
Noma: a neglected scourge of children in sub-Saharan Africa

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Poverty is the single most important risk indicator for noma (cancrum oris), a severe gangrene of the soft and hard tissues of the mouth, face, and neighbouring areas. The risk factors associated with an increased probability of noma developing include the following: malnutrition, poor oral hygiene, and a state of debilitation resulting from human immunodeficiency virus (HIV) infection, measles, and other childhood diseases prevalent in the tropics. There are many similarities between noma and necrobacillosis of the body surface of wallabies (Macropus reforgeus), and it is proposed that noma results from oral contamination by a heavy load of Bacteroidaceae (particularly Fusobacterium necrophorum) and a consortium of other microorganisms. These opportunistic pathogens invade oral tissues whose defences are weakened by malnutrition, acute necrotizing gingivitis, debilitating conditions, trauma, and other oral mucosal ulcers. The current escalation in the incidence of noma in Africa can be attributed to the worsening economic crisis in the region, which has adversely affected the health and well-being of children through deteriorating sanitation, declining nutritional status and the associated immunosuppression, and increased exposure to infectious diseases. Prevention of noma in Africa will require measures that address these problems, and most importantly, eliminate faecal contamination of foods and water supplies.

Introduction

Noma (from the Greek *nomen*, "to devour") is a severe gangrene of the soft and hard tissues of the mouth, face, and neighbouring areas. This disease, also known as "cancrum oris", was described by Tourdes in 1848 as a "gangrenous affection of the mouth, especially attacking children in whom the constitution is altered by bad hygiene and serious illness, especially from the eruptive fevers, beginning as an ulcer of the mucous membrane with oedema of the face, extending from within out, rapidly destroying the soft parts and the bone, and almost always quickly fatal..." (1). This description is still very accurate today, except for the markedly reduced mortality rate resulting from the timely administration of appropriate antibiotic therapy. Survivors of the disease may exhibit facial mutilation, impaired growth of the facial skeleton, nasal regurgitation of food, leakage of saliva, defective speech, and chewing difficulties. Reconstructive surgery of the resulting deformity is very costly, and the results are often less than satisfactory in terms of improvement in the patient's quality of life.

Noma was well known in Europe and North America some centuries ago (1), but today is virtually nonexistent in developed countries. In marked contrast, the disease is still frequently seen in developing countries, especially in sub-Saharan Africa, where it occurs almost exclusively among poor children, usually aged 3–10 years (1–7). More ominous are recent data from WHO that suggest an escalating increase in the incidence of noma in developing countries, particularly in several famine-stricken parts of Africa (M.H. Leclercq, personal communication, 1994). In November 1992, WHO underscored the urgency of the situation by initiating a global information campaign on noma. Also in 1992, the WHO/Fédération Dentaire Internationale (FDI) Joint Working Group on International Collaboration for Oral Health Research identified the disease as a major problem that would most benefit from shared international research, resources, and expertise (8). This view was reaffirmed on World Health Day 1994 (M.H. Leclercq, personal communication, 1994).

Some workers hold that noma begins as a purplish-red spot or indurated papule on the alveolar margin, most frequently in the premolar–molar region (1). The papule breaks down into an ulcer, which then extends to the labi gingival fold and onto the mucosal surfaces of the cheeks and lips (1, 2, 4, 9). Other workers maintain that noma of the face (cancrum oris) always starts as acute necrotizing gingivitis (ANG), a severe, painful form of gingivitis characterized by bleeding and necrosis of the inter-

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proximal papillae (4–6, 9). The early features of cancrum oris include soreness of the mouth, a swollen, tender, painful lip or cheek, a foul-smelling purulent discharge, and a bluish-black discoloration of the skin in the affected area (1, 2). The gangrene, once started, establishes itself rapidly, often in a matter of days, but remains remarkably well demarcated. Following separation of the soft tissue slough, sequestration of the exposed bone and teeth occurs rapidly.

In developing countries, noma is a neglected health problem that robs many children, particularly in Africa, of their future. In this review, widely held views on the cause of noma are reappraised in the light of recent observations. Also, a readily testable hypothesis is proposed, which suggests that in the presence of certain specific microorganisms any oral mucosal ulcer, and not only ANG, is potentially capable of evolving into cancrum oris in a malnourished, immunosuppressed child

Risk factors for noma

An important risk indicator for noma in African children is poverty (1, 9). The known risk factors associated with an increased probability of the disease developing in a given individual include malnutrition (particularly protein–energy malnutrition and vitamin A deficiency), poor oral hygiene, and a state of debilitation, often resulting from malaria, measles, and other childhood diseases prevalent in the tropics (1, 2, 6, 10, 11). The general hypothesis is that the interaction and/or increased virulence of certain specific microorganisms in the periodontal/oral mucosal environment of a susceptible host is an essential prerequisite for the genesis of noma.

