INTRODUCTION

Trachoma, an infectious disease triggered by *Chlamydia* [1, 2] is responsible for approximately 3% of the world’s blindness. The World Health Organization (WHO) estimates that trachoma provoked irreversible visual impairment in about 8 million people in 2011. If blindness is to be prevented, more than 100 million people need treatment, and emphasis should be placed on measures for hygiene improvement. Trachoma continues to be hyper endemic in many of the poorest and most remote poor rural areas of Africa [1, 3, 4–7], Asia [1, 8, 9], North (Mexico), Central (Guatemala) and South America (Brazil and Colombia) [1, 10–14], Australia [15, 16] and the Middle East [1, 16]. Trachoma is a warning signal for poor sanitation and insufficient water in extreme poverty environments [1, 3, 14, 17].

This blinding infection is transmitted through contact with eye discharge from an infected person (via towels, handkerchiefs, fingers, etc.) and by eye-seeking flies [1, 18]. After years of repeated infection, the inside of the eyelid may be scarred so severely that the eyelid turns inward and the lashes rub on the eyeball, scarring the cornea. If no proper treatment is administered, the cornea becomes sclerotic, lost its transparency and leads to blindness. Trachoma affects women and children, the most vulnerable members of poor communities [1, 3, 7, 8].

The World Health Organization leads an international alliance of interested parties to work for the global elimination of trachoma, the Alliance for Global Elimination of Trachoma by the year 2020 (GET 2020). International efforts to eliminate trachoma as a blinding disease are based on the WHO-developed strategy—a combination of interventions known by the acronym “SAFE” which stands for surgery for trichiasis (in inverted eyelashes); antibiotics; facial cleanliness and environmental improvement [1, 3, 7, 18–20].
Increased water availability and increased washing should reduce transmission of trachoma by eye-seeking flies (flies are considered to be a source of infection). Breeding sites of flies can be reduced or eliminated by improving the disposal of human excreta, animal dung and sewage disposal, by changing the way domestic animals are kept, by improving food handling, and by ensuring that waste is properly managed [1, 20]. Furthermore, washing of hands, clothes, and towels may reduce the frequency of transmission [18–21]. There is strong evidence that trachoma is related to water availability, and several cross-sectional surveys showed a positive association between the distance to the water source and the prevalence of active trachoma [6–8, 22–25].

Between 2007 and 2010, anti-trachoma campaigns were conducted by local ophthalmologists and nurses (trained and evaluated by WHO staff for clinical diagnosis of trachoma), who gathered the population in meetings to enhance awareness regarding hygiene [4]. Community involvement was stressed as an essential component of trachoma control and as the key to eliciting behavioral changes by promoting awareness of the disease, knowledge regarding possible solutions and action at the community level. Community agents (selected literate health aid inhabitants in each village) were involved in reaching candidates for trachoma surgery and aiding the distribution of antibiotics. Training for chiefs of local districts, teachers, religious leaders, and health aides was carried out using the following WHO guidelines and supplementary documents:

I) Trachoma control: A guide for programme managers:
- WHO SAFES documents (www.who.int/blindness/cause/trachoma/en/index.html);
- (http://www.who.int/blindness/guide/20english);
- (http://www.who.int/blindness/guide/20english);
- (http://www.who.int/neglecteddiseases/trachoma/en);

II) Trachoma Epidemiologic Survey Protocol
- (http://www.trachoma.org/sites/default/files/guidesandmanuals/prevalence_protocol_trachoma);

III) Trachoma control: A guide for programme managers
- (who.int/publications/2006/9241546905);

IV) SAFE strategy: Preventing trachoma. A guide for environmental sanitation and improved hygiene
- (http://www.trachoma.org/sites/default/files/guidesandmanualsSAFE);

V) Implementing the SAFE Strategy for Trachoma Control:
- A Toolbox of Interventions for Promoting Facial Cleanliness and Environmental Improvement (http://www.trachoma.org/sites/default/files/guidesandmanuals/TrachomaToolboxFinalEnglish.pdf).

Posters and booklets for children attending primary schools were provided by Ophtalmo sans Frontières.

After the first awareness campaigns for improvement of hygiene, the health agents repeatedly reported that the chiefs of villages (with a prevalence of active trachoma ≥25%) blamed children’s dirty faces on a lack of water due to the lack of funding by government and non-governmental organizations to build wells.

