Preventing trachoma through environmental sanitation: a review of the evidence base

A. Prüss[1] & S.P. Mariotti[2]

A review of the available evidence for the associations between environmental sanitation and transmission of trachoma was undertaken with a view to identifying preventive interventions. The WHO Global Alliance for the Elimination of Trachoma by the Year 2020 (GET2020) has adopted the ''SAFE'' strategy, consisting of four components: Surgery, Antibiotic treatment, promotion of Facial cleanliness and initiation of Environmental changes.

This review of 19 studies selected from the 39 conducted in different parts of the world shows that there is clear evidence to support the recommendation of facial cleanliness and environmental improvements (i.e. the F and E components of the SAFE strategy) to prevent trachoma. Person-to-person contact and flies appear to constitute the major transmission pathways. Improvement of personal and community hygiene has great potential for a sustainable reduction in trachoma transmission. Controlled clinical trials are needed to estimate the relative contribution of various elements to the risk of transmission of trachoma and the effectiveness of different interventions. These could show the relative attributable risks and effectiveness of interventions to achieve improvement of personal hygiene and fly control by environmental improvements, alone or in combination, and with or without antibiotic treatment.

Keywords: clinical trials; cross-sectional studies; evidence-based medicine; sanitation; trachoma, prevention and control, and transmission.

Voir page 264 le résumé en français. En la página 264 figura un resumen en español.

Introduction

This review of the available evidence for the associations between environmental sanitation and hygiene and transmission of trachoma was undertaken with a view to identifying preventive interventions. Trachoma is an infection of the eye caused by *Chlamydia trachomatis*, which may result in blindness after repeated reinfections. The disease remains the main cause of preventable blindness globally (*1*). WHO has therefore initiated a Global Alliance for the Elimination of Trachoma by the Year 2020 (GET2020). The alliance has adopted the "SAFE" strategy, consisting of four components to give a combined medical, behavioural and environmental approach: Surgery of trachomatous trichiasis; Antibiotic treatment of active cases; promotion of Facial cleanliness; and initiation of Environmental changes to reduce the transmission of trachoma.

The association between personal and environmental sanitation and hygiene and trachoma transmission has been noted previously (*2–4*). There is, however, still the need to investigate the role played by poor personal and environmental hygiene in the light of recent studies, and to guide the F and E components of the SAFE strategy.

This article also establishes a framework for assessing the impact of environmental sanitation on a specific disease, providing a "case example" of how environmental factors may influence disease transmission and control.

Literature search

Studies were identified through MEDLINE EXPRESS (1966–99) and HEALTHSTAR (1990–99). The keywords used for the searches included trachoma, hygiene, education, sanitation, face-washing, water, latrine, toilet, environment, flies and *Musca*. The searches were not restricted to English language articles. References cited in identified studies were checked for additional articles. Literature mentioned at the Third Meeting of the WHO Global Alliance for the Elimination of Trachoma (19–20 October 1998) was also included. Finally, three reviews undertaken about 10 years ago were checked for further studies.

Mechanisms of trachoma transmission

The literature was searched as described above for information on all transmission mechanisms for trachoma and the relative importance of transmission pathways. Relatively few publications were found on the role of flies (*5–8*). One study investigated the effect on trachoma transmission of reducing the fly population (*9*). The main findings were as described below.

[1] Technical Officer, Water, Sanitation and Health, Protection of the Human Environment, World Health Organization, 1211 Geneva 27, Switzerland. Correspondence should be addressed to this author.

[2] Medical Officer, Prevention of Blindness and Deafness, Injury Prevention and Rehabilitation, World Health Organization, Geneva, Switzerland.

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- The secretions of the eyes of infected persons contain the infective agent, *C. trachomatis* (*7*).
- The transmission of *C. trachomatis* by the housefly, *Musca domestica*, and by *M. sorbens* is possible under laboratory conditions (*5, 8*).
- Chlamydiae can be isolated from flies feeding at the eyes of children; although one reference did not specify the type of fly (*5*), another specified that the most likely insect vector was *M. sorbens* (*9*).

These findings indicate that flies are probably involved in trachoma transmission. Several types of flies may be implicated; the relative importance of each may vary according to region (*6*).

Several results reported by epidemiological studies also support the involvement in transmission of direct contact and personal hygiene, measured through factors such as crowding (*10, 11*) and the number of siblings with trachoma (*12–14*).

Evidence of environmental causation

Studies addressing the associations of interest for environmental causes of trachoma transmission were searched as described above. Studies were excluded if they did not satisfy the following criteria: use random selection for inclusion of study participants; use multivariate analysis with analysis of major confounders; describe exposure to risk factors quantitatively; provide information on the significance of the results; use an adequate sample size — at least 130 study participants are required to permit detection of a significant relative risk (RR) or odds ratio (OR) of 3 with a power of 80% and a confidence interval of 95%.[a]

Of the 39 studies identified (*9–47*), 19 were selected (Table 1) (*9–27*). Of these, four were clinical trials (of which three are listed in the Cochrane Library (*48*)), and 15 were observational surveys. Parameters of interest analysed in these studies include water availability, garbage collection, absence of latrine/toilet, frequency of face-washing, facial cleanliness, personal hygiene, fly density, presence of animals inside the house and indoor air quality.