It has been suggested that ANG (12) is an important antecedent lesion of noma (1–5). Contrary to the situation in industrialized countries, where ANG is found mainly among young adults (12, 13), in developing countries it occurs almost exclusively among socioeconomically disadvantaged children (1, 2, 10). Recent hospital-based studies in Nigeria suggest that the incidence of ANG is increasing among children (2, 14, 15). The etiology of this condition is still poorly defined, with the suspected predisposing factors including stress, poor oral hygiene, malnutrition, and impaired immune function (12, 15, 16). In recent years, there has been a global increase in the incidence of ANG associated with human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS) (17, 18). The reported frequency of ANG among those infected with HIV varies from 4.3% to 16.0% (17–19). None the less, in both HIV-positive and HIV-negative individuals, only a very

small number of ANG cases evolve into noma (2, 6, 10, 17, 20), suggesting that in this potential risk group, one or more unidentified factors are necessary for its occurrence. Consistent with this is the observation made by Pindborg et al. that noma could occur in South Indian children without any evidence of pre-existing ANG (20). Similarly, not all debilitated malnourished children with poor oral hygiene develop noma (6, 9, 10, 20).

Reappraisal of the etiology of noma

The remarkable speed with which noma establishes itself, and the very marked foul odour associated with it, suggest that a collagenase-type of enzyme, usually elaborated by anaerobic microorganisms is involved. Noma may therefore be a polymicrobial infection caused by Bacteroidaceae (particularly *Fusobacterium necrophorum* and *Prevotella melaninogenica*) and a consortium of other organisms. *F. necrophorum*, a Gram-negative, nonspore-forming, nonmotile, strictly anaerobic pleomorphic organism, produces a leukocidin, as well as butyric acid as the main metabolic end-products (21). *Bacteroides* spp. produce a wide range of destructive metabolites, e.g., collagenase, fibrinolysin, endotoxin, hydrogen sulfide, indole, ammonia, fatty acids, proteases capable of degrading the immunoglobulins and complement factors, as well as substances inhibiting neutrophil chemotaxis (21, 22). *F. necrophorum* could be the key microorganism in causing noma. Its infectivity is markedly enhanced by the simultaneous presence of other bacteria, ranging from strict aerobes to facultative and strict anaerobes (23), including *Corynebacterium pyogenes*, *Pseudomonas aeruginosa*, *F. nucleatum*, *Escherichia coli*, *P. melaninogenica*, *Bacteroides fragilis*, *Bacillus cereus* and *Staphylococcus aureus* (23). In instances when noma-like lesions have occurred in stressed, malnourished non-human primates, the key anaerobes isolated have been *Bacteroides* spp. and *Fusobacterium* spp., with *P. aeruginosa* and *S. aureus* as the predominant aerobes (3, 24).

F. necrophorum occurs in cases of foot rot in many domestic animals (21), as a commensal in the gut of herbivores (25), in human and animal faecal remains (25), and has been cultured occasionally from periodontal lesions (26). It has very little ability to invade intact epithelium, and infection usually arises from contamination of damaged mucous membrane or skin (23, 25).

In many ways noma is similar to necrobacillosis of the body surface of wallabies (*Macropus reforgeus*), which is characterized by a purulent, necro-

tizing lesion often affecting the periodontal tissues, maxilla, mandible, face, hind limbs and gastrointestinal tract (25, 27–29). It is a polymicrobial infection, *F. nucleatum* being the commonest organism isolated, often in pure culture (28). In a series of 27 wallabies with necrobacillosis, 14 were affected in the face; *F. nucleatum* and various *Bacteroides* spp. were the predominant organisms, occurring in 69% and 48%, respectively, of the facial lesions (30). Rosen has noted that in kangaroos, the microorganisms associated with necrobacillosis, especially *F. nucleatum*, are opportunistic pathogens that can only invade oral tissues if there is local weakening of defences resulting from abrasions, debilitating conditions, or trauma that may be a consequence of the eruption of molar teeth (27). It is also relevant that outbreaks of necrobacillosis in wild kangaroos in Australia occur during unusually prolonged droughts when the animals tend to congregate around water holes and there is heavy faecal contamination of artificial feeding areas (27, 28). Also, more deaths from necrobacillosis occur among wallabies in severely cold weather when daily food supplements are needed to make good any deficits in natural feeding (25).

There are similarities between noma and tropical skin ulcer, a painful, disabling condition occurring on the lower legs and feet of impoverished children in developing countries (31), and believed to result from faecal contamination of abrasions on the skin (32). *F. nucleatum* (31) and *F. necrophorum* (33) are reported to play a key role in causing tropical ulcer, and both these microorganisms have common antigens (26).

Discussion

For diseases such as noma, with multiple risk factors, testing for the etiologic role of individual factors is usually inadequate unless interactive associations between factors are considered. The most commonly reported illness preceding noma in African children is measles (1, 2), an infection that is not only immunosuppressive but which also elicits marked reduction in food intake (34) as well as significantly impairing mobilization of vitamin A from hepatic stores (35). The interactions between malnutrition and measles, even when the former is moderate or incipient, are greater and have far more serious consequences than for other infectious diseases of childhood (35, 36). Malnourished African children who suffer a severe attack of measles are prone to develop deep, erosive ulcers of the mouth and eyes (37). Similarly, protein–energy malnutrition and/or vitamin A deficiency can cause progressive damage to mucosal tissues, including oral mucosa

(35, 36). Thus, malnutrition acting in concert with an infection such as measles can readily lower the resistance of oral mucosa to colonization and invasion by the potential pathogens of noma.