One year after the first trachoma campaign (2008), the health managers expressed their frustration regarding the results obtained after the awareness campaigns because the cleaning habits (facial cleanliness and environmental improvement in the SAFE strategy) were not substantially modified. Nevertheless, with regard to screening and mass distribution of antibiotics they reported that the procedures for the setting up of therapeutic tasks (diagnosis, antibiotic and surgery) proved to be clear, direct, and practical.

One year after the first campaign, no changes in the hygienic conditions were observed (messages disseminated during the awareness campaigns following the training guides). During encounters in the villages, we sensed that the health workers and civil and religious authorities were unable to implement simple instructions for the purpose of improving the conditions regarding access to water (and better hygiene). The objective of this work was to assess if the absence of water in the villages with a high prevalence of active trachoma was linked with a lack of means to dig wells or waterholes.

**MATERIALS AND METHODS**

In 2009, 250 community level health workers (community agents) were selected for the trachoma campaign in the district of Kolofata, Extreme North Province of Cameroon according to their capacity to read and explain the content of the SAFE strategy items in the trachoma guides (WHO) (http://www.who.int/blindness/guide%20english.pdf); (http://www.who.int/gho/neglected_diseases/trachoma/en); (http://www.who.int/blindness/causes/trachoma/documents/en/).

This district (120,000 inhabitants, active trachoma 25% in children aged 10 or less) is composed of 250 villages or neighborhoods (200 to 2500 inhabitants/village). A series of posters and booklets designed specifically for the SAFE strategy by Ophtalmo sans Frontières (OSF) was provided to the 250 agents. The benefits of body hygiene—including washing of children’s faces, clothes and wraps—were explained in the local languages to the people attending the meetings. The community agents invited all the inhabitants of the villages to awareness meetings, especially the mothers with babies. In January 2011, meetings with village chiefs and family heads were held in 50 villages randomly selected from the 250 villages/neighborhoods of the district. Several parameters were recorded during meetings with vil-
lage chiefs and heads of families at the end of the prayers:
a- Number of free water wells for crops and livestock
b- Number of free wells or waterholes for so called drinking
water
c- Number of paying water wells or waterholes (National
Water Company taps)
d- Average cost of a pail (between 10 and 20 liters) of water
in CFA francs
e- One or more motorcycles in the village (less than 2 years
old)
f- Motorized (petrol) pumps for irrigation of onions or
other crops
g- Wires for electricity distribution
h- Cell phone owned by the community agents
i- Cell phone owned by the village chief or other inhabit-
ants in his concession (extended family consisting of the
father, one or more wives and their children. The com-
munity agents recorded widows and grandparents as part
of their children’s concession).
j- Number of goats per extended family (concession)
k- Number of oxen per concession
l- Number of oxen per village chief
m- Distance (m) of concessions from free waterholes pro-
siding so-called “drinking water”
n- Distance (m) of concessions from paying waterholes
providing so-called “drinking water”

RESULTS

Out of 250 villages (Kolofata district, Sahel region of
the Extreme North Province of Cameroon) the community
agents reported that the number of villages where the ani-
mal population represented <25 goats and 5 oxen was 0 and
the number of adults owning <1 goat was also 0. In 100% of
villages the herd of oxen was >1. In 2011, the number of
water sources actively maintained and used at a distance of
<500 m was 0 in 25% of the villages, and in one third of the
villages the distance to the waterhole for drinking water was
>2000 m. In 20% of the villages with herds >500 oxen the
distance to the wells was >2000 m.

As indicated in Table 1, no significant link was found
between the number of free water wells for the crops and
livestock and the number of free wells or waterholes for so-
called drinking water or the number of free water wells for
crops and livestock and the number of paying water wells or
waterholes (taps with water counters installed by the Came-
eroon National Water Company).

The cost in CFA francs of a pail of water (between 10
and 20 liters) in paying waterholes remained the same
throughout the region: 5 CFA francs (1 cent USD, monthly
income per extended family ≤25 USD). The association be-
tween the number of free water wells for crops and live-
stock and the average cost of a pail of water in francs as not
statistically significant. In 2011, motorcycles, cell phones
and satellite dishes for television reception can be seen in
more than 60% of the villages. The cost for the construction
of different types of wells estimated by the village chiefs,
and verified by the community health workers and by the
nurses is indicated in Table 2. These results strongly over-
rule a direct association between technological progress and
access to water.

