Community dermatology

Water and the skin: Skin carers collaborate with industry in a new initiative and humanitarian drive

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Introduction

One billion people do not have safe drinking water, 4000 children die each day from water borne disease and WHO, with UNICEF, have made strong statements to this effect. Clasen *et al*. (2007) have published a systematic review and meta-analysis on interventions to improve water quality for preventing diarrhoea. So great and obvious is the need for safe water for drinking that it has, however, tended to overshadow the requirement for water to wash and care for the skin. The emphasis on water for washing skin has been less than that for drinking, despite the fact that skin disease constitutes the majority of all disease in rural areas of the developing world. The value of such basic skin care as effective cleansing and moisturisation has been emphasised by many since the mid 19th Century and, indeed, Lister and Florence Nightingale can be noted especially in this regard.

It was in Tanzania that the surgeon Peter Bewes first emphasised that, when cleaning wounds, water had to be "fit for drinking" and not necessarily boiled. He was well aware of the difficulties of heating water in the developing world (Bewes, 1976). A recent Cochrane review concluded that using tap water to cleanse wounds did not increase infection rate and that, when of drinkable quality, may be as effective as sterile water or saline and more cost-effective (Fernandez and Griffiths, 2008).

There are three main calls for water in skin care, thus, namely (a) dermatology and sexually-transmitted infections (b) wounds, burns and lymphoedema (c) neglected tropical diseases.

Water, therefore, is of obvious and major benefit but its availability is often compromised by its lack. This may be due to seasonal variation, climate change or strife. Procter and Gamble's technology for water purification (PUR) is widely distributed as a humanitarian initiative to meet the need of water for drinking and is currently in use in centres of need around the world, including Haiti. In disasters such as the flooding in Pakistan, it is fitness for drinking rather than shortage that is the major problem.

Following a Memorandum of Understanding between Procter and Gamble, the International Foundation for Dermatology and The International Skin Care Nursing Group, a number of studies and explorations of the potential of PUR for skin care have been initiated, some of which are summarised in this paper.

Background

Skin care is a major remit for three major groups of health providers:

1. *The International League of Dermatological Societies*, (ILDS), which in 1987 created *The International Foundation of Dermatology* (IFD) to focus on skin problems in the developing world. *The International Union of Sexually Transmitted Infections* (IUSTI) is an historic collaborator and many of the members of the ILDS are named as Venereology. *The International Skin Care Nursing Group* (ISNG; affiliated with the *World Council of Nurses*) is a member of the ILDS that works in partnership with the IFD to deliver skin care.

2. *The World Alliance for Wounds and Lymphoedema Care*, (WAWLC) was initiated within the Buruli Ulcer Division of WHO in 2009 to work in partnership with communities world-wide to advance sustainable prevention and care of wounds, burns and lymphoedema, in settings with limited resources.

3. *Neglected diseases*. The WHO Neglected Tropical Diseases group lists 13 major disabling conditions that are amongst the most common chronic infections affecting the world's poorest people. It seeks partnerships to provide skin care as demanded by those conditions affecting the skin such as leprosy, lymphatic filariasis, leishmaniasis, oncocerciasis, yaws, trachoma and Buruli ulcer. Leprosy is, of course, a prototype of delayed wound healing and stigma featuring in Dermatology texts for several centuries.

A WHO statement, oft repeated, is that approximately 3 billion people living in remote areas of 127 developing countries are deprived of the most basic skin care. (Hay and Fuller,2011) in this series describe some studies justifying this view of the high prevalence of skin disease.. Africa features predominantly in this list and skin diseases in its countries are of huge public health concern. Although rarely life-threatening, they:

- Are an overwhelming burden for first-level health facilities
- Are of devastating economic consequence for low-income families
- Are among the 5 most common causes of loss of working hours and employment
- Can result in serious disability / incapacitation, when diagnosis and treatment is delayed
- Are a major loss of health-related Quality of Life (QoL)
- Are predominantly communicable and amenable to prevention
- Are, in general, highly responsive to management.

