



Benzalkonium Chloride & Viruses

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Overview

Much of the initial interest in Benzalkonium chloride (one of two active KleenHanz towel ingredients) arose in the mid 80's to 90's era regarding sexually transmitted diseases primarily due to the chemical nature of Benzalkonium chloride. Benzalkonium chloride is a cell surface, positively charged biocide belonging to the group of quaternary ammonium salts. It is a detergent (like all soaps-part of the molecule likes water, the other part hates water and the part that hates water interacts with lipids (fats-grease). So these molecules 'cut grease/grime' in identical fashion to that of something like New Blue Cheer and in so doing disrupt/damage the grease layer (membrane envelope) that surrounds living cells like bacteria and infectious agents such as viruses that require living cells to replicate (multiply).

POSITION

There are two general divisions of viruses; those that have an envelope (grease layer surrounding their 'blue print' nucleic acids like RNA and DNA) and those that do not. Therefore, you can appreciate why benzalkonium chloride would be an interesting candidate to negate sexually transmitted diseases such as HIV (virus, causative agent of human immuno deficiency syndrome) and *Chlamydia trachomatis* (bacteria causative agent for *Chlamydial* infections). Both of these as we speak are big, big time problems infecting cumulatively hundreds of millions. You can also appreciate why Benzalkonium Chloride is an effective, efficient spermicide because it ruptures the surrounding membrane of spermatozoa thus preventing fertilization (requires docking and binding of the spermatozoa to the ovum via the respective cell surfaces, i.e., membranes).

In specific reference to the viruses of interest (Hepatitis, Herpes, HIV, H1N1), Belec and coworkers (*Journal of Antimicrobial Chemotherapy*, 2000 46: 685-693) conducted an extensive study of a group of human viral pathogens (enveloped and nonenveloped players) focusing on 1) concentration of benzalkonium chloride required for inactivation/reduction of viral infectivity and 2) increasing time of exposure to benzalkonium chloride. What they observed was an increasing concentration of detergent (benzalkonium chloride) and increasing time of exposure to benzalkonium chloride dramatically affected these viruses in terms of infectivity. Simply stated it killed them (prevented their replication in living cells). Furthermore, the benzalkonium chloride (0.1 %, w/v) was shown to have no deleterious effects upon the living cells that were used as host for the viruses (viruses can only replicate in living cells). Our towels have a comparable 0.25% benzalkonium chloride, a concentration that has been shown to be far

below levels of benzalkonium chloride required to elicit adverse responses in animal models such as allergic reactions. I do not know of any alcohol based concoctions currently used that are effective at such low concentrations. Most of these products have 70 % by volume alcohol and assuming for the sake of argument the density of isopropyl alcohol to be ~0.8 gms/ml-this would correspond approximately to a 56% w/v or ~225-250 times more active ingredient (alcohol) than that of benzalkonium chloride used on the towel. This is why alcohol extracts fats from the grease layers surrounding your skin cells in addition to whatever is on the surface of your skin resulting in cracking of the skin (our first line of protection against bacterial and viral agents). Belec found that enveloped viruses as we would suspect from the properties of benzalkonium chloride were most susceptible. For example, using the 10 minute exposure data (respective viruses were exposed to benzalkonium chloride for 10 minutes) which would be comparable to using the towel and persistence of material on the hands, Herpes, Cytomegalo, Respiratory Syncytial, Adeno and Entero viruses' infectivity was reduced greater than 3 logs (99.9 % approaching 99.95 %). MOST IMPORTANT: the concentration that Belec employed to obtain their results was 0.050 % benzalkonium chloride. We use 5 times (0.25 %) this amount of active ingredient on our towels such that it would be logical to conclude that **even greater inhibition of infectivity** would be observed using the towel. Considering all things being equal, it is logical to conclude that our towel would be very effective against the viruses tested by Belec above.

A few more salient points regarding the viruses tested by Belec. Respiratory Syncytial Virus is a respiratory enveloped RNA virus very similar to Influenza (H1N1). HIV is an enveloped RNA (retro) virus which has previously (1987) been shown to be very susceptible to benzalkonium chloride (Chermann, JC et al., AIDS-Forschung (AIFO) 2: 85-6). There are other literature citations proving the point that can be listed. Furthermore, benzalkonium chloride has been shown to be virucidal (kills viruses) for sexually transmitted viruses such as Cytomegalo and Herpes (enveloped DNA viruses). Kawana et al. (Dermatology 195, Suppl. 2, 29-35, 1997) have demonstrated benzalkonium chloride to be very effective against Rotavirus, a non-enveloped RNA virus indicating that the detergent not only acts via membranes (in this case no membrane) but may alter viral integrity or specific virus-host cell interactions. Rotavirus is an enteric virus that multiplies in the gut and causes significant diarrheal disease (day care centers, schools, etc.) and very similar to Norwalk (outbreaks of diarrheal/intestinal disease on Cruise ships, etc.). Hepatitis B/C are both enveloped viruses which for all of the reasons given above should be very susceptible to benzalkonium chloride especially at the concentrations used on the towel. There are data supporting this germane to sexually transmitted diseases. Non-enveloped viruses are approximately one log less or range from 99 % to 99.9 % inhibition of viral infectivity.

The bottom line in all of this is that benzalkonium chloride is very effective against ~4 log enveloped viruses at 1/5th the concentration used on the towel and ~ 3 logs for non-enveloped viruses at 1/5th the concentration used on the towel. Furthermore, the concentration of the active ingredient on the towel is much lower (0.25 % w/v) than that of alcohol based sanitizers (~56-60 % w/v), non volatile, and does not damage (extract lipids) from cellular matrix that makes up the epidermis.

The mode of action for benzalkonium chloride with regard to a bacteria like MRSA is essentially identical to that of viruses (interacting/disrupting the surrounding bacterial plasma membrane). The case is clear for sexually transmitted bacterial agents such as *Chlamydia trachomatis* (Lyons and Ito, 1995, Clinical Infectious Diseases 21: Suppl. 2, S174-7). Other dangerous sexually transmitted bacteria [*Haemophilus ducreyi*, *Treponema pallidum* (causative agent of Syphilis) and *Neisseria gonorrhoeae* (causative agent of gonorrhea)] have all been shown to be significantly inhibited by benzalkonium chloride (Critical Reviews

in *Oncogenesis* 6: 327-56, 1995; *Clinical Infectious Diseases* 21: Suppl. 2: S 174-7; *Contraception Fertility Sexualite* 16: 403-11, 1998). Group B *Streptococcus* is a frequent cause of morbidity and mortality in infants. Mosca et al., have recently demonstrated Benzalkonium Chloride is very effective against Group B *Streptococcus* when topically applied in the birth canal in pregnant women prior to delivery (*J. of Antimicrobial Chemotherapy*, 2006, 57: 566-568). This is consistent with our findings as well as others that benzalkonium chloride is very effective against commonly occurring/encountered *Streptococcus pyogenes* as well as *Staphylococcus aureus*. Enteric organisms such as *E. coli* and *Salmonella typhi* that are found in fecal contamination; respiratory pathogens such as *Klebsiella pneumoniae* and *Mycobacteria* (acid fast pathogens that cause tuberculosis) are all very sensitive to benzalkonium chloride's disruption of their respective surrounding plasma membranes. Although we have not tested MRSA (methicillin resistant *Staphylococcus aureus*) specifically, there is nothing in the literature to suggest that this organism (*Staphylococcus*) would not respond to benzalkonium chloride in an identical manner observed for methicillin sensitive *Staphylococcus aureus* as is the same case for above mentioned *Streptococcus pyogenes* and Group B *Streptococcus*.

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