QUALITY OF CHLORINE-BASED ANTISEPTICS AND DISINFECTANTS CIRCULATING IN DAR ES SALAAM, TANZANIA

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Abstract

Background: Chlorine-based antiseptics and disinfectants have a stability problem especially when formulated as aqueous solutions. They tend to decompose slowly liberating chlorine on storage. Despite this instability, these products are commonly manufactured and labeled with a long shelf-life. Thus the labeled content of available chlorine is doubtful and this could pose a danger to public health by not providing adequate disinfection.

Broad Objective: This study aimed at assessing the quality of chlorine-based antiseptics and disinfectants circulating in Dar es Salaam, Tanzania.

Study setting: The study was carried out in the city of Dar es Salaam

Methods and materials: Nineteen (19) samples representing various product batches circulating in Dar es Salaam were collected randomly from pharmacies, shops and from a tertiary-level public hospital. Analysis of the samples was immediately done in which the content of available chlorine was determined using a titrimetric method (Iodometric titration) according to the British Pharmacopoea (BP) specifications.

Measures of outcome: Results for contents of available chlorine was compared to the limits of assay specified in the BP and thus the percent compliance was calculated. Samples with contents below that specified in the BP were deemed to have failed the quality tests. For those products for which no official specifications are available (eg. Waterguard®), the BP limits for assay (± 10% of label claim) was applied to assess compliance.

Results: Out of the 19 sample batches analyzed 12 (63%) did not comply with the specifications for available chlorine (BP Limits of Assay or within 90-110% manufacturer's label claim). This was especially serious with preparations containing calcium hypochlorite with boric acid (Eusol) which had a mean content of only 12% of the recommended strength.

Conclusion and recommendations: The results from this study have shown clearly that chlorine-based antiseptics/disinfectant products should not be manufactured on a large scale by pre-dilution. Rather, they should be supplied as concentrates or powders for reconstitution at the time of use to ensure quality, efficacy and safety to public health.

Key words: Quality assessment, Chlorine antiseptics/disinfectants

Introduction

Mankind has used antiseptics and disinfectants to protect himself against microbes since time immemorial. Antiseptics are antimicrobial agents applied topically to living tissue while disinfectants are used on inanimate objects such as medical equipment toilets and floors.[1,2] Of the many chemicals which are currently used in antisepsis and disinfection, chlorine and chlorine releasing compounds are unsurpassed in terms of efficacy, safety, ease of use and cost.[3] Hypochlorous acid (HOCl) is the active germicidal specie formed when chlorine is dissolved in water. HOCl is also released by inorganic hypochlorite salts such as Sodium hypochlorite (NaOCl) and Calcium hypochlorite ($CaOCl_2$) when dissolved in water under acidic conditions. It is also released by N-chloro-organic compounds.[2,3,4,5]

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Hypochlorous acid penetrates microbial cell membranes and acts by: (i) Attaching chlorine to amide nitrogen atoms in proteins thus denaturing them. (ii) Yielding hydrochloric acid and nascent oxygen, which acts as an oxidant of sulfhydryl groups in proteins, hence possibly inactivating some essential enzymes in microbes.[3,4,5]

In Tanzania, two products are commonly used; these contain either sodium hypochlorite or calcium hypochlorite. Preparations containing sodium hypochlorite are mainly used as household cleansers, bleaches and disinfectants. Currently, a kit under the trade name Waterguard® (0.75 % sodium hypochlorite in water) is being promoted for household water disinfection to control outbreaks of water-borne diseases such as cholera, which is still a major problem especially in Dar es Salaam city. Sodium hypochlorite in various concentrations is also used as a general disinfectant or bleach. For instance, in a concentration of 3.5% (JIK®), it is widely used in households as a toilet and floor disinfectant and when diluted to lower concentrations it can be used as a bleaching agent. Calcium hypochlorite is used for Municipal water disinfection. It is also used for preparation of antiseptics and wound cleansers. Chlorinated lime (calcium hypochlorite) in combination with Boric acid (Eusol) is widely used in the cleansing and treatment of septic wounds as wet dressings, irrigations or baths in hospitals and in homes. It is thus important to be absolutely sure that these products are of the required quality to avoid the danger of inadequate disinfection and transmission of water-borne diseases.[6]
Although chlorine-based disinfectants and antiseptics are widely used non-prescription preparations, they have a disadvantage of being unstable, especially when prepared as solutions and kept for a long period of time. They tend to decompose slowly releasing chlorine, thus decreasing the content of available chlorine which is important for the antimicrobial action. The BP recommends that wound cleansing agents such as Eusol should be freshly prepared, preferably extemporaneously and used within a period not exceeding two weeks.[7]