However, skin diseases are still accorded relatively low priority, despite the fact that they constitute approximately 30% of all disease encountered in urban areas (10% in developed countries), with an even higher incidence in rural areas (40-60%). The majority (50-80%) of dermatoses are attributable to infectious-parasitic disorders with a higher prevalence in rural and peri-urban areas. This is in contrast with developed countries where the incidence of infectious disease is less than one third of those of non-infective origin. The triad of scabies, pyoderma and superficial fungal infection prevails in most of the developing world and gives rise to massive morbidity superimposed by diseases peculiar to a region (e.g., Oncocerciasis, Buruli Ulcer, Leishmaniasis).

Skin Disease Group Incidence in Tanzania		%
1.	Pyoderma (bacterial infections)	20
2.	Mycoses (fungal infections)	16
3.	Eczema / dermatitis	15
4.	Parasitic infections (incl. scabies and filariasis)	12
5.	Papulo-squamous (scaly eruptions)	5
6.	Chronic bacterial infections (incl. leprosy)	5
7.	Nutritional disorders	4
8.	Allergic disorders	3
9.	Viral infections	3
10.	Pigmentary disorders	3

There is a significantly higher prevalence rate in children over adults for pyoderma (especially those under 5 years), certain mycoses (e.g., tinea capitis), and, to a lesser extent, scabies.

There are also geography / geology-specific skin conditions that inflict significant morbidity in localised populations, e.g., podoconiosis (non-filarial lymphoedema), restricted to populations working barefoot in alkali, volcanic soils (e.g., the uplands of Ethiopia).

According to the WHO report "Epidemiology and Management of Common Skin Diseases in Children in Developing Countries" (Mahe and Haye, 2005):

"…*despite the relative paucity of objective data and some methodological restrictions, it can be assumed that the main etiological factors whose role is probably significant in developing countries are a hot and humid climate (pyoderma), low hygiene and poor access to water (pyoderma), high interpersonal contact and household overcrowding (scabies and pyoderma), and certain other skin conditions like reactions to insects bites and scabies (pyoderma)*…".

The main populations of Africa are, therefore, very much at risk from skin disease, because they live in environmental conditions which are the key determinants in its pathogenesis.

The good news, however, is that the majority of skin diseases can be potentially controlled or cured by intervention at the Primary Health Care / Community-Based Health Care level by (a) prevention through coherent education programs in tandem with improved hygiene and access to water and (b) treatment / cure with simple interventions and cheap, effective locally-prepared therapies.

The critical role of water in skin health

The stratum corneum constitutes the primary human interface with the environment, the ultimate membrane, and it can be argued effectively that every structure within the skin compartment exists to support the efficient, continuous production of this vital outer integument. The integrity of the stratum corneum is reliant upon a delicate water gradient which, when perturbed even slightly, results in compromised barrier function and a dramatic change in its regulation and biomechanical properties (leading to failure and resulting entry points; Nash *et al*., 2007; Rawlings and Matts, 2005 and 2008; Matts, 2008). In the developed world, this can be a mere cosmetic annoyance; in the developing world, the consequences are frequently disastrous due to the lack of even basic skin care and the extremely high levels of microbial and other mass on the

skin surface and surrounding environment. Water is needed, therefore, to both restore proper stratum corneum hydration (with the adjacent use of appropriate humectants and emollients) and to remove skin surface contamination.

The Need for "Water Fit for Drinking" for At-Risk and Compromised Skin in the Developing World

There are three main calls for skin care inclusive of washing:

- Skin conditions as described above, including many sexually transmitted infections

- Wounds and burns as well as other traumas which, as a daily occurrence, are probably the most numerous of conditions requiring care inclusive of washing. Lymphoedema may be added to this group, including podoconiosis (discussed by Gail Davey in this series). In India, lymphatic filariasis alone accounts for 20 million cases requiring washing as a key therapy (discussed by Narahari in this series).

