Laboratory evaluation of chlorhexidine delivery into donor skin from the Biopatch® and 3M™ Tegaderm™ CHG IV Securement dressings

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Introduction

- An aqueous gel dressing and a urethane composite disk containing chlorhexidine gluconate (CHG), reduce the risk of catheter-related bloodstream infection (CR-BSI).[1]
- Delivery of CHG onto and into the upper layers of the skin from these materials has not been studied.
- This laboratory study evaluated CHG skin permeation from the aqueous gel dressing and urethane disk in a donor skin model.

Methods

- Dressings evaluated: 3M™ Tegaderm CHG, 3M Health Care, Minnesota, USA (aqueous gel dressing with 3.75 mg CHG/cm^2 [45 mg in 3 x 4 cm gel pad]) and Biopatch®, Ethicon Inc., New Jersey, USA (dry urethane disk with 18.63 mg CHG/cm2 [52.5 mg in 1.9 cm disk]) Tegaderm, 3M Health Care (a polyurethane film-dressing) was applied to cover the disk.
- Full thickness donor skin was collected from six women [median age 48 years (IQR 42-51.5)] post apronectomy following consent (ethics approval: 15/WS/0275). The donor skin was excised following application of 2% (w/v) CHG in 70% (v/v) isopropyl alcohol.
- CHG permeation into skin was evaluated in a model which mimics conditions similar to skin *in vivo.*[2]
- Skin samples (4 cm x 4 cm) were mounted on Franz diffusion cells.[3]
- 1 cm 5.0 Fr polyurethane central venous catheter (CVC) was passed through the skin and CHG gel applied. On separate skin samples (from same donor), disk placed around CVC segment prior to application of a transparent dressing.
- After 24 h, skin was removed and 7mm biopsies taken including CVC site and adjacent intact skin.
- Skins from all donors in the absence of a dressing were evaluated in parallel.
- Biopsies were sectioned (every 100µm).
- CHG quantified by high-performance liquid chromatography.[3]
- CHG quantity analysed on log transformed data with repeated measures ANOVA. % CHG delivered onto skin evaluated with the Wilcoxon matched-pairs signed rank test. The level of significance = 0.05.

Results

Donor skin without any dressing application

- CHG detected in the skin following use of pre-operative skin prep (median [IQR] concentration in top 100µm = 0.062 [0.029-0.144] µg/mg tissue).
- Concentration declined with increasing depth ($p<0.0001$). Below 400 µm median <0.009 µg/mg tissue (Figure).

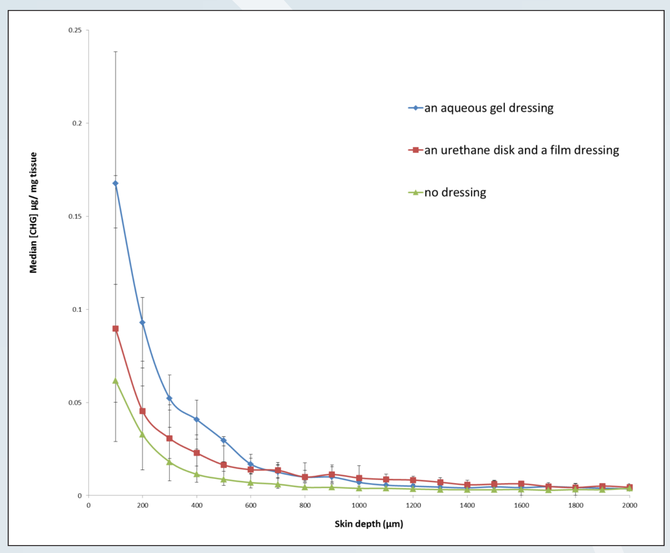
Skin following dressing application

- CHG >0.01 µg/mg tissue to 700 µm detected following application of gel or disk (Figure).
- Highest concentrations present in top 100 µm (median [IQR] CHG 0.168 [0.113-0.238] and 0.090 [0.050-0.172] µg/mg tissue, respectively).
- Concentration declined with increasing depth ($p<0.0001$).
- No significant difference in skin permeation of CHG from gel or disk ($p=0.162$).
- No significant difference in CHG skin permeation +/- CVC segment ($p=0.348$).
- Greater % CHG applied was delivered into top 100 µm skin from gel compared to disk ($p=0.043$)(Table).
- % CHG delivered to depth of 2000 µm greater from gel compared to disk, although not significant ($p=0.077$).

Discussion & Conclusion

- Donor human skin following pre-operative skin antisepsis (and no dressing application), had detectable CHG to depth of 2000 µm. If 1 g of skin is assumed to be equivalent to 1 mL, CHG in surface 100 µm ≥60 mg/L (higher than MIC of skin commensals)[4].
- CHG applied to IV catheter skin sites from the gel or disk delivered additional CHG. The estimated concentration of CHG in the surface 100 µm was ≥160 mg/L (gel) and 90 mg/L (disk).
- However no significant difference between two dressings in CHG delivery.
- When expressed as % applied CHG delivered over 10-fold higher after application of gel compared to disk.
- Results suggest CHG more readily released from gel compared to the disk.

Median (IQR) CHG presented as µg/mg of skin following 24h application of an aqueous gel or a urethane composite CHG disk or in the absence of a dressing. (n=12).



Comparison of CHG ex vivo† skin delivery from an aqueous gel dressing and an urethane composite disk after 24 h.
The background level of CHG in each donor skin was subtracted before calculation of CHG content in the skin following dressing applications.

		Pre-operative CHG skin preparation§	Aqueous gel	Dry urethane disk	p-value‡
CHG content in the dressing		(26 mL of 2% CHG applied over 1126 cm^2)	45 mg in 3 x 4 cm gel pad (12cm^2)*	52.5 mg in 1.9 cm disk with a 1.5 mm^2 centre hole (2.8176cm^2)**	
Total CHG content applied µg/ cm^2 skin		462	3750	18633	
CHG content (µg) in the top 100 µm layer of skin /cm^2 (% of the total applied CHG)	Mean	0.77 (0.17)	0.73 (0.02)	0.04 (0.0002)	p=0.043‡
	Median	0.39 (0.08)	0.58 (0.015)	0.15 (0.0008)	
Total content of CHG (µg) in 2000 µm thickness skin/cm^2 (% of the total applied CHG)	Mean	2.66 (0.58)	02.57 (0.07)	0.29 (0.002)	p=0.077‡
	Median	1.71 (0.37)	1.55 (0.04)	0.52 (0.003)	

§ CHG applied is estimated from *in vivo* pre-surgical skin preparation, assuming 26 mL of Chloraprep® were applied over recommended maximum skin surface area of 1126 cm² (accessed at: file:///C:/Users/tjk/downloads/IP_ChloraPrep-26mL-Clear_PL.pdf)
† The experiments were performed 12 times on full thickness donor human skin mounted onto Franz diffusion cells; ‡ Wilcoxon matched-pairs signed rank test to compare percentage of CHG delivered from each dressing.
* accessed at: https://multimedia.3m.com/mws/media/569354O/3m-tegaderm-chg-iv-securement-dressing-package-insert-english.pdf**accessed at: https://my.supplychain.nhs.uk/Catalogue/product/elw709

Acknowledgements

- We thank Tissue Services and surgeons at the University Hospitals Birmingham NHS Foundation Trust for supplying the donor skin.
- This work was supported by an educational grant from 3M Health Care, St. Paul, MN, USA.

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