Table 1. Association of parameters registered in 50 randomized villages or neighborhoods in the District of Kolofata, Extreme North Province, Cameroon (2011)

|                        | a  | b  | c  | d  | e  | f  | g  | h  | i  | j  | k  | l  | m  | n  |
|------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| a- crops/ livestock free wells | ** |    |    |    |    |    |    |    |    |    |    |    |    |    |
| b- free drinking water   |    | ** |    |    |    |    |    |    |    |    |    |    |    |    |
| c- paying wells/waterholes|    |    | ** |    |    |    |    |    |    |    |    |    |    |    |
| d- average cost of a pail of water |    |    |    | ** |    |    |    |    |    |    |    |    |    |    |
| e- motorcycles           |    |    |    |    | x  |    |    |    |    |    |    |    |    |    |
| f- motorized pumps       |    |    |    |    | x  |    |    |    | x  |    |    |    |    |    |
| g- electricity wires     |    |    |    |    |    |    |    | x  |    |    |    |    |    |    |
| h- agent’s cell phones   |    |    |    |    |    | x  |    |    | x  |    |    |    |    |    |
| i- chief’s cell phones   |    |    |    |    |    |    | x  |    | x  |    |    |    |    |    |
| j- goats/concession      |    |    |    |    |    |    |    |    |    |    |    |    | x  |    |
| k- oxen/concession       |    |    |    |    |    |    |    |    |    |    |    |    |    | x  |
| l- oxen/village chief    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| m- distance to free water|    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| n- distance to paying water|    |    |    |    |    |    |    |    |    |    |    |    |    |    |

white squares: lack of association; x: significant (positive) association (p < 0.5); **: significant (inverse) association (p < 0.5)
DISCUSSION

Trachoma control requires water availability, access to latrines and reduction in the density of flies in the environment. The results of the present study carried out in the Sahel region where active trachoma reaches proportions of ≥25% show that the distance required to fetch water (almost always by women, whether pregnant or not) is not linked to the wealth of the villages or technological progress.

Clean faces may be less attractive to flies, reducing transmission of *Chlamydia* [18–20]. Improved facial cleanliness (absence of ocular and nasal discharge) exerted a tangible impact on the reduction of transmission of trachoma as well as reducing auto-reinfection [3, 19, 20–22].

The prevalence of severe trachoma in children with dirty faces compared with children with clean faces showed a more than three-fold increase in cross-sectional surveys. The quantity of water used by the household may be a good predictor of trachoma; and a positive association was found between the distance to the water source and the prevalence of active trachoma [6, 18, 22–25].

Several surveys reported that the prevalence of active trachoma was significantly reduced in dwellings where the distance to water (round trip to water source) was below a threshold of 30 minutes [23–26]. Families with trachoma in Gambia used less water for washing their children than families without trachoma, and this was independent of the amount of water available, suggesting that the amount of water used for personal hygiene is an essential factor in determining further actions for the elimination of blinding trachoma [27].

In the present study, more than 15 goats and 10 oxen were observed in the 50 randomized villages out of 250 in the district. Considering the cost of a well, it is reasonable to assume that if the village chiefs or heads of families make some livestock available, access to water and the living conditions of women—who often suffer the hardship of having to fetch water—would be improved. However, the results of this survey, in which villages with no access to water had quite numerous livestock need to be interpreted in the specific historical and cultural framework. In fact, the critical analysis of our observations over 2010 and 2011 opens up the question of the universality of inter-personal solidarity.

In Western society, the concept of social solidarity is relatively recent, especially since Léon Bourgeois’ work at the beginning of the 20th century [28]. For him, solidarity was the “mutual responsibility that is established between two or more people with a connection that obligates human beings to one another” [29].

The aim of our work with the village inhabitants is not to criticize the lack of sharing or distribution of property, but to heighten people’s perception of contributing something themselves, with the understanding that a goat is in fact a significant contribution. The idea of social solidarity should be deliberated as a form of non-religious humanitarianism based on a social connection that constitutes a kind of debt that each person owes to his or her group. Indeed, all organisms function only as a result of the cooperation of their individual parts with the whole [28–30].