- Neglected tropical diseases also require skin care and sufferers can be counted in their billions. Examples include leprosy (discussed by Ganapati and Vangee Handog in this series), lymphatic filariasis (discussed by Ersser *et al*., in this series), oncocerciasis, Buruli ulcer, trachoma, leishmaniasis.

As mentioned in the introduction,Peter Bewes, a surgeon operating at the Kilimanjaro Christian Medical Centre Tanzania, asserted that water used in the treatment of wounds and burns should be "fit for drinking" (Bewes, 1976). The benefits of clean water are highlighted prominently in literature on hygiene and grooming as well as in the care of the skin. Beyond simply cleaning and irrigation of skin, water of course plays a pivotal role in regulating stratum corneum mechanics, integrity, regulation and maturation – and, thus, in fundamental skin barrier function (Matts, 2008).

It should not be assumed that the conditions seen regularly in the skin clinic are the major need for skin care and washing. Leading concerns in contemporary literature are the washing of hands, and the utilisation of fuel for water heating. Shortage of water is commonplace and this is highlighted in conditions of strife, climate change, mobile populations as well as communities and health centres located in desert regions or with seasonal drought. Ironically, conditions of severe flooding or tsunamis make water fit for drinking difficult or impossible to access. The recent earthquake in Haiti highlights the desperate need of a population devastated by an environmental disaster.

PUR Water Purifying Technology

PUR is a powdered water purification technology packaged in a 4g sachet, using ferric sulphate as a coagulant (neutralising charge on particulate matter, causing flocculation within 10 minutes under constant stirring) and calcium hypochlorite to impart residual chlorine as a disinfectant. One sachet treats up to 10 litres of contaminated water.

The PUR technology has significant advantages over conventional field water purification systems, making it of particular relevance in applications in the developing world and in epidemics of typhoid, cholera and hepatitis:

- It provides significant knock-down of bacteria (>8.0 log reduction), viruses (>5.0 log reduction), chlorine-resistant cysts (e.g., giardia, cryptosporidium; >3.0 log reduction) and is also effective in removing / reducing to below WHO guidelines heavy metals (e.g., arsenic, lead), pesticides and organics (Souter *et al.*, 2003).

- It is rapid – 10 minutes of constant stirring followed by 10 minutes of standing produces up to 10 litres of purified water.

- It provides a dramatic visible signal that the water is getting cleaner, even in highly turbid water, and this has been proven, in field studies in Guatemala, to increase user confidence and overall compliance.

- The portability of the light-weight sachets makes them a viable option for distribution to victims of emergencies and natural disasters or to hard-to-reach rural areas.

- Only simple, readily available implements – a container, stir stick and filter cloth – are needed to use PUR.

- Residual chlorination means that water will retain microbial stability for about a day – although purified water can be maintained for longer using simple techniques (e.g., storing in a clear plastic container and placing in direct sunlight throughout the day).

The U.S. Centres for Disease Control and Prevention and Johns Hopkins University have conducted 5 clinical trials of PUR and proven that it significantly reduces diarrheal illness in children and the total population.

In the last few years, 240 million sachets have been distributed (equating to 2.4 billion litres of clean water provided), working with over 80 strategic partnerships worldwide. Currently, the gift of over 6 million sachets in Haiti is an example of benefit.

Clearly developed as a technology to provide clean drinking water, PUR is also ideally suited to providing “water fit for drinking” for bathing / washing at risk / compromised skin in developing countries with scarce / contaminated water supplies. PUR already has a relatively mature distribution network in developing countries which enables a potentially rapid and simple re-direction of some PUR supply to meet skin needs. Indeed, the separate needs for clean water for drinking and for bathing will likely be co-located geographically, considering the overwhelming commonality of cause in morbidity, that of microbial contamination.

There are also significant advantages in a system that does not use boiling as a means of sterilisation. Boiling requires fuel and, in the developing world, wood for burning has resulted increasingly in deforestation. There are also many reports of respiratory disease (from smoke inhalation), childhood burns, and even the rape of women as they walk further from home to obtain firewood.