Study results

The results are summarized in Table 2.

Water availability was analysed by measuring access to a water source, in terms of walking time or distance, availability of water inside the house or daily water quantity in the house. The median protective effect on trachoma prevalence for improved access to water was 27% (range, 11–83%) when considering distance to the water source. Six studies had positive results (*10, 12, 17, 19, 24*), one study had non-significant results (*13*) and one had negative results (*27*). The influence of the quantity of available water was positive in two studies, with a median protective effect of 21% and 76%, respectively (*17, 18*), and non-significant in one study (*24*). The availability of piped water inside the house also had a significant protective effect in one study (*18*).

The presence of a latrine was reported to be significant by all four studies that investigated this parameter, with a median reduction of trachoma prevalence of 28% (*12, 16, 18, 22*, *27*).

Garbage collection showed a median protective effect of 69% in two studies (*11, 18*).

The presence of animals inside the house was assessed by one study as being non-significant (*11*).

While sleeping next to a cooking fire exhibited a negative effect in two studies (*22, 24*), cooking in a central room had a protective effect in another (*11*). Traditional cooking usually creates smoke in the room, which tends to decrease fly density. On the other hand, the use of one central room for cooking and sleeping (i.e. crowding, which also plays a role in trachoma transmission) may have influenced the results.

Four of the studies that investigated the impact of flies on the faces of children or fly density on trachoma showed a protective effect for fewer flies (*14, 15, 22, 23*), and one reported a non-significant result (*25*), with a 39% median reduction in prevalence of trachoma.

Facial cleanliness was reported by four studies to be inversely associated with the prevalence of trachoma in children (*13, 22, 24, 25*) and as non-significant by one study (*14*). The median protective effect was 41%. Frequency of face-washing was non-significant in the three studies that investigated the impact of this parameter (*12, 18, 26*).

Satisfactory personal hygiene was reported by one study to have a positive impact by reducing trachoma prevalence by 48% (*19*).

A clinical trial of the effects of introducing a community-based care group into a selected community reduced the prevalence of trachoma by 62% over a study period of 3 years, while the reduction in the control community was negligible (*21*). A clinical trial providing mass treatment with topical tetracycline, accompanied or not by a face-washing intervention programme, showed that a sustainable clean face had a significantly protective effect against constant severe trachoma (*13*). Another clinical trial found that a health education programme did not improve the effectiveness of mass treatment campaigns; there was even a negative interaction between the two interventions (*20*).

A clinical trial investigating the effect of reducing the fly population (*9*) reported a decrease of 75% in new trachoma cases compared with the control group.

Discussion

The validity of the studies covered here can be affected by several factors. The main bias may arise because environmental risk factors, such as water

[a] Using Epi Info 6, version 6.04, 1997 Centers for Disease Control and Prevention and World Health Organization.

Table 1. **List of selected studies**

Year	Country	Study type	Risk factors investigated	Ref.
1999	Gambia	Clinical trial	Fly density	*9*
1997	Ethiopia	Cross-sectional survey	Water availability, absence of toilet/latrine	*27*
1996	United Republic of Tanzania	Clinical trial	Water availability, facial cleanliness	*13*
1995	Mali	Clinical trial	Hygiene education	*20*
1992	United Republic of Tanzania	Cross-sectional survey	Fly density	*15*
1992	Brazil	Cross-sectional survey	Water availability, absence of toilet/latrine, garbage collection, frequency of face-washing	*18*
1992	Ethiopia	Cross-sectional survey	Garbage collection, animals in house, indoor air quality	*11*
1991	Egypt	Cross-sectional survey	Absence of toilet/latrine	*16*
1991	United Republic of Tanzania	Cross-sectional survey	Fly density, facial cleanliness	*14*
1991	United Republic of Tanzania	Cross-sectional survey	Facial cleanliness	*25*
1989	United Republic of Tanzania	Cross-sectional survey	Absence of toilet/latrine, indoor air quality, fly density, facial cleanliness	*22*
1989	United Republic of Tanzania	Cross-sectional survey	Water availability, indoor air quality, facial cleanliness	*24*
1988	United Republic of Tanzania	Cross-sectional survey	Fly density	*23*
1988	Malawi	Cross-sectional survey	Water availability, absence of toilet/latrine, frequency of face-washing	*12*
1987	Mexico	Cross-sectional survey	Facial cleanliness	*26*
1983	South Africa	Clinical trial	Hygiene and environment education	*21*
1970	India	Cross-sectional survey	Water availability, personal hygiene	*19*
1969	China (Province of Taiwan)	Cross-sectional survey	Water availability	*10*
1968	Morocco	Cross-sectional survey	Water availability	*17*

availability, presence of latrine and garbage collection, tend to occur together in the same families and confound each other, unless sufficient control for this effect is introduced. This would lead to an overestimation of the studied association. By considering less "distant" risk factors, which are more directly related to the transmission mechanisms, such as fly density or facial cleanliness (*9, 13–15, 22, 23, 25*), confounding would be reduced. In addition, the relation of trachoma to environmental risk factors affecting more than one particular household (e.g. the effects of absence of latrine or garbage collection, or fly density) could lead to a non-differential misclassification bias when assessing outcomes and risk factors on an individual rather than a community basis. This would result in an underestimation of effect. Therefore, studies that assess these risk factors and the outcome on a community basis (*9, 21, 22*) would be expected to be more accurate. In studies that include children and adults, the effects of risk factors will be lower than in those investigating children only. Since prevalence in children is usually higher, the inclusion of adults leads to a "diluting" effect unless transmission mechanisms are different. In summary, studies that define the study unit precisely and assess less distant risk factors are expected to be the most accurate. In this review they are, therefore, given more weight in the evaluation of evidence.