However, in Tanzania these products are manufactured in large quantities in various pharmaceutical industries and supplied to pharmacies, medical stores, dispensaries and hospitals with a long shelf-life indicated. There is a danger that such products sold and used on patients and by the general public for general disinfection may be of poor quality and ineffective thus posing a danger to public health.[3,5,7]

Literature on the quality of chlorine-containing compounds circulating in Tanzania is very scanty. In a study which was done in Hongkong in early 2005 on usage pattern and content of available chlorine it was found that, out of 154 samples analyzed, only 88 samples (57%) contained ±10% of the quoted chlorine content.[8] The 66 samples with inadequate chlorine content generally contained about 70% to 80% of the quoted strength. However Chlorinated lime (Eusol) solution was an exception with a mean of only 12% of the quoted strength. Results of this study underscores the importance of surveillance and control of the quality of chlorine-based antiseptics-disinfectants.[8]

The aim of the present study was to assess the quality of chlorine based antiseptics and disinfectants circulating in Dar es Salaam, Tanzania.

Materials and Methods

Product samples

A total of 19 sample batches of chlorine-based disinfectants and antiseptics were collected at random from different pharmacies, medical stores, shops and from a tertiary level government hospital between March and June 2005. The following samples were collected: -

i) Chlorine-based water treating agents (WaterGuard®) from various pharmacies.
ii) Chlorine-based bleaching and cleansing agents (JIK®) from various shops.
iii) Chlorinated lime powder for Eusol preparation from a government hospital.
iv) Eusol solution extemporaneously prepared from a government hospital
v) Eusol solutions from various pharmacies and medical stores.

The batch number, manufacturing and expiry dates were recorded for each sample. The samples were immediately analyzed for content of available chlorine.

Methods of analysis

All samples were analysed using an iodometric titration method according to the British Pharmacopea (BP).[7] Generally, in these titrations, the solution or the suspension of the chlorine-based disinfectant or antiseptic was treated with an excess of a solution of potassium iodide, and strongly acidified with acetic acid. The liberated iodine was titrated with standard sodium thiosulphite solution using a starch indicator.

Preparation and standardization of reagents and solutions was carried out according to previously described standard procedures.[7,9,10] Results for contents of available chlorine was compared to the limits of assay specified in the BP and thus the percent compliance was calculated. For those products for which no official specifications are available (eg. Waterguard®, the BP limits for assay (± 10% of label claim) was applied to assess compliance.

Results

The shelf age of the samples ranged from 1 day to 7 months. Two samples of JIK® had no manufacturing date and hence the age of the products could not be ascertained. Three samples of Eusol® from company B had no expiry date (Table 1). All samples with the exception of WaterGuard®, Chlorinated lime powder and Eusol from a local company C, had no instructions for proper storage of the products.

The results for chemical analysis were recorded and compared to BP specifications (for Eusol and chlorinated lime powder). Results for non-BP products (Water Guard® and JIK®) were compared with the manufacturer's labeled content. These samples were considered to have passed the test if the content was within ± 10% of label claim. The results are summarized in Table 1 and 2.

Table 1. Results for Determination of Available Chlorine in Samples Containing Sodium Hypochlorite (n=7)

Sample and Assay Limit or Label claim % Cl	Batch No.	Manuf. Date	Expiry Date	Age on shelves	% Available Cl (average)	% Assay Limit or Label Claim Compliance (Acceptable range 90-110 %)
Waterguard ®	614	Sept 2004	Aug 2005	7 Mon	0.61	81.3
	693	Sept 2004	Aug 2005	7 Mon	0.62	82.7
0.75 %	721	Sept 2004	Aug 2005	7 Mon	0.65	86.7
	772	Jan 2005	Dec 2005	4 Mon	0.71	94.7
	794	Jan 2005	Dec 2005	4 Mon	0.72	96.0
JIK® 3.50 %	JR 100 B08A31	-	Aug 2006	-	2.95	84.1
	JR027 C04A05	-	Aug 2006	-	3.20	91.4