Results of Health Intervention Trials

Average Diarrhea Reduction of 50%

Location / Setting	Study Design	% Diarrhea Reduction
Guatemala Rural	2982 people 52 weeks	24-29%
Guatemala Rural	3401 people 13 weeks	40-72%
Kenya Rural, Turbid water	6615 people 20 weeks	17-42%
Pakistan Urban slum	12090 people 39 weeks	59-64%
Liberia Refugee camp	2191 people 12 weeks	87-95%

Table 1: Results of health intervention trials with PUR

Access to and use of water - reporting from Africa

Despite accelerated urbanisation, the majority of the population of Sub-Saharan Africa (70-80%) is still rural. Rural-to-urban migration has only led to an urbanisation of poverty (>70% of urban dwellers are living without water and sanitation). Moreover, around 50% of the total population in Africa (25% in developed countries) constitutes children below the age of 15 years (with 21% <5 years). To meet Africa's needs for skin care, The International Foundation for Dermatology focused on an education project based in Northern Tanzania.

The Regional Dermatology Training Centre (RDTC), Moshi, Tanzania

Through Terence Ryan, Procter & Gamble have been introduced to the Regional Dermatology Training Centre (RDTC), based in Moshi, Tanzania as a central resource to evaluate the potential utility of PUR for skin in Africa.

The RDTC stands alone in Africa, and arguably worldwide, as a response to the call for Healthy Skin for All:

- Since 1990, the RDTC has been a tripartite joint venture between The United Republic of Tanzania (through the Ministry of Health) and the International Foundation For Dermatology (IFD, under the endorsement of the International League of Dermatological Societies [ILDS]) and The Good Samaritan Foundation of Tanzania (GSF) / Kilimanjaro

Christian Medical Centre (KCMC). The annual Advisory Board meeting includes representation by the Deputy Health Minister and WHO.

- It is a WHO Collaborating Centre For Dermatology, Leprosy and Sexually Transmitted Diseases, first designated in 1998 and re-designated in 2005.

- It aims to foster regional co-operation and communication to aid human resource development for dermato-venereology services in the Regional Health Communities of East, Central and Southern Africa.

- It was established as a National and Regional Reference Training and Research Centre to help support consultancy programs within the Region.

- Importantly, it focuses on the provision of formal and continuing education on skin diseases, leprosy, HIV/AIDS and other STI's to Trainers of Trainers and to health care providers. In particular, the RDTC has an emphasis on up-grading the training of front-line and intermediate level health workers to Community Dermatologists (Dermato-Venereology Officers).

Under the supervision of Principal Professor John Masenga and Vice Principal Professor Henning Grossmann, the RDTC has:

- succeeded in the extraordinary achievement of graduating, to date, 200 Dermato-Venereology Officers (from 15 Anglophone countries in East, Central, Southern and West Africa) from its 2 year course in Dermato-Venereology and Leprosy (for Assistant Medical Officers, Clinical Officers / Medical Assistants / Family Health Practitioners). The course covers Clinical Dermatology, Sexually Transmitted Diseases, Leprosy and Health Service Organisation (epidemiology, statistics, etc).

- provided regional Inpatient and Out-patient services as well as consultancy at KCMC

- under the leadership of Consultant Dr Alfred Naburi, developed numerous community-based outreach activities for dermatological / sexual health education and information (e.g., a Mobile Albino Care Clinic, an HIV / AIDS Community Intervention Project, Rehabilitation and Prevention of Disabilities and Deformities in Persons Affected with Leprosy (PALs) and Lymphatic Filariasis, as well as Community Dermatology projects in the Nyumba ya Mungu and Maasai Steppe areas).

- operated a Dermatological Topical Medication Compounding Facility (donated by the Vancouver Rotary Club) for production of essential dermatological preparations. (under the umbrella of the Unit For Appropriate Technology Transfer In Dermatology). All students are taught how to compound in this facility.