Causation of trachoma by "unclean environments" fostering the proliferation or attraction of flies (i.e. uncollected excreta or garbage) can be considered as the most likely interpretation of the results, according to Bradford Hill's "considerations" for causation in environmental studies (*49*).

- The strength of association was verified by relative risks ranging between 1 and 4.
- The association of interest was consistent in studies carried out in several countries.
- The association was specific, since the exposures to flies were related to a specific pathogen.
- The associations were temporally consistent, since exposures were usually continuously present.

Table 2. **Summary of study results**

Risk factor	RR /OR[a] for case–control studies	Risk factor studied	Measure of outcome	Results, attributable risks or benefits from interventions	Ref.
Water availability		Distance to water source:	Active trachoma	35% reduction for attached vs >500 m	*10*
	1.13 (1.08–1.19)[b,c]	<49 m vs attached			
	1.24 (1.15–1.45)[c]	50–99 m vs attached			
	1.27 (1.13–1.44)[c]	100–199 m vs attached			
	1.35 (1.17–1.56)[c]	200–499 m vs attached			
	1.55 (1.34–1.78)[c]	>500 m vs attached			
		Distance to water source:	Active trachoma	11% reduction for <500 vs >2500 m	*17*
	1.12 (1.03–1.22)[c]	>2500 vs >500 m			
	1.15 (1.01–1.35)[c]	1500–2000 vs <500 m			
	0.91 (0.80–1.05)	500–1500 vs <500 m			
		Water use per person:	Active trachoma	21% reduction for >10 vs <5 l/day	*17*
	1.26 (1.09–1.45)[c]	<5 vs >10 l/day			
	1.18 (1.03–1.35)[c]	5–10 vs >10 l/day			
	4.24 (2.78–6.47)[c]	Water use in household <5000 vs >5000 l/month	TF/TI [d] present in household	76% reduction for >5000 vs <5000 l/month	*18*
	5.21 (1.89–14.41)[c]	No piped water vs pipe inside	TF/TI present in household	81% reduction inside vs no pipe; 83% reduction for outside vs no pipe	*18*
	5.83 (3.89–8.72)[c]	Pipe outside vs pipe inside			
	1.41(1.31–1.50)[c]	Water supply source beyond vs within 180 m	Active trachoma	29% reduction for source within vs beyond 180 m	*19*
	1.34, $P = 0.01$[c]	Walking time to water source >60 vs <5 min	TI in children of <6 years	26% reduction for walking time to source <5 vs >60 min	*12*
	1.9 (0.9–1.9)	Walking time to water source >2 vs <2 hours	Constant severe trachoma in children of 1–7 years	NS[e]	*13*
		Walking time to water source:	TF/TI in at least one child of 1–7 years in household	27% reduction for <0.5 vs >2 hours; 31% reduction for <0.5 vs 0.5–2 hours	*24*
	1.37 (1.01–1.87)[c]	>2 vs <0.5 hours			
	1.45 (1.08–1.95)[c]	0.5–2 vs <0.5 hours			
		Water used in household:	TF/TI in at least one child of 1–7 years in household	NS	*24*
	1.19 (0.87–1.64)	>45 vs<25 l/day			
	0.99 (0.74–1.32)	25–45 vs <25 l/day			
	0.82 (0.69–0.98)[c]	Walking time to water source 16–30 vs <16 min	TF/TI	18% increase for time to water source 16–30 vs <16 min	*27*
Absence of toilet/latrine	3.3 (1.6–6.2)[c]	Absence of latrine	TI in children of 1–5 years	70% reduction for presence of latrine	*16*
	3.76 (1.76–8.04)[c]	No toilet vs toilet with flush	TF/TI present in household	81% reduction for toilet with flush vs no toilet or toilet without flush	*18*
	6.07 (3.91–9.43)[c]	Toilet without vs with flush			
	1.39 (1.11–1.72)[c]	Latrine absent vs present	TI in children of 1–7 years	28% reduction for presence of latrine	*22*
	1.20, $P = 0.0001$[c]	Latrine absent vs present	TI in children of <6 years	17% reduction for presence of latrine	*12*
	1.23 (1.10–1.38)[c]	Latrine absent vs present	TF/TI	19% reduction for presence of latrine	*27*
Garbage collection	4.12 (2.51–6.74)[c]	No vs daily collection	TF/TI in household	75% reduction for daily collection; 72% reduction for irregular collection	*18*
	3.62 (2.23–5.86)[c]	Irregular vs daily collection			
	2.70 (2.29–3.19)[c]	Garbage including faeces <20 vs >20 m from house	Trachoma	63% reduction for garbage >20 vs <20 m from house	*11*
Animals	1.47 (0.995–2.17)	Animals inside house vs no animals inside house	Trachoma	NS	*11*
Indoor air quality	2.66 (2.21–3.21)[c]	Cooking in separate room vs cooking in central room	Trachoma	62% reduction for cooking in central room vs in separate room	*11*
	1.24 (1.08–1.43)[c]	Cooking fire in sleeping room, yes vs no	TI in children of 1–7 years	19% reduction for no cooking fire in sleeping room	*22*