Table 2. Results for Determination of Available Chlorine in Samples Containing Calcium Hypochlorite (n=12)

Sample and Assay Limit or Label claim % Cl	Batch No.	Manufacturing Date	Expiry Date	Age on shelves	% Available Cl (average)	% Assay Limit or Label claim Compliance (90-110 %)
(i) Eusol □ 0.25 %	15613	Dec 2004	Dec 2005	6 Mon	0.04	14.2
Company A	15619	Feb 2005	Feb 2006	3 Mon	0.05	20.4
	15628	Apr 2005	Apr 2006	1 Mon	0.08	31.6
CompanY B	0075	Jan 2005	-	4 Mon	0.04	14.6
	0078	Jan 2005	-	4 Mon	0.06	24.1
	0095	May 2005	-	1 Mon	0.09	35.9
Company C	EUS 4043	Nov 2004	Oct 2005	7 Mon	0.03	13.6
	EUS 4092	Jan 2005	Jan 2006	4 Mon	0.06	25.0
Hospital Eusol Samples	-	-	-	1 Day	0.30	120.0
	-	-	-	3 Days	0.28	112.0
	-	-	-	7 Days	0.26	104.0
(ii) Clorinated Lime Powder (□30 %)	09999	Sept 2003	Aug 2005	7 Mon	30.0	100.0

Discussion

All samples of Waterguard® had a one year shelf life indicated on the label. Three out of the 5 samples (60%) analyzed failed the content test. All failing samples were seven months old. The two samples which passed the test were four months old, which underscores the importance of storage time for these products.[7]

Samples from two batches of JIK® were analyzed. Of these, one batch had a concentration within acceptable limits (± 10% of quoted strength). One batch failed the test. All JIK® samples had no manufacturing date indicated but all had expiry date set at August 2006 which was about 18 months away from the date of data collection.

As a result, the actual age of the samples on the shelf could not be ascertained. This practice is a contravention of the concept of Good Manufacturing Practice (GMP) for pharmaceutical products which is very particular about proper labeling.There was a large reduction of the content of available chlorine in the chlorinated lime solutions (Eusol) which ranged between 13.6- 31% of BP specifications. The lowering of chlorine content increased with age of the sample whereby at seven months the content went down to 13.6%. Products from two companies (A and C) had a one year shelf life while products from company B had no expiry date. This raises doubt as to whether such products could produce any antimicrobial action at all. The recommended concentration for antimicrobial action is in the range 0.1 – 0.5% available chlorine for high level disinfection of equipment, water and antisepsis of wounds.[3,5,7]

These findings corroborates the results obtained in a Hong Kong study where 81% of Eusol solutions were found to have a mean content of only 12% of the quoted strength of available chlorine.[8] Eusol solutions prepared in the hospital passed the test up to 7 days post manufacture. Chlorinated lime powder which is used in the manufacture of Eusol passed the test up to seven months from the manufacturing date indicating that chlorinated lime powder, if well stored is stable. It is normally given a shelf–life of 2 years.

The extent of the reduction of the content of available chlorine in WaterGuard® and JIK® was not as serious as in the chlorinated lime solutions (range 81.3–96.0 % of stated strength for WaterGuard® after 4 to 7 months post-manufacture). The reason for this could be the fact that WaterGuard® and JIK® are supplied as concentrated sodium hypochlorite solutions and no Boric acid is added. Boric acid enhances degradation and release of HOCl (Eusol contains Boric acid).[7,9] These results clearly support the suggestion that Eusol solutions are unstable and should be prepared extemporaneously and used within a short time, approximately within two weeks as recommended by the BP.[7]

Conclusion

This study has shown that contrary to belief and practice in the pharmaceutical industry, pre-diluted chlorine releasing antiseptics and disinfectants are unstable and deteriorate rapidly on storage and should only be prepared extemporaneously. If manufactured in industry, a short half-life and instructions on proper storage should be indicated on the label. Preferably, these products should be supplied as concentrates or powders for reconstitution at the site of use. Stringent measures should be instituted to control the manufacture and handling of these products to ensure quality, efficacy and safety to public health. A study on the stability profiles of these products and performance of microbial challenge tests to determine the antimicrobial capacity of the low content chlorine solutions forms part of our continuing work.

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