- run an annual Continuing Medical Education (CME) Conference for returning graduates and partners.

In addition, the RDTC has pioneered

- Maggot Debridement Therapy
- Bee-keeping to provide honey for wound management

- The growth of local plants for herbal remedies (e.g., aloe vera as an anti-inflammatory)
- A Waste For Energy program
- A Collaborative Modern and Traditional Health Care Dialogue Program

The RDTC and its staff represent an ideal base in which and from which to assess the utility of PUR for at-risk and compromised skin in Africa and, indeed, trialling of PUR at the RDTC is on-going.

Interviews Conducted (11th – 14th January 2010) to Research Water Usage and Washing Habits in Africa

In order to gain first-hand accounts of the way in which water is used in Tanzania, with particular emphasis on skin bathing and washing, Terence Ryan and Paul Matts conducted interviews with Medical Staff and local people.

Interviews conducted with Assistant Medical Officers (AMO) for Tanzania, January 11th, 2010, RDTC

AMOs are highly qualified medical staff, equivalent to a General Surgeon or Clinician, qualified to perform a broad range of duties. They have received 3 years of medical training followed by approximately 5 years of practical experience in the community. They have also completed a further 1 year course with some degree of specialisation (for example, in orthopedics, gynecology) and now also undergo an extra 2 years of dermatological training via the RDTC's Dermato-Venereology and Leprosy course. They are responsible for the organisation of health service provision in their district and the on-going education of key personnel, including clinical officers and birth attendants. AMOs are the principal channels of communication and means of distribution for health campaigns – e.g., HIV/AIDS, water-borne disease. 5 of the 6 AMOs covering Tanzania currently undergoing further training at the RDTC were interviewed on January 11th 2010.

During the interview, the AMOs provided the following answers in response to questions on the use of water:

Birthing:	A Traditional Health Attendant is apparently present for up to 50% of births. It was generally agreed that, without direction, most mothers remove the protective vernix too early by washing soon after birth, using water of indeterminate source. All 6 AMOs advised their patients to retain the vernix for a day or two.
Elderly:	When asked what allowances were made for washing with water of the elderly with incontinence or diarrhea, consensus was "none".
Ulcers:	Consensus that tropical ulcers were washed – three agreed that most used boiled water with added salt, two were not sure and thought the water could come from any source.
Menstruation:	Consensus that use of absorbent cloth was the main way of dealing with menstrual flow, and that washing was only used at a minimum (if at all).

Feet:	Consensus that the bare feet of the agricultural worker were not washed at all.
Burns:	All reported village use of honey, sugar or "fur" to help burn healing. Also reports of water (of indeterminate source) or human saliva being used for acute burn relief.
Genital Cleansing:	AMOs reported that the upper social classes would normally have a bath or shower each day, but did not know what was practiced in the villages.
Sea Water:	All but one AMO agreed that washing in the sea was not generally practiced, as a second "wash" with non-salt water was needed to remove white salt residues (of high contrast vs background skin).
Boiling:	All reported widespread disinclination to boil water as it apparently leaves an unpleasant taste.
Harvesting:	All said, unprompted, that help should be given to villages to harvest rain water during the wet season, for storage and later usage.
Priority:	It was reported that, among the Maasai, the order of priority for water use was: *Water for drinking for Cattle > Water for drinking for humans > Washing* The remainder agreed that, otherwise, the order of priority for water use was: *Drinking > Cooking > Washing*

Interview conducted with mother of disabled child, YWCA, Moshi, January 12th 2010

An interview was conducted with Anna (an intelligent, well-groomed woman in her 30's), the mother of Abel, a 10 year child with cerebral palsy, residential for a week at the YWCA in Moshi. Anna and Abel were under the care of occupational therapists, supervised by Herma Grossman.