The environment change component of trachoma-control programs generally incorporates elements of increasing water availability, improving access to latrines, reducing the density of flies in the environment, and avoiding crowding, especially in sleeping areas, as well as health education to facilitate the uptake of more hygienic behavior. The high cost of behavioral intervention was reported as a major limitation for intensive hygiene education applicability to non-research settings [21–25]. According to the analysis performed in this study, it could be hypothesized that social solidarity, without extra cost, would widen the scope of the SAFE strategy, making it not only a CHANCE (which is the acronym for SAFE in French), but CHANCES (with the S standing for the plural of chance and for the concept of solidarity, equally valid in the English language).

In conclusion, the results of the present study indicate that the lack of water in trachomatous districts is not linked systematically with a lack of means for digging wells at the village level. Consequently, the addition of the concept of

| Characteristics of the well for water supply | Price (expressed in herd) | Number of goats | Number of oxen |
|---------------------------------------------|--------------------------|----------------|---------------|
| Lined shaft well (between 8 and 15 meters) without requiring drilling through rock for watering, clothes washing and livestock | 15–25 | 0.5–2 |
| Lined shaft well (between 8 and 15 meters) requiring drilling through rock for watering, clothes washing and livestock | 25–35 | 1–3 |
| Drinking water well (lined shaft of between 30 and 80 meters without requiring drilling through rock) | 50–200 | 3–15 |
| Drinking water well (lined shaft of between 30 and 80 meters requiring drilling through rock) | 100–200 | 5–30 |
social solidarity to the awareness guides for neglected diseases and neglected populations [1, 30–31] deserves to be gauged to determine whether inter-personal social solidarity can release certain extremely deprived regions from the dead end of having to wait for external assistance to achieve access to water.

