Reducing Disinfectant Wastage

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Summary

In order to lower departmental costs in an ophthalmological outpatient department by reducing wastage, the stability of available chlorine at levels of 280 ppm and 560 ppm in litre solutions of sodium dichloroisocyanurate was investigated over a three-week period. There was no significant decay in available chlorine at these levels in solutions kept at 20°C. Sodium dichloroisocyanurate may be prepared on a weekly instead of a daily basis with an annual saving of £1200 to £1400.

In busy ophthalmology outpatient departments, the tonometer prism is the most likely potential source for patient to patient spread of inapparent infection. Consultations may be separated by 15 minutes or less, and since good practice dictates the frequent use of the tonometer, a rapid effective disinfection procedure is essential.

In 1985 following an adenovirus outbreak and with HIV infections in prospect, two of us (KM'C and VD) made recommendations to this end based on the available chlorine in a solution of sodium dichloroisocyanurate (NaDCC). Five trouble-free years later, one of us working in the clinic on a daily basis reviewed the practice (St Paul's Eye Hospital) and costed it retrospectively at £9,000 (excluding labour costs) for the five years.

The aim of this study was to investigate the possible reduction in disinfectant wastage by monitoring the stability of available chlorine levels of 280 ppm and 560 ppm in a litre solution of NaDCC over a one to three-week period.

A recent study of the use of disinfectants in ophthalmology departments in the United

Kingdom, reveals that 84 out of 173 use free chlorine-based disinfectants,¹ so that our findings may have a general application.

We present a revised scheme which is acceptable on microbiological, clinical, nursing and pharmaceutical grounds and which will cut costs by around 70% without loss of efficacy.

NaDCC was adopted for use at St Paul's Eye Hospital for the following reasons:

(1) Tablets of NaDCC are stable and compact and allow a predictable and reliable way of obtaining a solution of available chlorine at the desired concentration.² Solutions of sodium hypochlorite (NaOCL) (Milton) or chlorinated lime and boric acid (Eusol), however, need to be stored in well-filled airtight containers, protected from light and at a temperature not exceeding 20°C.³ Furthermore, even solutions of chlorinated lime and boric acid deteriorate on storage and need to be used within 2 weeks.³

(2) NaDCC tablets are easier and safer to handle than concentrated NaOCL solutions,² thus avoiding the hazards to both the user and the patient, of solutions containing a high concentration of available chlorine.

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(3) NaDCC has a significantly higher bactericidal capacity and is more resistant to inactivation by organic matter than NaOCL.^{4,5,6} In NaDCC solutions, only a proportion of the total available chlorine is free, whilst the rest is combined; as free available chlorine is used, more is released from the combined form.² This may account for the enhanced bactericidal effect, improved resistance to organic inactivation and reduced corrosiveness of NaDCC solutions compared with NaOCL solutions.² The practice in this hospital (since 1985) is to prepare on a daily basis a litre solution of NaDCC at an available chlorine concentration of 560 ppm⁷ for each slit-lamp biomicroscope in use. Sterile water is used to avoid contamination with organic matter and the possibility of organisms surviving in non-sterile water. The daily changing of solution is based on the manufacturer's recommendation (Surgikos UK). Grounds for changing fluids daily are now under review. The tonometer prism is detached and disinfected between patients or occasionally if unilateral infection is suspected, between eyes by soaking for 10 minutes in approximately 15 ml aliquots of solution before rinsing in sterile water. These aliquots are changed between patients.

An assessment of the amount of solution left in each litre bottle at the end of each day in the outpatient department of this hospital varied between 500 and 800 ml. This residuum represents a significant wastage of solution, which if used on successive days, would reduce the number of bottles used by at least 66%. The cost per litre bottle of solution in this hospital is 46.5 pence (1.5p per tablet of NaDCC and 45p per litre of sterile water, excluding labour costs). More than three hundred bottles are used per month, giving an annual cost of over £1,800. Since the introduction of NaDCC in this hospital in 1985, the residual amount of potentially usable (if activity is maintained) solution represents a financial loss of over £6,000. Accordingly we measured the stability of available chlorine in litre solutions of NaDCC under the conditions prevailing in our outpatient department.

Method

Solutions were made with either 0.5 g (one

tablet) or 1 g (2 tablets) of NaDCC (Presept Tablets, Surgikos, UK) dissolved in one litre volumes of sterile water to give expected concentrations of 280 ppm (A) and 560 ppm (B) of available chlorine according to the manufacturers' specifications. Solutions were kept on the laboratory bench away from direct sunlight at 20°C room temperature and tested three times per day by one observer for three weeks. Between testing the bottles were kept closed.