Anna lives in a small village near, Himo, approximately 30km East of Moshi. Anna has no access to water near her house and so walks 2km to a river where she draws 20 litres of water into a plastic container and then walks the 2km back to her house carrying the 20kg of water on her head. She does this trip twice a day, morning and evening. She also collects firewood to boil a portion of the water for drinking. She reported that many of her friends do not boil drinking water because of an apparent residual unpleasant taste. Water used for skin washing is not boiled.

Figure 1 Woman in Ethiopia carrying 20L plastic container of water to her home, from the water source several kilometres away

Interviews conducted with villagers in Shiri-Mgungani, 14th January 2010

P Matts and Dr Alfred Naburi interviewed residents of Shiri-Mgungani village, located in the Hai district approximately 5km south-west of Moshi. The area is fertile, known for its horticultural production, with abundant water and shade.

Male villager, aged in his late 30's: He reported that drinking water was drawn from the local river (Karanga) and that his family boiled it first. He also reported that many of is neighbours did not boil water for drinking. All skin washing and bathing was performed in the river itself. Water for washing of garments or for cooking was taken from the local irrigation ditches.

Two females, aged late teens / early twenties: Both reported that they walked 1km, twice daily, to the local Bonite Bottling Plant to take water from the clean running water tap, gifted to the local villagers by the company.

Family of two elderly ladies (aged 40/50+), son and grandson: the family lived in one mud-walled dwelling, with flowing irrigation ditches either side of the property. When asked if they

made use of this water on their doorstep, they were surprised and answered that they could not use it as they knew that it was contaminated with pesticides, fertilisers and sewage. Indeed, during the interview, the son arrived wearing a pesticide sprayer he had been using on the local crops. They sourced all their water, therefore, from the local Karanga river. The water was turbid, brown and contained numerous visible live larvae of unknown identity. Water for drinking was not boiled before use and washing and bathing of skin was performed in the river itself.

A demonstration of the PUR technology was performed in front of the family using 10 litres of water from the Karanga river. The purified water supernatant was filtered through the son's shirt and all were extremely surprised at the transformation. The family asked for more sachets and these were supplied via the RDTC.

Summary of Interviews

In summary, the feedback from all interviewees was consistent:

- Water is often fetched from long distances, correspondingly precious and is used for perceived priority (i.e., drinking water for humans and live-stock)

- Skin washing / bathing is consistently the last priority

- Water for routine bathing is generally not treated in any way – boiling of large quantities of water requires considerable effort (firewood collection, etc.). Use is made of local rivers, if sufficiently close at hand

- Water used for bathing compromised skin is boiled and salted – under expert recommendation – although it is unclear how far this advice has penetrated the general rural populace

In addition, there are situations where water is abundant, but is un-useable because of contamination by pesticides, fertilizers and other materials leaching from surrounding soil (e.g., local irrigation channels in agricultural areas).

Clearly, therefore, there is major opportunity for education to promote the washing of at-risk and compromised skin and PUR represents a significant opportunity to provide clean water "fit for drinking" from even the dirtiest of sources.

Case study of PUR technology for washing of at-risk or compromised skin - Trial in a Ugandan District Hospital

A recent Cochrane review (Fernandez and Griffiths, 2008) concluded that where tap water is of drinkable quality it may be as beneficial as other methods such as sterile water or saline and more cost-effective. It is now used extensively in the UK for managing wounds. Accordingly, the project reported below describes the use of PUR to provide water of drinkable quality for use in the busy surgical ward of a 160 bed district hospital in Uganda, a project supervised by Jill Brooks. As the hospital previously used expensive products such as sterile IV normal saline, savlon of variable dilutions and hydrogen peroxide for washing wounds and burns, the additional benefit of economy is emphasised.

Methods

Prior agreement for this study was obtained from the Medical Director of the hospital. A teaching session was given on the preparation and use of the treated water at one of the weekly Continuing Medical Education meetings. This was attended by doctors, pharmacists, nurses, midwives and other qualified staff.