Table 2. **Summary of study results, cont.**

Risk factor	RR /OR[a] for case–control studies	Risk factor studied	Measure of outcome	Results, attributable risks or benefits from interventions	Ref.
	1.48 (1.14-19.2)[c]	Sleeping next to a cooking fire, yes vs no	TF/TI in at least one child of 1–7 years in household	32% reduction for not sleeping next to cooking fire	*24*
Fly density	0.25 (0.09–0.64)[c]	Approximately 75% reduction in muscid flies	Trachoma	75% reduction with approximately 75% reduction of muscid flies	*9*
	1.87 (1.47–2.38)[c]	Children with vs without face flies	TF/TI in children of 1–7 years	46% reduction for children without vs with face flies	*15*
	1.62 (1.06–2.49)[c]	Household-fly score in dry season >3 vs <3	TF/TI in children of 1–7 years	38% reduction for household-fly score <3 vs >3	*15*
	0.60 (0.34–1.06)	Household-fly score for wet season			*15*
	1.63 (1.17–2.29)[c]	Fly score >7 vs <3	TI in children of 1–7 years	39% reduction for fly score <7; 26% reduction for fly score 3–6	*22*
	1.36 (1.26–2.18)[c]	Fly score 3–6 vs <6			
	1.39 (1.09–1.77)[c]	Fly score >6 vs 0	TI in children of 1–7 years	28% reduction for fly score 0 vs >6	*23*
	1.28 (1.00–1.65)	Fly score 3–5 vs 0			
	0.96 (0.69–1.33)	Fly score 1–2 vs 0			
	1.11 (1.03–1.20)[c]	Risk per increase of one fly	TF/TI in children of 1–7 years	10% reduction for decrease of one fly	*14*
	1.37 (0.93–2.00)	1–2 flies vs no flies on face	TF/TI in children of 1–7 years	NS	*25*
Facial cleanliness	1.72 (1.17–2.50)[c]	Unclean vs clean face	TI in children of 1–7 years	42% reduction for clean face	*22*
	1.30 (1.11–1.54)[c]	Unclean vs clean face	TF/TI in children 1–7 years	23% reduction for clean face	
	0.4 (0.3–0.7) [c]	Sustainable clean face, yes vs no	Constant severe trachoma in children of 1–7 years	60% reduction for sustainable clean face	*13*
	1.13 (0.83–1.54)	Unclean vs clean face	TF/TI in children of 1–7 years	NS	*14*
	1.74 (1.19–2.55)[c]	Nasal discharge and flies, yes vs no	TF/TI in children of 1–7 years	43% reduction for no nasal discharge or flies	*25*
		Clean face:	TF/TI in children of 1–7 years	41% reduction of no vs all children in household with clean faces	*24*
	1.70 (1.22–2.35)[c]	all vs no children			
	1.30 (0.82–2.08)	some vs no children			
Frequency of face-washing	Not significant; data do not permit calculation of RR	Not stated	TF/TI present in household	NS	*18*
	1.20, $P = 0.57$	Frequency of face-washing <1 vs >2 times/day	TI in children of <6 years	NS	*12*
	Not significant; data do not permit calculation of RR	Frequency of face-washing <7 vs >7 times/week	TI in children of <10 years	NS	*26*
Hygiene	Negative effect ($P = 0.03$)	Treatment with vs without health education programme in village	TF/TI	Negative effect of health education programme	*20*
	2.4 (1.1–5.1) [c]	Health education alone		58% reduction for health education	
	2.63 (1.41–4.91)[c]	Care group promoting hygiene and environmental education, yes vs no	Intense trachoma in children of 0–6 years	62% reduction with care group	*21*
	1.93 (1.43–2.61)[c]	Poor vs satisfactory or good hygiene	Active trachoma	48% reduction for satisfactory vs poor hygiene; 32% reduction for satisfactory vs fair hygiene	*19*
	1.46 (1.07–1.98)[c]	Fair vs satisfactory or good hygiene			

[a] RR/OR = relative risk/odds ratio.

[b] Figures in parentheses are 95% confidence intervals.

[c] Significant result for 95% confidence interval.

[d] TF/TI = follicular trachoma/inflammatory trachoma.

[e] NS = not significant.

- The biological gradient was verified in most of the few studies in which it was investigated.
- The relationship is plausible, since laboratory trials have shown the ability of flies to carry the pathogens, and breeding and attraction places are known for these flies.
- The results are coherent, since the cause-and-effect interpretation of the data does not conflict with previous knowledge of the disease.
- Preventive action has been shown in two experiments (*9, 21*).
- There is analogy to the transmission of a number of other diseases by flies, although not with this specific pathogen.