CONFLICT OF INTEREST

None

REFERENCES

1. Mariotti SP, Pascolini D, Rose-Nussbaumer J. Trachoma: global magnitude of a preventable cause of blindness. Br J Ophthalmol 2009; 93: 563–568.
2. Dean D, Kandel RP, Adhikari HK, Hessel T. Multiple Chlamydiaceae species in trachoma: implications for disease pathogenesis and control. PLoS Med 2008; 5: e14.
3. Kuper H, Solomon AW, Buchan J, Zondervan M, Foster A, Mabey D. A critical review of the SAFE strategy for the prevention of blinding trachoma. Lancet Infect Dis 2003; 3: 372–381.
4. Amza A, Goldschmidt P, Einterz E, Huguet P, Olmiere C, Bensaid P. Bella-Assumpta L. Elimination of active trachoma after two topical mass treatments with azithromycin 1.5% eye drops. PLoS Negl Trop Dis 2010; 4(11): e895.
5. Rog M, Swenor B, Cajás-Monson LC, McHive W, Kiboko S, Mkocha H, West S. A Cross-Sectional Study of Water and Clean Faces in Trachoma Endemic communities in Tanzania. BMC Public Health 2011; 11: 495.
6. Tielsch JM, West KP Jr, Katz J, Keyvan-Larjani E, Tizazu T, Schwab L, Johnson GJ, Chirambo MC, Taylor HR. The epidemiology of trachoma in southern Malawi. Am J Trop Med Hyg 1988; 38: 393–399.
7. Lynch M, West SK, Mmbaga BB, Katala SJ, Turner V, Lynch M, Muñoz B, Rapoza PA. Hygiene factors and increased risk of trachoma in central Tanzania. Arch Ophthalmol 1989; 107: 1821–1825.
8. Amza A, Goldschmidt P, Afghani T, Nadeem M, Ali-Khan W, Chaumeil C, de Barbeyrac B. Clinical and microbiological diagnosis of trachoma in children living in rural areas in the district of Attock, Punjab, Pakistan. Ophthalmic Epidemiol 2006; 13: 335–342.
9. Gürraşin A, Gülülü G. Prevalence of trachoma in eastern Turkey. Int J Epidemiol 1997; 26: 436–442.
10. Goldschmidt P, Vanzinzi Zago V, Diaz Vargas L, Espinoza Garcia L, Morales Montoya C, Peralta B, Mercado M. Chlamydia trachomatis in the conjunctiva of children living in three rural areas in Mexico. Rev Panam Salud Publica 2007; 22: 29–34.
11. Bailey R, Bottazzi ME, Franco-Paredes C, Ault SK, Periago MR. The neglected tropical diseases of Latin America and the Caribbean: A review of disease burden and distribution and a roadmap for control and elimination. PLoS Negl Trop Dis 2008; 2: e300.
12. Miller H, Gallego G, Rodríguez G. Clinical evidence of trachoma in Colombian Amerindians, Vaupés Province. Biomédica 2010; 30: 432–439.
13. West S, Muñoz B. Trachoma in Latin America: an opportunity for elimination. Biomédica 2010; 30: 315–316.
14. Schneider MC, Aguilera XP, Barbosa da Silva Junior J, Ault SK, Najera P, Martinez J, Riquero J, Nicholls RS, Yadon Z, Silva JC, Leanes LF, Periago MR. Elimination of neglected diseases in Latin America and the Caribbean: a mapping of selected diseases. PLoS Negl Trop Dis 2011; 5(2): e964.
15. Michel CE, Roper KG, Divena MA, Lee HH, Taylor HR. Correlation of clinical trachoma and infection in Aboriginal communities. PLoS Negl Trop Dis 2011; 5(3): e986.
16. Adams KS, Burgess JA, Dharmage SC, Taylor H. National Trachoma Surveillance and Reporting Unit. Trachoma surveillance in Australia, 2009. A report by the National Trachoma Surveillance and Reporting Unit. Commun Dis Intell 2010; 34: 375–395.
17. Elarab GE, Khan M. Estimation of the prevalence of trachoma in Egypt. Br J Ophthalmol 2010; 94: 392.
18. West SK, Muñoz B, Lynch M, Kayongoya A, Mmbaga BB, Taylor HR. Risk factors for constant, severe trachoma among preschool children in Kongwa, Tanzania. Am J Epidemiol 1996; 143: 73–78.
19. Roba AA, Wondimu A, Patel D, Zondervan M. Effects of intervention with the SAFE strategy on trachoma across Ethiopia. J Epidemiol Community Health 2011; 65: 626–631.
20. Emerson PM, Bailey RL, Walraven GE, Lindsay SW. Human and other faeces breeding media of the trachoma vector Musca sorbens. Med Vet Entomol 2001; 15: 314–320.
21. Cairncross S, Feachem R. Environmental health engineering in the tropics. 2nd ed. London: John Wiley & Sons; 1993.
22. Lynch M, West SK, Muñoz B, Kayongoya A, Taylor HR, Mmbaga BB. Testing a participatory strategy to change hygiene behaviour: face washing in central Tanzania. Trans R Soc Trop Med Hyg 1994; 88: 513–517.
23. Marshall CL. The relationship between trachoma and piped water in a developing area. Arch Environ Health 1968; 17: 215–220.
24. West S, Lynch M, Turner V, Munoz B, Rapoza P, Mmbaga BB, Taylor HR. Water availability and trachoma. Bull World Health Organ 1989; 67: 71–75.
25. Hachschmann A, Metcalfe N, Kanjaloti S, Godia H, Mtambo O, Chipeta T, Barrows J, Witte C, Courtright P. Reduction of trachoma in the absence of antibiotic treatment: evidence from a population-based survey in Malawi. Ophthalmic Epidemiol 2001; 8: 145–153.
26. West S, Muñoz B, Lynch M, Kayongoya A, Chilangwa Z, Mmbaga BB, Taylor HR. Impact of facewashing on trachoma in Kongwa, Tanzania. Lancet 1995; 345: 155–158.
27. Bailey R, Downes B, Downes R, Mabey D. Trachoma and
water use; a case control study in a Gambian village. Trans R Soc Trop Med Hyg 1991; 85: 824–828.
28. Leon Bourgeois. Solidarite. Presses universitaires du Septentron, Villeneuve-d’Ascq. 1998 ISBN-:2859395407 9782859395407.
29. Steinar Stjerno. Solidarity in Europe: The History of an Idea. Cambridge University Press. 2009. ISBN-13: 978-0521605113.
30. Beland D. Back to Bourgeois? French social policy and the idea of solidarity. International Journal of Sociology and Social Policy 2009; 29: 445–456.
31. Hotez PJ, Mistry N, Rubinstein J, Sachs JD. Integrating neglected tropical diseases into AIDS, tuberculosis, and malaria control. N Engl J Med 2011; 364: 2086–2089.