A member of the pharmacy staff was trained to prepare the water to be used for wound cleansing. Initially it was made up daily but this was later refined to alternate days. The surplus each day was stored in the refrigerator. The water was made up in a large, clean labelled container. The powder was added to tap water from the hospital's bore hole which was of indeterminable – though questionable – quality. As per PUR usage instructions, it was then stirred continually for 10 minutes during which a floc formed, containing microbial and chemical impurities. The floc was allowed to settle for a further 10 minutes before being strained through a clean piece of cotton cloth into another clean, labelled container. The used cloths were washed thoroughly in hot soapy water after each use and then rinsed and dried. The resulting treated water was poured into clean 0.5L labelled containers. Each day, at least 1.5L of treated water was delivered to the surgical ward. Any remaining water was used by the children's ward to reconstitute oral hydration fluids and in the last 2 weeks of the trial, 1.5 – 2L per day was used for wound cleansing in the minor operations theatre.

Figure 2 Pharmacy staff making up 10L batch of water

In the surgical ward, PUR-treated water was used to clean the wounds of 32 patients over a 6 week period. The patients were of both sexes and all ages, the youngest being 14 months and the oldest 73 years. It was used for cleansing superficial wounds as well as for irrigating very deep and extensive sinuses. Some of the wounds were dressed twice daily, while others were dressed

daily or less frequently depending on the amount of exudate and the general condition of the wound. The longest period of usage on any one patient was 29 days. The types of wounds treated included superficial burns, necrotic wounds on babies caused by poor injection practices, trauma wounds, surgical wounds of various types including those resulting from incised abscesses and haematomas, surgical amputations, surgically-debrided necrotic wounds which were the result of injections of paraffin, and surgical wounds from abdominal operations for peritonitis, some of which developed multiple fistulae. Additionally, because of a treatment fee, many patients discharged themselves before wounds were healed. Microscopy, culture and sensitively facilities were not available at the hospital.

Results

The water was prepared easily, with no issues, by a member of the pharmacy staff and was readily accepted as a cleansing agent by the nursing staff and the doctors. There was no noticeable rise in infection rates of wounds. Wounds that started clean remained clean. Infected wounds were treated with IV antibiotics and all burns were treated with silver sulphadiazine cream.

The use of savlon, hydrogen peroxide and IV normal saline to clean wounds in the surgical ward ceased during the trial. In a normal 4 month period, the spend on wound-cleansing products in the surgical ward was as follows:

Material	**Cost (Ugandan shillings)**
Hydrogen peroxide	7,865
Savlon	54,900
IV normal saline (estimated)	76,500
Total	139,265

This equates to a saving of approximately 417GBP per annum which, in a resource-poor country, is a very significant cost-saving. If the water was also used for wounds in the maternity ward and the minor operating theatre, the savings would be even greater.

Conclusions

This trial has demonstrated that PUR can be used to produce water “fit for drinking” for use in the effective cleansing of wounds, with the additional benefit of considerable cost-saving. The authors are working actively to reapply this model in other hospitals, clinics and outreaches.

Podoconiosis outreach clinics, Ethiopia

Podoconiosis is a debilitating disease causing massive swelling of the feet and legs (elephantiasis). It is also known as “Mossy Foot” or non-filarial lymphoedema / elephantiasis. It affects at least 5% of the population (some 2.5 million sufferers suspected across Ethiopia) in highland tropical areas with alkali, volcanic soils and high rainfall,. This geological combination produces a sticky red soil, rich in silicates which are thought to penetrate via cracks in the thick, dry, un-cared stratum corneum of plantar skin of susceptible individuals as they go about their

daily business barefoot. These particles appear to be taken up in the lower limb lymphatics, causing endolymphangitis and obliteration of the lymphatic lumen.

Ensuing lymphoedema of the lower limbs results in gross swelling and a breakdown in stratum barrier function. The skin becomes rough and bumpy (looking like moss, hence the name) and, with recurrent infection, produces a highly offensive smell. The swelling is extremely painful, so much so that walking is often impossible, effectively preventing the individual from working or taking part in family life. Sufferers can be ostracised, forced to become beggars and some community members believe that they have been cursed.