For unclean faces, the criteria for causation are similarly fulfilled, although the results are less consistent. Experimental results did not show a systematic effect when hygiene education was associated with a mass treatment campaign (*13, 20*). Although only two clinical trials investigated this association, this may indicate that other important transmission factors were not considered.

Causation by more distant risk factors is less evident. For example, the direct relationship with distance to water source and water quantity used in the house (*24*), or with frequency of face-washing was not always verified. Nevertheless, the review results strongly suggest that water availability has a positive effect, decreasing trachoma prevalence.

Overall, the results indicate that trachoma transmission is a function of fly density, its endemicity and personal hygiene, including facial cleanliness and person-to-person contact. However, direct quantitative conclusions on the relative attributable risks of transmission cannot be drawn. The three factors are related to each other; for example, an increase in unclean infected eyes will lead to an increase in pathogen-carrying flies; and an increase in pathogen-carrying flies will in turn tend to infect more eyes. Person-to-person contact and flies seem to play a significant role and constitute the major transmission pathways for trachoma. On the basis of the best available data for the environments studied, the role of flies seems to be of greater importance, which suggests that an attributable risk for trachoma transmission by flies of 50% should be considered to be conservative. This is supported by the studies in this review, which were selected for their methodological quality and were conducted in a wide variety of countries. However, the attributable fractions may vary according to local levels of hygiene, trachoma prevalence, and fly density in the community. These findings do not suggest that flies are the single most important mode but that they carry a major weight in trachoma transmission. For example, qualitative observations on hyperendemic trachoma reported it to occur even with low fly densities (*46*).

Only two studies assessed hygiene practices and flies in the same communities (*14, 22*). One showed that an increased number of flies around the house was a predictor of presence of infection, while the association of facial cleanliness with infection was not significant (*14*). The other showed similar relative risks for poor facial cleanliness (1.72; 95% confidence interval (CI) = 1.17–2.50) and household fly density (for high fly counts: 1.63; 95% CI = 1.17–2.29) (*22*).

In addition to transmitting trachoma, flies have been shown to carry a wide variety of pathogens, and the reduction of their population by environmental improvements may thus contribute to a decline in other endemic diseases in the community. Environmental improvements that have been demonstrated to contribute significantly to the prevention of trachoma (such as access to water) are also associated with a wide range of health, social and economic benefits.

In terms of preventive action, it is likely that both hygiene education and fly control by environmental improvements have a significant impact. The specific effectiveness of these two interventions is, however, likely to depend on the existing levels of hygiene and fly density in the community. In a population where trachoma is endemic, an initial antibiotic treatment to reduce the reservoir of *C. trachomatis* will have an immediate impact, reducing trachoma prevalence in the short term, while hygiene and environmental improvements are likely to lead to a sustainable reduction. The effectiveness of interventions may also be affected by the dominant eye-seeking fly species in the local setting, and targeted actions to destroy breeding sites and attraction may be beneficial.

Recommendations

There is sufficient evidence to support the recommendation of facial cleanliness and environmental interventions (i.e. the F and E components of the SAFE strategy) to prevent trachoma. Several studies have suggested that reducing fly densities and hygiene education decrease transmission of trachoma. Personal and domestic hygiene appear to have great potential for a sustainable reduction in transmission. Effective antibiotic treatment of active cases would also assist in reducing the pathogen reservoir.

In order to improve the targeting of interventions, a better understanding of the relative contributions of the various elements to the risk of trachoma transmission and the effectiveness of different interventions is required. Controlled clinical trials are needed to determine the relative attributable risks and effectiveness of interventions to improve personal hygiene and fly control, alone and in combination. Baseline levels of hygiene, fly density and prevalence of trachoma should be assessed, since the relative importance of transmission mechanisms may vary according to the specific local circumstances. ■

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Résumé

Prévention du trachome par l'assainissement de l'environnement : analyse des faits

Cet article passe en revue les éléments qui plaident en faveur d'une association entre l'assainissement de l'environnement, l'hygiène, et la transmission du trachome, dans l'intention d'identifier des interventions à but préventif. L'Alliance OMS pour l'Elimination mondiale du Trachome d'ici 2020 a adopté la stratégie « CHANCE », qui comporte quatre éléments : **CH**irurgie du trichiasis, traitement **A**ntibiotique des cas de trachome évolutif, **N**ettoyer le visage pour prévenir la transmission de la maladie et **C**hanger l'**E**nvironnement.

On a examiné 19 études spécialement choisies parmi les 39 effectuées entre 1958 et 1998 dans différentes parties du monde. Ces études ont été répertoriées dans MEDLINE EXPRESS (1966-1999) et HEALTHSTAR (1988-1999). Les références citées dans ces articles ont également été étudiées. La recherche n'a pas été limitée aux articles rédigés en anglais.

On trouvera également dans le présent article un cadre servant à l'évaluation de l'impact de l'assainissement de l'environnement sur une maladie précise prise comme « cas d'école ».