A number of ecological and behavioural variables intensify the risk of oral and gastrointestinal diseases in impoverished sub-Saharan African communities (38). These include poor food supply and preservation, reliance on inadequate and often heavily contaminated water supplies, close proximity of livestock to humans, earth-floored residential units, and very poor disposal of human and animal faeces (3, 38, 39). Over the last decade, malnutrition has remained stable in South America, decreased in Asia and Central America, but has increased in sub-Saharan Africa as a result of long-term decline in food supplies (40). The International Monetary Fund (IMF), as part of its lending policies, has imposed structural adjustments on the economies of most African countries (41, 42). The resulting economic crisis is adversely affecting the health and well-being of children by causing increasingly overcrowded living conditions, deteriorating sanitation, declining nutritional status, and increased exposure to infectious diseases. Malnutrition in sub-Saharan Africa is now severe and getting worse in several countries (43). The most pressing health problem in such communities is therefore the well-known synergism of malnutrition and infection (36), as typified by noma.

In rural and poor urban settings in Africa, supplies of water are often obtained from polluted streams and shallow underground wells; also, traditional weaning foods are microbiologically hazardous, being heavily contaminated with faecal organisms (44, 45). Microbial contamination of foods in developing countries occurs more readily during the rainy season (45, 46); it is perhaps not fortuitous that the reported frequency of noma in Nigerian children is highest during the rainy season (1, 47).

Prevention of noma depends on implementing measures aimed at eradicating malnutrition, improving oral hygiene status, and minimizing damage to the oral mucosa, as well as avoiding contamination of the oral environment by a heavy load of Bacteroidaceae, particularly *F. necrophorum*. Among vulnerable children, not only ANG but also other oral mucosal ulcers and traumatic lesions, including the trauma of tooth eruption, should be considered to be potentially capable of evolving into noma. An important public health measure that will help to contain the current upsurge of noma among sub-Saharan African children is the prevention of faecal contamination of water and weaning foods, carried out concurrently with reduction in host susceptibility through improved nutrition and oral hygiene practices.

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Résumé

Le noma: un fléau négligé de l'enfance en Afrique subsaharienne

La pathogénie du noma (cancrum oris) — une gangrène grave des tissus mous et des os de la bouche, de la face et des régions adjacentes — est encore très mal connue. Selon une hypothèse générale, une association d'un ou plusieurs micro-organismes spécifiques dans le milieu buccal/périodontique d'un hôte réceptif serait la condition indispensable à son apparition.

La pauvreté est un indicateur crucial du risque de noma dans les pays en développement, la probabilité d'apparition de cette maladie augmentant en présence des facteurs suivants: malnutrition, mauvaise hygiène buccale, gingivite ulcéro-nécrotique, et état d'affaiblissement dû au paludisme, à la rougeole, à l'infection par le VIH (virus de l'immunodéficience humaine), et à d'autres maladies immunosuppressives prévalentes dans les pays en développement les plus pauvres. Néanmoins, seuls quelques rares sujets présentant ces facteurs de risque font un noma.

Dans cette brève mise au point, l'auteur fait observer que le noma partage de nombreuses caractéristiques avec la nécrobacillose cutanée du wallaby (*Macropus rufogriseus*) et avance une hypothèse étiologique faisant intervenir une contamination massive de la bouche par des Bacteroidaceae (en particulier *Fusobacterium necrophorum* et quelques *Bacteroides* spp.) et une association de divers autres micro-organismes qui concourent à renforcer leur infectiosité. *F. necrophorum* pourrait être le micro-organisme clé dans le processus d'apparition du noma. Tous ces agents pathogènes opportunistes envahissent les tissus de la bouche à la faveur d'une faiblesse locale des défenses due à la malnutrition, à des maladies débilitantes, à une gingivite ulcéro-nécrotique et à d'autres ulcérations et traumatismes buccaux. Chez des enfants sensibles, non seulement la gingivite ulcéro-nécrotique mais aussi d'autres ulcérations et lésions traumatiques buccales sont considérées comme susceptibles de conduire au noma.

En Afrique, l'incidence du noma a augmenté ces dernières années du fait de l'aggravation de la crise économique, qui a eu des effets nocifs sur la santé et le bien-être des enfants par une détérioration des conditions d'hygiène et de l'état nutritionnel, et par une exposition accrue aux maladies infectieuses. La prévention du noma chez les enfants africains repose sur la mise en œuvre de mesures de santé publique appropriées, afin d'améliorer le niveau d'hygiène bucco-dentaire, de réduire la malnutrition et les lésions de la muqueuse buccale, de contrôler l'incidence et la gravité des maladies infectieuses et, surtout, d'éliminer la contamination fécale des aliments et de l'eau.

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