Hungry World

IMPACT OF THE SAHELIAN DROUGHT IN MAURITANIA, WEST AFRICA

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Summary Data were needed for the planning of disaster relief in West Africa, which has been subject to a prolonged drought. A nationwide survey was undertaken to determine the nutritional status of the Mauritanians and the rates of important communicable diseases. The main findings were that: (*a*) acute malnutrition was most severe among nomads; (*b*) malnutrition was of the marasmic variety; (*c*) severe vitamin deficiency was present in isolated pockets; (*d*) measles was present in epidemic proportions; (*e*) a cholera outbreak occurred and was controlled; and (*f*) crude mortality-rates were as much as three times normal. The Government's remarkably effective food-distribution programme was modified as results of the survey became known. The cholera outbreak demonstrated the detection and response capability of the country's communicable-disease surveillance system. Vitamin supplementation was undertaken in areas with high rates of vitamin deficiency. Recommendations included intensified measles vaccination efforts and institution of periodic nutritional surveillance to facilitate appropriate food distribution.

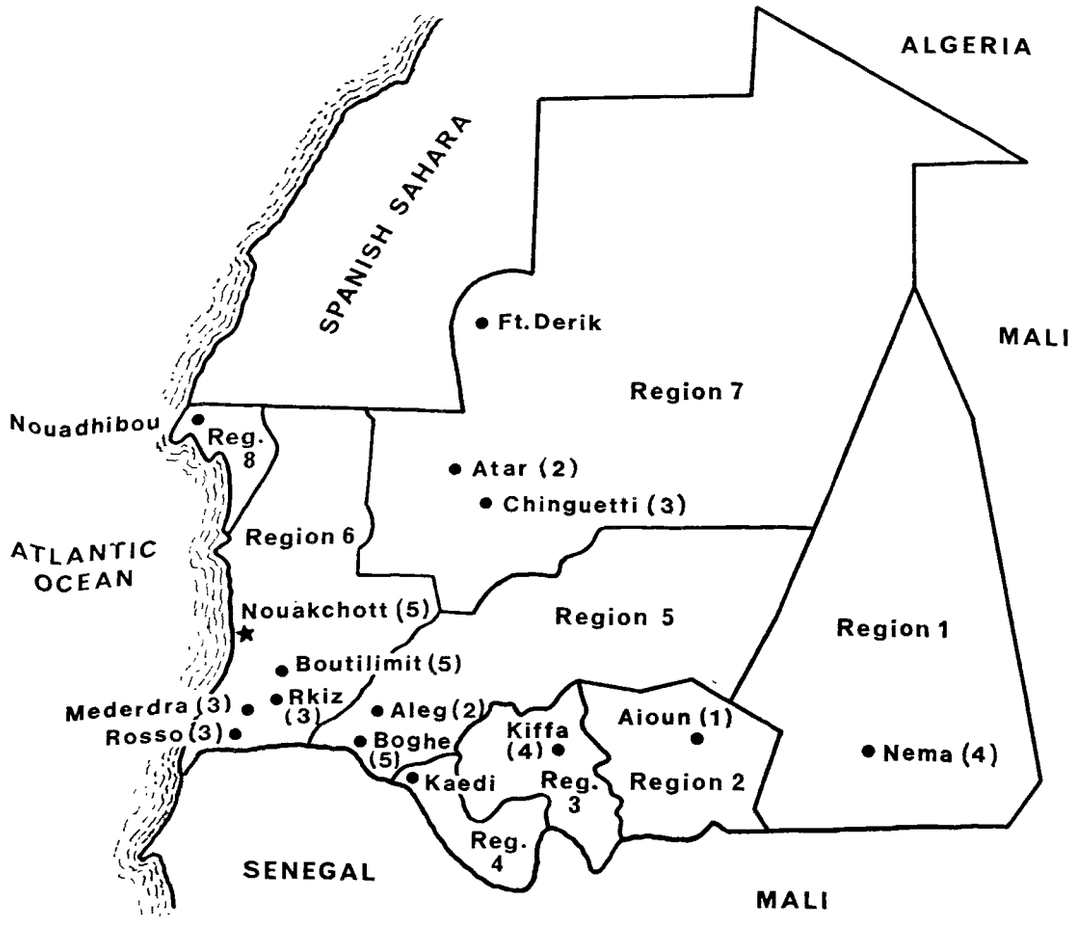
INTRODUCTION

THE prolonged drought in the Sahelian zone of West Africa has been the focus of considerable publicity and political debate. Under contract from the U.S. Agency for International Development, in anticipation of assisting in both the short and long term relief effort, the Center for Disease Control undertook the collection of objective data to provide a basis (*a*) for deciding the amount of relief that was required, (*b*) for selecting areas in which the need was acute, and (*c*) for evaluating the impact of the assistance provided. Mauritania was one of four countries studied. This paper summarises the major findings of a ten-week (July–September, 1973) nationwide field survey of the nutrition and disease status of the Mauritanian population.

BACKGROUND

Mauritania is situated in northwest Africa, bounded by Spanish Sahara, Mali, Algeria, Senegal, and the Atlantic Ocean (see accompanying map). It has an area of 1,030,700 sq. km. (approximately the size of Texas and California combined) and is divided into three geographic regions:

(*a*) The Senegal River valley, in the south, where a sedentary agricultural lifestyle predominates;
(*b*) The Sahel, north of the river valley, a broad east-west band of sandy plains and fixed dunes with



Survey sampling sites in Mauritania Nutrition Survey.
In parentheses, number of sample clusters examined in each village.

sparse grass and scrub trees inhabited by nomadic herdsmen; and

(*c*) The Sahara Desert, a large northern area with shifting sand-dunes and rugged rocky plateaus, only sparsely populated.

The climate is hot and dry. The limited rainfall is concentrated in the southern part of the country during the months of July to October and averages 300 mm. a year. Parts of the country in the Saharan zone have not had a rainfall for more than 10 years. The population is an estimated 1·2 million, 80% of whom are nomadic herdsmen of mixed Arab and Berber stock. The remaining 20% are black Africans, predominantly sedentary farmers living in the Senegal River valley. The domestic gross national product is estimated at $160 per caput. The average life expectancy is 40 years, with an estimated annual death-rate of 23 per 1000.