On a mis en évidence un effet protecteur médian contre la transmission du trachome pour les paramètres environnementaux suivants : proximité d'une source d'eau, 27 % ; quantité d'eau disponible, 21 % ; présence de latrines, 24 % ; collecte des ordures ménagères, 69 % ; faible densité des mouches ou nombre réduit de mouches sur le visage des enfants, 39 % ; propreté du visage, 41 %. On a estimé que la densité des mouches et la propreté du visage associées au trachome devaient être moins sujettes à erreur, puisqu'elles sont plus étroitement impliquées dans les mécanismes de transmission. Des paramètres plus « distants », tels que la disponibilité en eau, la présence de latrines et la collecte des ordures ménagères, n'influent probablement sur la transmission que de façon indirecte. Par exemple, ils peuvent favoriser une toilette plus fréquente du visage ou réduire les gîtes larvaires et l'attraction exercée sur les mouches.

Les études ont été analysées en fonction de leur qualité méthodologique ; celles qui ont été considérées comme « plus précises » ont davantage pesé dans l'interprétation des résultats. Le lien de causalité entre le trachome et les « environnements sales » favorisant la prolifération des mouches ou l'attraction exercée sur elles est l'interprétation la plus vraisemblable que l'on puisse faire des résultats, selon les critères de Bradford Hill sur les relation de cause à effet rencontrées pour le trachome dans les études environnementales. Lorsque le visage n'est pas propre, ces critères sont remplis, même si les résultats sont moins uniformes. Les résultats expérimentaux n'ont pas montré un effet constant lorsqu'on associe l'enseignement de l'hygiène à une campagne de traitement de masse.

Ces résultats montrent que l'on dispose de suffisamment d'éléments pour recommander la propreté du visage et des interventions sur l'environnement (à savoir, les éléments N et CE de la stratégie CHANCE) pour prévenir le trachome. Plusieurs études laissent à penser qu'une diminution de la densité des mouches associée à un enseignement de l'hygiène permettent de diminuer la transmission du trachome. Les contacts interpersonnels et les mouches semblent bien constituer les principaux modes de transmission. L'amélioration de l'hygiène individuelle et communautaire offre une possibilité importante de réduire durablement la transmission. Le traitement des cas d'endémie serait une aide, car il permettrait de réduire le réservoir de germes pathogènes. Il serait utile de mieux connaître la contribution respective des divers éléments qui entrent en jeu dans le risque de transmission du trachome et l'efficacité des différentes interventions. Il faudrait procéder à des essais cliniques contrôlés pour déterminer les risques attribuables relatifs et l'efficacité des interventions pour ce qui est de parvenir à améliorer l'hygiène individuelle et la lutte contre les mouches, qu'elles soient associées ou appliquées isolément.

On a montré que, outre le fait qu'elles transmettent le trachome, les mouches étaient porteuses de toutes sortes de germes pathogènes et le fait de diminuer leur population en assainissant l'environnement pourrait donc permettre d'abaisser le nombre de cas d'autres maladies d'endémie dans la communauté. L'assainissement de l'environnement dont on sait qu'il pourrait ainsi contribuer grandement à la prévention du trachome (par exemple en facilitant l'accès à l'eau) est également associé à un large éventail d'effets positifs, tant sur le plan sanitaire que social et économique.

Resumen

Prevención del tracoma mediante el saneamiento ambiental: examen de la base científica

En el presente artículo se analiza la base científica disponible para relacionar el saneamiento ambiental, en particular la higiene, y la transmisión del tracoma; dicho estudio se realizó para identificar medidas preventivas. La Alianza Mundial OMS para la Eliminación del Tracoma para el Año 2020 ha adoptado la estrategia «SAFE», compuesta de cuatro elementos: corrección quirúrgica de la triquiasis tracomática, tratamiento antibiótico de los casos activos, fomento de la higiene facial e introducción de cambios ambientales.

El análisis abarcó 19 estudios específicamente seleccionados de los 39 realizados entre 1958 y 1998 en diferentes partes del mundo. Los estudios se identificaron mediante MEDLINE EXPRESS (1966-1999) y HEALTHSTAR (1988-1999). También se buscaron las referencias citadas en los artículos identificados y la

búsqueda no se limitó a los artículos redactados en inglés.

Este artículo facilita asimismo un marco para evaluar los efectos del saneamiento ambiental en una enfermedad concreta tomada como «ejemplo».

Se determinó la mediana del efecto protector en la reducción de la transmisión del tracoma para las siguientes variables ambientales: proximidad del agua, 27%; cantidad de agua disponible, 21%; existencia de letrinas, 24%; recogida de basuras, 69%; baja densidad o bajo número de moscas en la cara de los niños, 39%; e higiene facial, 41%. Se consideró que el número de moscas y la higiene facial eran las variables que menos se prestaban a confusión, dada su mayor implicación en los mecanismos de transmisión. Otras variables «distantes», como la disponibilidad de agua, la existencia de letrinas y la recogida de basuras posiblemente sólo influyen en la transmisión de un modo indirecto. Por ejemplo, pueden fomentar una higiene facial más frecuente o reducir los criaderos y el potencial de atracción de moscas.

