recommendations.

**Methods:** Every ophthalmology unit with training recognition in the UK was contacted ( $n = 155$ ). A senior nurse at each institution completed a telephone questionnaire regarding local tonometer disinfection practice.

**Results:** The response rate was 100%. Thirty-five units (23%) reported exclusive use of disposable tonometer heads and were excluded from further analysis. One hundred and twenty units (77%) used either reusable or a combination of reusable and disposable tonometer heads. Where reusable heads were used, 80 units (67%) immersed them in a chlorine-based solution such as sodium hypochlorite or sodium dichloroisocyanurate. Others used isopropyl alcohol (18 units), hydrogen peroxide (12 units), chloramine (5 units), chlorhexidine (4 units) and peracetic acid (1 unit). Where a chlorine-based agent was used, the concentration of available chlorine ranged from 125 to 30 000 p.p.m., with 50 units (63%) using a concentration of less than 5 000 p.p.m. (i.e., inadequate based on published recommendations). Where the tonometer head was immersed in disinfectant between patients ( $n = 101$ ), 29 units (29%) provided just one tonometer head per practitioner, making adequate soak time between patients unlikely. Every unit replenished the disinfectant at least daily, deemed sufficient for most agents. However, hydrogen peroxide solutions should be replenished twice daily, which did not take place in nine units.

**Conclusion:** This survey reveals disparity between current tonometer disinfection practice and published international

recommendations, with some institutions using practices that may render patients susceptible to transmissible infection.

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**Keywords:** disinfection; tonometry; glaucoma

## Introduction

Intraocular pressure measurement using the Goldmann applanation tonometer forms a part of the routine ophthalmic examination. The reusable tonometer prism represents a potential vehicle for the cross-transmission of tear film pathogens between eyes and numerous adenoviral keratoconjunctivitis epidemics have implicated the applanation tonometer.<sup>1</sup> Other viruses that have been isolated in the tear film include herpes simplex virus (HSV),<sup>2</sup> human immunodeficiency virus (HIV),<sup>3</sup> hepatitis B virus (HBV)<sup>4</sup> and hepatitis C virus (HCV).<sup>5</sup> Although there have been no documented cases of transmission of these via contaminated ophthalmic equipment, hepatitis B infection following exposure of the ocular surface to infectious material has been demonstrated in a primate.<sup>6</sup> More recently, corneal epithelial cells<sup>7</sup> and proteinaceous material<sup>8</sup> have been found to be retained on the tonometer head following decontamination of the prism using standard cleaning and disinfection regimes. This has been proposed as a potential source of Creutzfeldt–Jakob disease (CJD) transmission, the infectious agent being the prion protein. To date, there has been one definite,<sup>9</sup> one probable<sup>10</sup> and two possible<sup>11,12</sup> cases of CJD transmission from penetrating keratoplasty. An epidemiological study by Davanipour *et al.*<sup>13</sup> found a positive association between intraocular pressure

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measurement and onset of CJD, although this finding was not founded by Zerr *et al.*<sup>14</sup>

The United States Centers for Disease Control and Prevention (CDC) and the American Academy of Ophthalmology (AAO)<sup>15</sup> recommend that after use, the tonometer prism should be wiped and then immersed in a 0.5% solution of sodium hypochlorite (equivalent to 5000 p.p.m. of available chlorine) for a minimum of 5 min. Alternatively, a 3% hydrogen peroxide or 70% isopropyl alcohol solution is recommended. The tonometer prism should then be rinsed under running water and wiped dry. Furthermore, the CDC and AAO recommend that two tonometer prisms should be made available for each practitioner to ensure sufficient soak time between patients and that disinfectant solutions should be changed at least once daily (for sodium hypochlorite solutions) or twice daily (for hydrogen peroxide and alcohol solutions), depending on the disinfectant agent in use. The Royal Australian and New Zealand College of Ophthalmologists (RANZCO) have adopted similar guidelines, with additional alternatives of 70% isopropyl alcohol wipe or immersion in 2% glutaraldehyde. The Spongiform Encephalopathy Advisory Committee (SEAC) and The College of Optometrists and The Association of British Dispensing Opticians advise that a 1 h exposure to a 2% solution of sodium hypochlorite, containing 20 000 p.p.m. of available chlorine is effective at inactivating prion proteins and should be used for all contact lenses and ophthalmic devices that touch the eye.<sup>16</sup>

The purpose of this survey was to assess current tonometer disinfection practice in the UK, and compare this with published recommendations.