During the 5 years before the field survey, there had been a considerable reduction in rainfall. The average rainfall in 1972 was 140 mm.—less than half the amount expected, with many areas receiving no rain at all. This had resulted in sharp curtailment of water and grass for the Mauritanian herds (sheep, goats, cattle, and camels). Although objective data do not exist, reasonable estimates of herd losses were 25% for the year 1972. In the summer of 1972, the Senegal River failed to flood for the first time in over 60 years. For the alluvial agriculture of the south, this resulted in virtually no harvest. Nomads began to congregate near the population centres in hopes of obtaining food. The capital city of Nouakchott had tripled in size (20,000 to 60,000) in the several years before the investigation. There were reports of widespread human and animal mortality from starvation and disease. In this setting, our field survey was undertaken.

METHODS

The major goal of the nutritional survey was to obtain a baseline measurement of the extent of *acute* malnutrition in Mauritania, primarily to provide a means of evaluating the impact of the relief programme over time, and also to assess current food needs. Chronic undernutrition results in linear growth retardation with proportionate failure to gain weight (" stunting "). Acute malnutrition results in weight-loss which is disproportionate to height (" wasting "). Weight for height has been found to be relatively independent of age, race, and sex, and is thus a most useful anthropometric index in disasters in which food is notably scarce.[1,3] Such an index also avoids the need for obtaining the age of children. Exact ages of children can only rarely be ascertained in West Africa. Young children, because of high growth-rates and susceptibility to disease, are at much greater risk from nutritional deprivation than adults. Thus, body measurements of children are regarded as a very sensitive index of famine and were the primary focus of this survey.

A list of accessible population centres was compiled as a basis for selection of survey sites. Each population centre was visited, and a second list was prepared of surrounding population groupings which were reachable given constraints of time and transport. This list included all known encampments within an 80 km. radius. Forty sampling sites located in all regions of the country were visited (see map). At each site, a starting-point was chosen at random, and the survey team then proceeded from tent to tent, examining all children between 70 cm. and 120 cm. in height. A total of 1191 children were examined. Height was measured to ±1 mm. and weight to ±0·1 kg. A brief clinical examination was performed for œdema and signs of advanced avitaminosis. For purposes of analysis, the subjects were divided into nomadic (66%) and sedentary (34%) subgroups. Data were also tabulated by political region. The team consisted of myself, a Mauritanian male nurse, and an American Peace Corps volunteer.