In order to simulate the clinic situation it was assumed that an average of 15 patients were seen per tonometer per clinic (one to two clinics per day) and 15 ml aliquots used to sterilise the tonometer prism. Fifteen ml aliquots were discarded from each litre bottle (two containing 0.5 g NaDCC and two containing 1 g NaDCC), during the day leaving a growing air space. Measurements were then repeated in triplicate on each of the following two days on the residual 550 ml. A Lovibond 2000 comparator (Tintometer UK) was used for all tests. The comparator was calibrated using 1 ppm, 2 ppm and 3 ppm, chlorine standards (1 ml, 2 ml and 3 ml of a 0.0891 g/l solution of potassium permanganate to 99 ml, 98 ml and 97 ml of deionised water respectively). One in 400 and one in 800 dilutions

Table I. Available chlorine (ppm) in litre solutions of sodium dichloroisocyanurate, kept at 20°C away from direct sunlight

Day	Soln. A	Soln. B	Day	Soln. A	Soln. B
1.	280	520	10.	280	520
	280	560		240	560
	240	560		240	520
2.	240	520	11.	240	520
	240	520		280	520
	280	520		240	520
3.	280	560	12.	240	520
	240	520		280	560
	280	520		240	560
4.	280	560	15.	240	520
	240	560		240	520
	280	520		240	520
5.	240	520	16.	280	560
	240	560		240	520
	240	520		280	520
8.	240	520	17.	240	520
	280	560		280	560
	280	560		240	560
9.	240	520	18.	280	560
	280	560		240	520
	280	520		280	520

Table II. The average available chlorine levels in litre solutions of sodium dichloroisocyanurate over a three-day period.

day 1	267	280	563	600
2	253	280	560	587
3	267	280	560	587
$F_{2,6}$	0.3	0.0	0.3	0.5 ($p > 0.05$)

respectively were made of the expected 280 and 560 ppm solutions A and B. A 'DPD number one' available chlorine test tablet (Tintometer UK) was dissolved in 10 ml of the test solution and 10 ml of water used as a blank. A chlorine filter test disc '3/40 A' (Tintometer UK) was used. Each measurement was made using a north daylight source and recorded to the nearest 40 ppm.

Statistical analysis

An overall between-replicates basic variance s^2 , was assessed using the formula $s^2 = (\sum y_{ij}^2 - \sum S_i^2/n_i)/(n - k)$ where n = number of measurements, k = number of days tested, and $S_i = \sum y_{ij}$. Linear regression and correlation analysis using the method of least squares was carried out, to examine the linear relationships between available chlorine levels and time.

Also a mean square based on the day to day mean variation was compared with the basic measure of variance by an F test, using the F ratio: $F_{k-1, n-k} = (\sum S_i^2/n_i - S^2/n)/\{(k-1)s^2\}$ where $S = \sum S_i$.

This affords a one-way Analysis of Variance test of constancy with time, therefore testing for possible non-linear variation in time (Table III).

Results

In the first experiment 42 measurements were made for each solution, A and B. (see Table I).

The average available chlorine concentration on day one was 267 ppm for solution A and 547 ppm for solution B, which represents 95% and 97% of the expected concentration. There was no significant linear correlation with time for either solution: for A, r was 0.07 and for B, r was 0.04, $p > 0.05$, so there was no evidence of any linear trend of available chlorine with time. An F test on constancy with time gave: $F_{13,28} = 0.647$, $s^2 = 457.1$,

$k = 14$ for solution A and $F_{13,28} = 0.755$, $s^2 = 419.1$, $k = 14$ for solution B, neither of which were significant at even the 10% level (Table III). There was therefore no significant change in the available chlorine concentration over the three-week period. In the second experiment the average available chlorine concentrations obtained prior to and after removing 15 ml aliquots are shown in Table II. A one-way Analysis of Variance showed there was no significant change in the available chlorine concentration over the three-day period in either solution, ($F_{2,6} = 0.3, 0.0, 0.3, 0.5$; $p > 0.05$).

Discussion

Clinical audit is an important part of hospital practice. In this study we have shown that the concentration of available chlorine at levels of 280 ppm and 560 ppm is stable in a solution of NaDCC over a three-week period at 20°C. This means that it is unnecessary to prepare daily solutions of NaDCC.

Coates measured the stability of solutions of NaDCC in a water-bath at 25°C. After one week there was no change in the available chlorine at 580 and 160 ppm. After two weeks the concentration of available chlorine in both solutions had reduced to 75% of the initial value.² The difference at two weeks between our findings, may have been due to the higher temperature of 25°C at which Coates' solutions were stored. We stored the solutions at 20°C as this is the average temperature in the outpatient department.

If a litre bottle of solution were used for three to five days, this would represent a saving of £1,200 to £1,400 per annum. Under the conditions described the stock solution of one litre can safely be replaced on a weekly instead of a daily basis, or better still working

Table III. (Anova)

Source	df	s.s	m.s.	F
Solution A				
Between days	13	3847	295.9	0.647
Within days	28	12800	457.1	
Total	41	16647		
Solution B				
Between days	13	4114	316.5	0.755
Within days	28	11733	419.1	
Total	41	15847		

aliquots of the solution could be prepared once per week for daily use followed by discard.

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