Se analizó la calidad metodológica de los estudios, y al interpretar los resultados se dio más importancia a los estudios considerados «más exactos». Conforme a los criterios de Bradford Hill relativos a la causalidad en estudios ambientales, la interpretación más probable de los resultados es que existe una relación causa-efecto entre los «ambientes sucios» que fomentan la proliferación de moscas o atraen a estos insectos y el desarrollo de tracoma. Estos criterios de causalidad se cumplen igualmente en el caso de la falta de higiene facial, aunque los resultados son menos coherentes. Diversos resultados experimentales no han mostrado un efecto coherente en respuesta a la inclusión de medidas de educación sobre higiene en una campaña de tratamiento masivo.

Estos resultados revelaron que existen pruebas suficientes para apoyar la recomendación de fomentar la higiene facial y los cambios ambientales (los dos últimos componentes de la estrategia SAFE) a fin de prevenir el tracoma. Algunos estudios llevan a pensar que la reducción de la densidad de moscas y la educación sobre higiene conducen a la disminución de la transmisión del tracoma. El contacto personal y las moscas parecen ser las principales vías de transmisión. La mejora de la higiene personal y comunitaria posiblemente contribuye a la reducción sostenible de la transmisión. El tratamiento de los casos endémicos ayudaría a reducir el reservorio de patógenos. Convendría conocer más a fondo las contribuciones relativas de los diversos factores al riesgo de transmisión del tracoma, así como la eficacia de las diferentes intervenciones. Es preciso realizar ensayos clínicos controlados para determinar los riesgos relativos imputables y la eficacia de las intervenciones orientadas a mejorar la higiene personal y la lucha contra las moscas, ya se emprendan por separado o en conjunción.

Además de transmitir el tracoma, las moscas han demostrado ser portadoras de una gran diversidad de patógenos, por lo que la reducción de su densidad, mediante mejoras ambientales, puede ayudar a reducir otras enfermedades endémicas en la comunidad. Las mejoras ambientales que han demostrado contribuir considerablemente a la prevención del tracoma (como el acceso al agua) también se asocian con una gran variedad de beneficios sanitarios, sociales y económicos.

References

1. **Thylefors B et al.** Global data on blindness. *Bulletin of the World Health Organization*, 1995, **73**: 115–121.
2. **Marx R.** Social factors and trachoma: a review of the literature. *Social science and Medicine,* 1989, **29**: 23–34.
3. **Prost A, Négrel AD.** Water, trachoma and conjunctivitis. *Bulletin of the World Health Organization,* 1989, **67**: 9–18.
4. **Esrey SA et al.** Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis and trachoma. *Bulletin of the World Health Organization,* 1991, **69**: 609–621.
5. **Forsey T, Darougar S.** Transmission of chlamydiae by the housefly. *British Journal of Ophthalmology,* 1981, **65**: 147–150.
6. **Harwood RF, James MT.** Muscoid flies, and louse flies. In: *Entomology in human and animal health*, 7th ed. New York, Macmillan, 1979: 248–295.
7. **Darougar S et al.** Isolation of *Chlamydia trachomatis* from eye secretion (tears). *British Journal of Ophthalmology,* 1979, **63**: 256–258.
8. **Zardi O.** [Importance of ''*Musca domestica*'' in transmission of the trachoma virus]. *Nuovi Annali d'Igiene e Microbiologia,* 1964, **15**: 587–590 (in Italian).
9. **Emerson PM et al.** Effect of fly control on trachoma and diarrhoea. *Lancet,* 1999, **353**: 1401–1403.
10. **Assaad FA, Maxwell-Lyons F, Sundaresan T.** Use of local variations in trachoma endemicity in depicting interplay between socioeconomic conditions and disease. *Bulletin of the World Health Organization,* 1969, **41:** 181–194.
11. **Sahlu T, Larson C.** The prevalence and environmental risk factors for moderate and severe trachoma in southern Ethiopia. *Journal of Tropical Medicine and Hygiene,* 1992, **95**: 36–41.
12. **Tielsch JM et al.** The epidemiology of trachoma in southern Malawi. *American Journal of Tropical Medicine and Hygiene,* 1988, **38**: 393–399.
13. **West SK et al.** Risk factors for constant, severe trachoma among preschool children in Kongwa, Tanzania. *American Journal of Epidemiology,* 1996, **143**: 73–78. (See also: **West S et al.** Impact of face-washing on trachoma in Kongwa, Tanzania. *Lancet*, 1995, **345:** 155–158.)
14. **West SK et al.** Epidemiology of ocular chlamydial infection in a trachoma-hyperendemic area. *Journal of Infectious Diseases,* 1991, **163**: 752–756.
15. **Brechner RJ, West S, Lynch M.** Trachoma and flies. Individual vs environmental risk factors. *Archives of Ophthalmology,* 1992, **110**: 687–689.
16. **Courtright P et al.** Latrine ownership as a protective factor in inflammatory trachoma in Egypt. *British Journal of Ophthalmology,* 1991, **75**: 322–325.
17. **Kupka K, Nizetic B, Reinhards J.** Sampling studies on the epidemiology and control of trachoma in southern Morocco. *Bulletin of the World Health Organization,* 1968, **39**: 547–566.
18. **Luna EJA et al.** Epidemiology of trachoma in Bebedouro State of São Paulo, Brazil: prevalence and risk factors. *International Journal of Epidemiology,* 1992, **21**: 169–167.