The weight-for-height reference values used were the age-specific median values for weight and height of the Stuart-Meredith standards.[3] Because weight for height seems to be independent of age, race, and sex, and, further, because previous experience has shown that well-nourished West African children actually follow these standards closely, their use in this survey is believed to be valid.[1,2,4,5] 80% of the median Stuart-Meredith weight for height was designated in this study as the borderline below which a child would be classified as acutely malnourished. This represented two standard deviations from the Stuart-Meredith means, and was designated the " acute malnutrition threshold."

Much of the morbidity and mortality associated with starvation results from concomitant infectious disease——e.g., epidemic typhus during the Irish potato famine, measles in Biafra, smallpox and cholera in Bangla Desh. Many of these diseases are subject to effective control measures. We therefore attempted to determine which of these diseases were contributing to mortality in Mauritania. These data were gathered from personal interviews with the health officials in each of the population centres visited and from the national infectious-disease surveillance and reporting system.

The final goal of the study was to estimate the mortality-rate in this population. This was virtually impossible to do in any fashion that might be considered accurate and reproducible. A crude estimate of the mortality-rate was obtained by interviewing the head of each family studied and inquiring: (*a*) How many people live in your tent now? (at the time of interview) and (*b*) How many people who lived in your tent have died in the past 12 months?

RESULTS

Nutritional Assessment

In general, 16·6% of the nomadic children and 8·0% of the sedentary children examined fell below the acute-malnutrition threshold. This is a statistically significant difference ($t=4·28$, $P<0·001$). This same difference between the sedentary and nomadic populations was observed with respect to cases of marasmus and advanced avitaminoses. Among nomads, 51 (6·5%) were believed on clinical grounds to have marasmus, as compared to 8 (2·0%) sedentary children ($t=3·46$, $P<0·001$). Advanced avitaminoses (scurvy=pronounced gingival hypertrophy, gingival bleeding, or petechiæ; beri-beri=characteristic muscle weakness or paralysis of recent onset) were observed in 22 (2·8%) nomadic children and 6 (1·5%) sedentary children ($t=1·46$, $P<0·010$). About two-thirds of these cases were scurvy and one-sixth were beri-beri. Œdema was not detected in a single subject. No cases of kwashiorkor were observed:

Illness	*Sedentary children* (*n* = 781)	*Nomadic children* (*n* = 410)
Acute malnutrition*	8·0%	16·6%
Marasmus†	2·0%	6·5%
Advanced avitaminosis‡	1·5%	2·8%
Kwashiorkor	0·0%	0·0%
Œdema	0·0%	0·0%

* $t=4·23$, $P<0·001$. † $t=3·46$, $P<0·001$. ‡ $t=1·46$, $P>0·10$.

RESULTS OF NUTRITION SURVEY AMONG MAURITANIAN CHILDREN, BY GEOGRAPHICAL REGION

Region	Area	% below undernutrition threshold								
		Nomad			Sedentary*			Total		
		No. clusters	No. children	% threshold	No. clusters	No. children	% threshold	No. clusters	No. children	% threshold
1	Nema	4	102	18	..	..	..	4	102	18
2	Aioun	1	37	19	..	..	..	1	37	19
3	Kiffa	4	108	14	..	..	..	4	108	14
5	Boghe	4	101	10	1	33	12	5	134	10
5	Aleg	2	70	13	..	..	..	2	70	13
Total	Region 5	*6*	*171*	*11*	*1*	*33*	*12*	*7*	*204*	*11*
6	Nouakchott	3	151	18	2	74	4	5	225	13
6	Boutilimit	4	105	17	1	29	0	5	134	13
6	Rkiz	2	56	18	1	35	14	3	91	16
6	Rosso	1	21	52	2	55	11	3	76	22
6	Mederdra	1	30	17	2	50	10	3	80	13
Total	Region 6†	*8*	*212*	*21*	*5*	*169*	*9*	*14*	*381*	*16*
7	Chinguetti	..	..	..	3	81	10	3	81	10
7	Atar	..	..	..	2	53	2	2	53	2
Total	Region 7	..	..	..	*5*	*134*	*7*	*5*	*134*	*7*
Grand total		*26*	*781*	*17*	*14*	*410*	*8*	*40*	*1191*	*14*

* Includes children of government workers. † Excludes Nouakchott.