### Materials and methods

Every ophthalmology unit with training recognition in England, Ireland, Scotland and Wales was identified from the Royal College of Ophthalmologists 'Directory of Training Posts in Ophthalmology 2005–2006'. At each institution, a senior nurse who was familiar with the day-to-day running of the out-patient ophthalmology clinic, responded to a structured telephone questionnaire regarding various aspects of local tonometer disinfection practice (Table 1). Where such an individual was unavailable to participate due to clinical time constraints, a second telephone call was made at a more convenient time. Where clarification about a response was required, a follow-up telephone call was made.

A potential source of error with this survey is reliance on precise information being provided verbally over the telephone by nursing staff. We attempted to counter this by verifying that each nurse completing the telephone questionnaire at each institution was familiar with the

**Table 1** Structured telephone questionnaire

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- |     |   |
|-----|---|
| Q1. | Are disposable, reusable, or a combination of tonometer head types used in your unit?<br><i>If 'disposable only', then end of questionnaire.</i>  |
| Q2. | What disinfectant solution is used to clean the tonometer head between patients?  |
| Q3. | Is this used to wipe or to immerse the tonometer head?<br><i>If 'prism wiped', then end of questionnaire.</i>   |
| Q4. | What concentration of disinfectant solution is used?<br><i>Where pre-prepared by manufacturer, concentration is read from packaging.</i><br><i>Where prepared on site by nursing staff, concentration given in grams / litre.</i> |
| Q5. | Is the tonometer head rinsed by immersion or placed under running water?  |
| Q6. | How many tonometer heads are available per doctor?  |
| Q7. | How frequently is the disinfectant solution changed?  |
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daily running of the clinic and felt capable of providing accurate responses. However, despite this potential weakness, the use of a telephone questionnaire proved to be a versatile and practical approach that facilitated comprehensive data collection.

### Results

A total of 155 eye units were identified and contacted. The response rate was 100%. Thirty five units (23%) reported exclusive use of disposable tonometer heads and were excluded from further analysis. The remaining 120 units (77%) used either reusable tonometer heads only (95 units) or a combination of reusable and disposable tonometer heads (25 units) (Figure 1). Where reusable heads were used, 80 units (67%) immersed prisms in a chlorine-based solution such as sodium hypochlorite (NaOCl) (eg 'Milton') or sodium dichloroisocyanurate (NaDCC) (eg 'Haz-tabs' or 'Presept'). Other commonly used disinfection techniques were isopropyl alcohol wipes (eg 'Sterets') or spray in 18 units (15%) and immersion in hydrogen peroxide in 12 units (10%). The remainder used immersion in chloramine (eg 'Chlorman T') (5 units), chlorhexidine wipes or immersion (4 units) or immersion in peracetic acid (eg 'Perasafe') (1 unit) (Table 2).

The antimicrobial efficacy of a chlorine-based disinfectant is dependant on chlorine concentration, exposure time and other factors. Where a chlorine-based disinfectant such as NaOCl or NaDCC was in use, the concentration of the available chlorine was calculated and found to range from 125 to 30 000 p.p.m. (Figure 2). Fifty units (63%) used a chlorine concentration of less than 5000 p.p.m. (i.e. inadequate based on CDC and AAO recommendations for HIV inactivation<sup>17</sup>). Of particular concern, 2 units (3%) used a chlorine concentration of less than 200 p.p.m., the minimum

chloride concentration required for adenovirus inactivation.<sup>1</sup> Regarding the SEAC guidance on the inactivation of prion proteins, 5 units (6%) met the recommended chlorine concentration of 20 000 p.p.m., but no unit routinely soaked tonometer heads for 1 h between patients.

Where the tonometer head was immersed in the disinfectant between patients ( $n = 101$ ), 85 units (84%) subsequently rinsed the tonometer head by immersion in water, 4 units (4%) placed the tonometer head under running water, and 12 units (12%) did not rinse the tonometer head. Seventy two units (71%) provided two or more tonometer heads per practitioner. The remaining units provided just one tonometer head per practitioner, making an adequate soak time of at least 5 min between each patient unlikely.