19. **Mathur GM, Rameshwar S.** Influence of some socio-economic factors on the prevalence of trachoma. *Indian Journal of Medical Sciences,* 1970, **24**: 325–333.
20. **Resnikoff S et al.** Health education and antibiotic therapy in trachoma control. *Revue internationale du Trachome et Pathologie oculaire subtropicale et de Santé publique,* 1995, **72**: 89–98.
21. **Sutter EE, Ballard RC.** Community participation in the control of trachoma in Gazankulu. *Social Science and Medicine*, 1983, **17**: 1813–1817.
22. **Taylor HR et al.** Hygiene factors and increased risk of trachoma in Central Tanzania. *Archives of Ophthalmology,* 1989, **107**: 1821–1825.
23. **Taylor HR.** A simple method for assessment of association between synanthropic flies and trachoma. *American Journal of Tropical Medicine and Hygiene,* 1988, **38**: 623–627.
24. **West S et al.** Water availability and trachoma. *Bulletin of the World Health Organization,* 1989, **67**: 71–75.
25. **West SK et al.** Facial cleanliness and risk of trachoma in families. *Archives of Ophthalmology,* 1991, **109**: 855–857.
26. **Wilson M et al.** The epidemiology of trachoma in Chiapas (Mexico). *Revue internationale du Trachome,* 1987, **64**: 159–166.
27. **Zerihun N.** Trachoma in Jimma zone, south western Ethiopia. *Tropical Medicine and International Health,* 1997, **2**: 1115–1121.
28. **Bailey R et al.** Trachoma and water use; a case control study in a Gambian village. *Transactions of the Royal Society of Tropical Medicine and Hygiene,* 1991, **85**: 824–828.
29. **Bobb AA, Nichols RL.** Influence of the environment on clinical trachoma in Saudi Arabia. *American Journal of Ophthalmology*, 1969, **67**: 235–243.
30. **Cairncross S, Cliff JL.** Water use and health in Mueda, Mozambique. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 1987, **81**: 51–54.
31. **Dawson CR et al.** Severe endemic trachoma in Tunisia. *British Journal of Ophthalmology,* 1976, **60**: 245–252.
32. **Gupta CK, Gupta UC.** Flies and mothers as modes of transmission of trachoma and associated bacterial conjunctivitis. *Journal of the All-India Ophthalmological Society,* 1970, **18**: 17–22.
33. **Hardy D et al.** The cytology of conjunctival smears from aboriginal schoolchildren at Yalata, South Australia, after improved hygienic conditions and treatment with oxytetracycline and systematic sulphormetoxine. *American Journal of Ophthalmology,* 1967, **63**: 1538–1540.
34. **Katz J et al.** Prevalence and risk factors for trachoma in Sarlahi district, Nepal. *British Journal of Ophthalmology,* 1996, **80**: 1037–1041.
35. **Majcuk JF.** A study of trachoma and associated infections in the Sudan. *Bulletin of the World Health Organization*, 1966, **35**: 262–272.
36. **Mann I.** Correlation of race and way of life in Australia and territory of Papua and New Guinea with incidence and severity of clinical trachoma. *American Journal of Ophthalmology*, 1967, **63**: 1302–1309.
37. **Marshall CL.** The relationship between trachoma and piped water in a developing area. *Archives of Environmental Health,* 1968, **17**: 215–220.
38. **Messadi M et al.** [The epidemiology and natural history of trachoma in Tunisia]. *Revue internationale du Trachome*, 1974, **4**: 7–29 (in French).
39. **Misra KK.** Safe water in rural areas. *International Journal of Health Education,* 1975, **18**: 53–59.
40. **Peyramaure F et al.** Effect of water supply on the incidence of trachoma: preliminary results of a prospective study in Mali. *Revue internationale du Trachome et Pathologie oculaire subtropicale et de Santé publique,* 1994, **71**: 87–94.
41. **Portney GL, Portney SB.** Epidemiology of trachoma in the San Xavier Papago Indians. *Archives of Ophthalmology*, 1971, **86**: 260.
42. **Pratt-Johnson JA, Wessels JHW.** Investigation into the control of trachoma in Sekhukuniland. *South African Medical Journal*, 1958, **32**: 212–215.
43. **Reinhards J et al.** Studies in the epidemiology and control of seasonal conjunctivitis and trachoma in Southern Morocco. *Bulletin of the World Health Organization*, 1968, **39**: 497–545.
44. *National trachoma and eye health programme.* Sydney, Royal Australian College of Ophthalmologists, 1980.
45. **Tabbara KF, al Omar OM.** Trachoma in Saudi Arabia. *Ophthalmic Epidemiology*, 1997, **4**: 127–140.
46. **Taylor HR, Velasco FM, Sommer A.** The ecology of trachoma: an epidemiological study in southern Mexico. *Bulletin of the World Health Organization*, 1985, **63**: 559.
47. **Tedesco LR.** Trachoma and environment in the Northern Territory of Australia. *Social Science and Medicine*, 1980, **14D**: 111–117.
48. *The Cochrane Library.* England Cochrane Collaboration. UK, version 1997, updated 1999.
49. **Bradford Hill A.** The environment and disease: association or causation? *Proceedings of the Royal Society of Medicine,* 1965, **58**: 295–300.