Significant regional differences were apparent (see table). In general, as one progressed further from the capital acute-malnutrition rates increased. This was probably because of the increasing length and unreliability of supply-lines bringing Government relief food to the population centres. Acute-malnutrition rates were higher in the north than in the south, probably as a result of the concentration of sedentary population groups in the southern part of the country. The one glaring exception to this was region 7, the northernmost area visited, where the malnutrition-rates were relatively low. This was because of out-migration of the nomads, a recent date harvest, and higher-than-average Government food rations per caput. Aside from these general trends, perhaps most striking was the finding of isolated pockets of acute malnutrition in areas where the Government food-distribution programme otherwise seemed to have been effective.

Communicable-disease Problems

Endemic diseases included malaria, schistosomiasis, tuberculosis, and parasitic infestation. No cases of yellow fever or smallpox, and only sporadic cases of meningitis and typhoid fever, had been reported. Localised outbreaks of infectious hepatitis and whooping-cough had been reported earlier in 1973, but had subsided by the time this survey was undertaken.

Cholera broke out during the month of August, centred in Rosso along the Senegal River. This provided an excellent opportunity to assess the effectiveness of the Mauritanian communicable-disease surveillance and reporting system, as well as the Mauritanians' ability to intervene in a public-health crisis of this nature. The outbreak was identified and was reported almost immediately, and the contaminated wells were identified and closed within 3 days of the first case. An intensive vaccination and chemoprophylaxis-for-contacts campaign was undertaken, and a major effort was made to educate both local officials and the populace regarding appropriate precautionary measures. The outbreak was terminated within 3 weeks, with a total of only 149 cases and 29 deaths. Given the constraints of inadequate manpower, transportation, and general hygiene, this was a remarkable achievement.

The major current communicable-disease problem in Mauritania, as in much of West Africa, is measles. In the mid to late 1960s, an intensive measles-vaccination campaign was mounted under the combined auspices of U.S.A.I.D., the Centre for Disease Control, and the World Health Organisation. The reported number of cases of measles was relatively low in 1969 and 1970 (mean 2800). The rate began to climb in 1971 and is still rising, with perhaps as many as 15,000 cases expected in 1973:

Yr.	*No. of cases*
1969	3450
1970	2389
1971	4890
1972	8997
1973*	14,338

* Estimate based on data reported for the first three-quarters of 1973.

Although no accurate figures were available, health authorities estimated a 10% case/fatality ratio. This was certainly higher than one normally sees in highly developed countries, but was not as high as the rates reported in populations experiencing massive starvation (where case/fatality ratios may reach 50%). Reasons for this rising measles case-rate, despite continuing vaccination activity, included exposure of previously isolated, virus-naïve, populations to urban reservoirs of the measles virus, crowded conditions in peri-urban shanty-towns, increased numbers of cases in adults who had never been vaccinated, increased host susceptibility to infection as a result of malnutrition, and technical difficulties surrounding vaccine storage and administration.

Mortality-rates

In the aggregate, mortality-rates as determined by the above method were not significantly different from normal (23 per 1000). The rates reported in the two subgroups were 26 per 1000 among nomads and 21 per 1000 among the sedentary people. Failure to

find higher mortality-rates almost certainly is due primarily to the inaccuracy of the method used. However, there were isolated villages in which the death-rate reported was as high as 65–70 per 1000. If one assumes that this higher rate was a reasonable approximation of the true death-rate, and further, if one assumes that almost all the excess mortality related to famine occurred in the nomadic population, it is possible to estimate the annual excess mortality for Mauritania during 12 months before our study:

Total estimated population	1,200,000
Estimated nomad population	960,000
Nomadic deaths during non-famine year ...	23,040 (960,000 × 0·024)
Nomadic deaths during famine year ...	67,200 (960,000 × 0·07)
Excess mortality due to famine	44,160