Every unit replenished the disinfectant at least on a daily basis, which is deemed to be sufficient for most disinfectant agents. However, as hydrogen peroxide is liable to degrade particularly rapidly in the presence of organic matter, such solutions should be replenished twice daily. This did not take place in 9 units where hydrogen peroxide was in use.

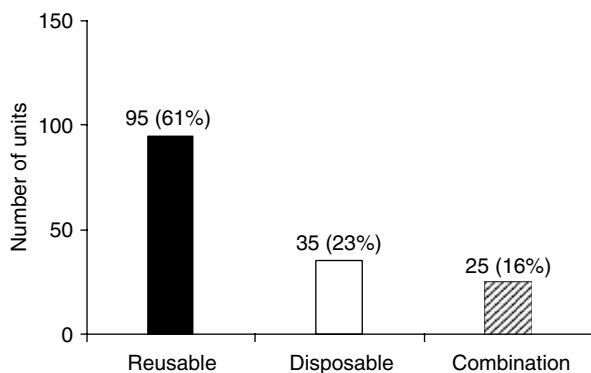


Figure 1 Type of tonometer head in use ( $n = 155$ ).

## Discussion

This national survey reveals that despite the introduction of a new generation of disposable tonometer heads, the majority of eye units in the UK continue to favour reusable Goldmann tonometer heads. A wide range of different tonometer disinfection regimes are in current use, which may be a consequence of the fact that no comprehensive guidelines for the disinfection of high-risk reusable ophthalmic instruments such as the tonometer head exists in the UK. Behind immersion in a chlorine-based solution, 70% isopropyl alcohol wipe was found in our survey to be the most common disinfectant method. This convenient method has been shown to be effective at inactivating adenovirus,<sup>18</sup> HIV and HSV.<sup>19</sup> However, a 70% isopropyl alcohol wipe has been found to be ineffective against hepatitis B and C<sup>20,21</sup> and is not included in the CDC and AAO recommendations. Of particular concern, some units continue to use 0.02% chlorhexidine gluconate, a chemical agent with unreliable virucidal action. Indeed, the humble adenovirus has been shown to be markedly resistant to chlorhexidine at this concentration.<sup>22</sup>

Repeated immersion of the tip of the tonometer head in 70% isopropyl alcohol results in structural damage, causing irregularities and grazing of the applanation surface and breakdown of the glue that holds the biprism to the rest of the body of the tonometer head.<sup>23,24</sup> This leads to reduced clarity of the corneal contact rings, causes corneal epithelial disturbance and may potentially harbour epithelial cells and microbes, making them harder to eradicate during disinfection.<sup>7,25</sup> A 70% isopropyl alcohol wipe causes similar, but less severe structural damage.<sup>23,26</sup> Of the disinfection methods available, immersion in 3% hydrogen peroxide has been found to be the least abrasive, followed by 0.5% sodium hypochlorite.<sup>23</sup> To date, no study has addressed the structural effects of high concentrations of sodium

Table 2 Disinfectant agents and techniques in use ( $n = 155$ )

Disinfectant agent	Number of units (%)	Method of disinfection	Concentration of disinfectant
Chlorine solution (NaDCC or NaOCl)	80 (67)	Immersion	125–30 000 p.p.m. (see Figure 2)
Isopropyl alcohol	18 (15)	Wipe (17 units)	70%
		Spray (1 unit)	30%
Hydrogen peroxide	12 (10)	Immersion	3% (10 units)
			10% (2 units)
Chloramine	5 (4)	Immersion	—
Chlorhexidine gluconate	4 (3)	Immersion (3 units)	0.02% (2 units)
			2% (1 unit)
Peracetic acid	1 (1)	Wipe (1 unit)	—
		Immersion	—

NaDCC, sodium dichloroisocyanurate; NaOCl, sodium hypochlorite; p.p.m., parts per million of available chlorine; —, data not available.