In the majority of cases simple, inexpensive treatment has dramatic results. Relatively straightforward skin care such as regular washing of the legs and treatment with Whitfield Ointment can produce dramatic improvement and at least stop the condition getting worse.

Once hidden from view, it has now become one of the "Neglected Tropical Diseases" and several publications in leading journals, especially by Gail Davey (see review of 2010 and further in this series), have brought it the attention of the contemporary scientific community.

Figure 3 Uncared-for, brittle skin on the heel of an agricultural worker in Ethiopia with deep cracks and entry points

In November 2010, Terence Ryan, Paul Matts and Claire Fuller (East Kent HUFT), visited the Mossy Foot Project headquarters in Sodo, Ethiopia and, visiting 5 of 14 established clinics, witnessed firsthand the astonishing numbers of sufferers attending the centres (in one case, up to 575 a month).

Clearly, the ability of PUR to provide water of drinkable quality is a potential significant asset to projects such as this where water plays a pivotal role in therapy. The use of PUR was, therefore, demonstrated in the field to both the staff of the Mossy Foot Project and to sufferers with enthusiastic acceptance. Over the next months, a team including the authors is planning trials to

evaluate the utility of PUR in the treatment of water for use with podoconiosis sufferers in Ethiopia.

The use of PUR is almost certainly applicable to the treatment of other forms of lymphoedema. The Institute of Applied Dermatology (IAD) in Kerala headed by Dr SR Narahari is conducting a major study (see the paper in this series) of patients afflicted by lymphatic filariasis (estimated to be at least 20 million in India). More than 1000 patients have benefited using integrated medicine, combining effective components of Ayurvedic Medicine and Biomedicine. The authors, together with Claire Fuller (EKHUFT) and Peter Mortimer (St George's Hospital, London) visited the IAD in November 2010 and were able to demonstrate once again the utility of PUR in providing clean water for the critical washing and soaking stages of the treatment.

Conservation of water

As water continues to become an increasingly precious commodity, its conservation is a matter of urgent global attention and this is certainly the case with water for bathing. For example, rather than direct application to skin (resulting in significant wastage of resource), modern absorbent paper (of the type used in kitchens and which retains mechanical strength when wet) can be wetted by pouring water slowly on to it, minimising wastage. Terence Ryan has found that a whole body can be washed effectively with wetted paper using only 100ml of water and experiments are underway to develop these methods further.

Furthermore, attention is also turning to efficient humectant technology to retain water on and in the stratum corneum, to augment and promote skin barrier function. Glycerin remains the cheapest, most potent and skin-active humectant in our arsenal and, besides these properties, also has antibacterial, anti-viral and anti-inflammatory properties (Fluhr *et al*., 2008). Procter & Gamble remains the world's largest manufacturer and supplier of glycerine and donations are now in the RDTC where trials will assess the utility of this agent in the field (e.g., the simple addition of a few percent by volume to PUR-treated wash water to produce a highly effective humectant soak).

Summary

Water is pivotal to stratum corneum barrier function and, thus, to skin and systemic health. Nowhere is this more true than in the developing world. Clean water is, however, scarce in these regions and, where available, used preferentially for drinking and cooking. Provision of adequate supplies of clean water, and education in its additional use in basic skin care, is vitally important. Trials completed and on-going are showing that the use of PUR can fulfil this need in some cases. Developing models, such as the use of PUR-treated water for the care of wounds in hospitals and clinics with associated cost-savings, are exciting and open to re-application.

We believe that water "fit for drinking" produced by this method can and should be promoted for use in dermatology and sexually-transmitted infections, wounds, burns and lymphoedema and neglected tropical diseases. Accordingly, the Program Development group of the World Alliance for Wound and Lymphoedma Care have placed on their agenda "*Assure water purification methods (PUR sachets)*" and the Neglected Tropical Disease group will, in due course, be encouraged to adopt a similar program of skin care.

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