

Dakin's and Cytotoxicity— what you need to know

Healthcare providers often associate Dakin's Solution with cytotoxicity, because the original, full-strength formulation was so potent. Today, most products in the Dakin's line contain a much smaller concentration of Sodium Hypochlorite, maintaining similar antimicrobial effectiveness without impeding wound healing.

Cytotoxicity defined

Cytotoxicity is the term for [how toxic a substance is to living cells](#). A substance that is cytotoxic causes cell damage or death.

In a wound care setting, when we refer to a product as non-cytotoxic, we generally mean that it does not damage healthy cells present in a wound bed. Ideal wound care solutions eliminate infection and help dissolve dead, necrotic tissue, but they are non-cytotoxic to body cells that promote wound healing.

Strong antiseptics can negatively impact wound healing due to cytotoxicity

Studies show that strong antiseptics can impair the function of cells like fibroblasts and keratinocytes that are necessary for wound healing.^{[4][5][7]}

Thus, it is important to balance the antimicrobial effectiveness of wound care solutions with their effects on healthy wound tissue.

Is Dakin's Solution cytotoxic?

Cytotoxicity for Dakin's Solution is dependent on the concentration strength.^{[3][4][5]}

The full-strength solution invented during WWI is incredibly effective at debriding and cleaning wounds. But concerns about its cytotoxicity lead many providers to limit its use.

The original formulation (a 0.5% buffered sodium hypochlorite solution) was invented during WWI by a British chemist, Dr. Henry Drysdale Dakin. It saved countless lives and limbs by preventing or treating infection in battlefield wounds.^{[1][2]} Dakin's Solution rapidly became a common antiseptic and debridement agent in the hospitals across the United States

This original strength was a revelation in wound care treatment, but as the understanding of wound healing advanced, focus shifted from "prevention of infection" to "creation of an optimal environment for the repair process."^[1] Researchers were concerned that antiseptics could be toxic to the cells of the repair process. Dr. Dakin's original solution came under scrutiny when numerous studies showed adverse effects on cells involved in the wound healing process.^[2]

Lower concentrations have since been shown to have similar antimicrobial efficacy without the same detrimental effects on healing tissue.





In-vitro studies performed by Hegggers et al. and Lineaweaver et al. showed that a 20-fold dilution (NaOCl 0.025%) of Dakin's original formulation retained its bactericidal effects without impeding wound healing or injuring fibroblasts in tissue culture.^[4]

These same researchers also used an in vivo incisional model to determine the effects of sodium hypochlorite therapy on wound healing in rats. They concluded that toxic effects of sodium hypochlorite on wound healing elements were confined to a restricted range of sodium hypochlorite concentrations.^[4]



Because of this, many hospitals use a modified sodium hypochlorite solution of 0.025% for wound care.^[3]

Century Pharmaceuticals, the only commercial manufacturer of Dakin's Solution™, offers 4 strengths, as indicated below.

Concentration of Sodium Hypochlorite

0.0125%	0.125%	0.25%	0.5%
			
Di-Dak-Sol	Quarter Strength	Half Strength	Full Strength

Original Dakin's Solution Line

		Shown not to inhibit wound healing
Wound Cleanser	Wound Cleanser Pro	

New: Dakin's Wound Cleansers

In in-vitro tests, our lowest strength kills 99.9+ percent of important wound pathogens (including biofilm-forming bacteria) in under 30 seconds.

Our two lowest strengths have been shown not to inhibit wound healing in vivo:^[6]

0.0125%	0.125%	0.25%	0.5%
Di-Dak-Sol <i>Wound Cleanser</i>	Quarter Strength <i>Wound Cleanser Pro</i>	Half Strength	Full Strength
Non-cytotoxic	Limited cytotoxicity in vitro ^[5] , shown not to impede wound healing in vivo.	Cytotoxic	Cytotoxic

In contrast, Dakin's Full Strength (0.5%) and Half Strength (0.25%) are more potent antiseptics. In current practice, these strengths are used by many providers for chemical debridement or infection control on an as-needed basis or for limited periods of time.^[8]

Note: Dakin's Solution labeling may cause some confusion for healthcare providers regarding strength. Our labels list strengths as full strength at 0.5%, half strength at 0.25%, and quarter strength at 0.125%. This terminology can cause confusion for healthcare providers who assume the half strength and quarter strength to correspond to 0.5% and 0.25%, respectively. ^[3]

Other Studies

In-vivo vs in-vitro toxicity

Per the table above, while our 0.125% solutions exhibit cytotoxicity *in vitro*, they have been shown not to impede wound healing *in vivo*.^[6]

A wound healing study in Yucatan swine showed that wounds treated with a sodium hypochlorite 0.125% solution (Dakin's Quarter Strength) had decreased time to heal when compared to untreated wounds. Histopathology analysis also indicated better healing scores, decreased inflammation and improved wound healing."^[6]

The importance of serum and other factors in vivo

A more recent study supports differences in cytotoxicity between in vitro and in vivo experiments due to the presence of serum, collagen, bacteria, and other proteins present in open wounds.^[5]

Vick et al. conducted experiments in a dermal equivalent designed to simulate the wound microenvironment. This included 3D collagen gels with fibroblasts incorporated. Researchers tested Dakin's Solution with and without serum and found that cytotoxicity was mitigated in the presence of serum. They concluded that up to 0.05% Sodium Hypochlorite could be safely used when conditions favored more of an in vitro setting with serum present.

This paper pointed out that many of the previously conducted in vitro studies did not take into consideration factors like serum, bacteria, and other proteins present in open wounds.

These researchers noted:

"The protein in the serum reduced the cytotoxicity of the Dakin's solution, which was protective for the collagen, but in the face of infection could also have reduced the antiseptic potential of the solution ...

We hypothesize that, in clinical use, wounds with higher amounts of purulence and infection might initially benefit from a higher concentration of Dakin's Solution. As the infection and exudate are being cleared from the wound, the concentration of the solution can likely be weaned to a more dilute mixture that will continue to provide bacteriostatic action in the wound at a concentration that is not toxic to the cells. As with all solutions, once necrotic debris and/or the biofilm are progressively resolving, the use of topical agents should also be progressively minimized to facilitate wound healing.^[5]

Note: Sodium hypochlorite is the sodium salt of hypochlorous acid. It is more stable than hypochlorous acid. In a wound environment, it is expected that both sodium hypochlorite and hypochlorous acid exist together at equilibrium. Both are in the same ingredient category under the FDA.

Concentration is Key

Lower concentrations of Dakin's Solution™ (below 0.125%) are known to be safe for use in vivo and do not inhibit wound healing.^[6] These solutions have antimicrobial properties, targeting important wound pathogens and biofilm without disrupting the healing environment.

Conclusions

Healthcare providers often associate Dakin's Solution with cytotoxicity, because the original, full-strength formulation was so potent. Today, most products in the Dakin's line contain a much smaller concentration of Sodium Hypochlorite (<0.125%). These wound cleansers maintain similar antimicrobial effectiveness without interfering with wound healing.

At diluted concentrations, the active ingredient in Dakin's Solution™ can fight infection and disrupt biofilm^[7] without detrimental effects on wound healing.^[6] This makes it an ideal wound care agent.

References

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We are currently conducting additional research on the safety and efficacy of Dakin's Solution. Get the results of these studies as they are published.

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