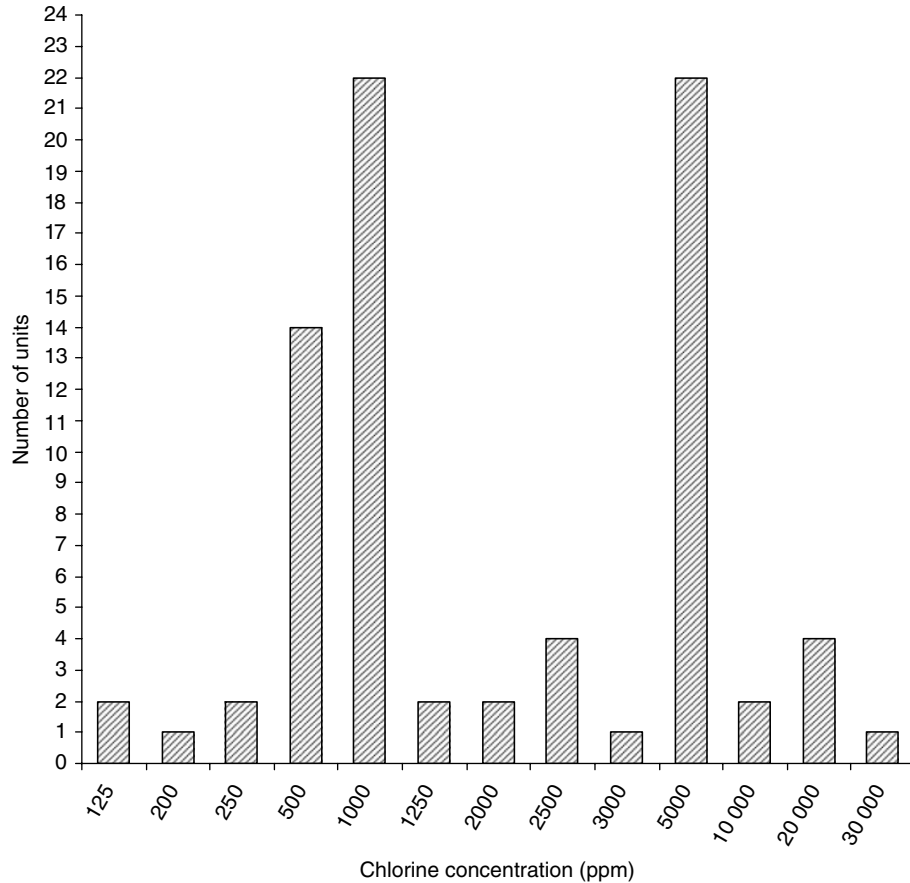


Figure 2 Chlorine concentrations in use ( $n = 79$ )<sup>a</sup>.

hypochlorite, such as that recommended by the SEAC. It seems reasonable to assume that significant and premature damage would result. Another potential hazard of such disinfectant agents is corneal toxicity, which has been reported following immersion of the tonometer head in 3% hydrogen peroxide<sup>27</sup> and 70% isopropyl alcohol wipe.<sup>28</sup> In both cases, temporary corneal opacification occurred as a result of residual disinfectant present on the tonometer tip at the time of applanation. Corneal epitheliopathy has also been reported following applanation tonometry of two eyes that had recently undergone photorefractive keratectomy, using a tonometer that had been disinfected in a 5000 p.p.m. chlorine solution.<sup>29</sup>

Unlike the disposable tonometer shield (eg Tonoshield<sup>TM</sup>), disposable acrylic tonometer prisms (eg Tonosafe<sup>TM</sup> and Tonojet<sup>TM</sup>) have been found to correlate well with standard Goldmann tonometry measurements in the general and emergency eye clinic setting.<sup>30,31</sup> However, a recent study has found the Tonosafe<sup>TM</sup> prism to be less accurate in a glaucoma population, particularly where the intraocular pressure

exceeds 25 mm Hg.<sup>32</sup> Furthermore, the use of a disposable tonometer does not completely eliminate the risk of cross-contamination between eyes due to manual handling of the tonometer prism<sup>33</sup> and has cost implications.<sup>30</sup>

Currently, in the UK, there appears to be great disparity between current tonometer disinfection practice and published international recommendations, with some institutions using non-evidence-based practices, which may render patients susceptible to transmissible ocular infections and possibly systemic disease. This survey highlights the need for the development of tonometer disinfection guidelines in the UK.

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