The validity of the assumptions underlying this calculation is borne out by data collected in Niger, Mali, and Upper Volta by Center for Disease Control epidemiologists in the field at the same time as the current study. Their data supported the contention that the drought had its primary impact on nomadic populations, with relative sparing of the sedentary population. Similarly, the maximum observed death-rate was 70 cases per 1000.[6]

DISCUSSION

The experience reported here, corroborated by the C.D.C.'s teams in other Sahelian countries, shows that it is possible rapidly to assess the nutrition and disease status of large populations affected by a natural disaster. The data obtained are most important as a benchmark against which future studies can be viewed as one attempts to evaluate the impact of short and long term relief. Similar studies over time are an absolute necessity if one is to understand the health and nutrition problems of this region. Local standards of normal growth and development are desperately needed as well.

The survey results were of great importance in assisting the Government of Mauritania in planning its food-distribution programme. Areas with unexpectedly high rates of acute malnutrition received additional food supplements, and areas with high rates of avitaminosis received vitamin supplementation.

Acute malnutrition was detected significantly more frequently among nomadic children than sedentary children. Marasmus followed the same pattern, as did the rate of severe avitaminosis. Both these phenomena suggest that the nutritional status of the population was substantially impaired. It is important to note that these observations were made 3–4 months after the onset of a remarkably effective Government food relief programme. Virtually all the nomads examined had received and were totally dependent upon relief food for survival. Most Government officials and health authorities agreed that the situation had been considerably worse several months before our arrival. This change was attributed to the effectiveness of the Government food-distribution programme.

The excess-mortality estimate based on the highest recorded mortality-rates was considerably lower than the figures being quoted by international relief agencies, Government officials, and the Press. Our data do not support the claim that "millions are dying" in West Africa. The relatively low excess mortality is even more striking in view of the fact that most of the drought impact seems to have fallen on the nomads, who constitute approximately 15% of the people in the Sahelian Zone (nearly half of whom live in Mauritania).

This survey was notable for the extreme variability of findings, even among sampling sites in the same region. For this reason, one of the recommendations of the survey team was that the Mauritanian Government establish a mechanism for the identification of these pockets of acute malnutrition, in order to distribute food supplies more effectively. One possible solution would be to employ a mobile nutrition-assessment team, analogous to the mobile vaccination teams already organised by the Ministry of Health. Use of the weight-for-height index as described here would be fairly reliable and simple, requiring a minimum of training for those involved.

The question naturally arises, Is the situation really as desperate as people have claimed? The rates of acute malnutrition, marasmus, avitaminosis, and death apparently are not as high as one might have expected, although (acording to local officials) they do seem to be in excess of "normal". What is the source of this apparent discrepancy? First, as noted above, emergency food distribution had probably led to significant improvement in the nutritional status of the Mauritanians before the study, narrowly averting widespread starvation. Second, it is my opinion that the indices assessed do not measure all important dimensions of the problem. At the time of this survey the real tragedy in West Africa was measured, not in terms of human morbidity and mortality, but in terms of animal morbidity and mortality. The decimation of the Mauritanian herds by thirst and famine has frightening implications for this nomadic people. A Mauritanian's herd is his source of food, money, status, and security. His skills are those developed over the centuries which have enabled him to care for his animals and his family, thus surviving in an extraordinarily hostile environment. To lose his herd is to lose everything. The suffering experienced by the Mauritanians who have lost their livelihood and have been forced to move to the cities for survival has been enormous. The majority of displaced persons interviewed insisted they would not return to the desert, *even if the Government replaced their lost herds*. Thus the nomads, having no other skills to rely upon, are now almost totally dependent upon the Government for food. They have made the giant leap from a mediæval pastoral life to twentieth-century urban unemployment in the span of several years. In view of the failure of the rains and crops again in the fall of 1973, the need for food relief from the international community will continue at least for the next several years. The solution to the long-term problems of survival and development in this region remains undefined.

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Occasional Survey

HOW EFFICIENT IS IMMUNOLOGICAL SURVEILLANCE AGAINST CANCER AND WHY DOES IT FAIL?

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Summary If immunological surveillance can at times prevent carcinogenesis, it evidently often fails. The following factors may be involved in the failure of immunological surveillance: (1) inherited selective defects of the immune response, mediated directly by Ir genes or through various mechanisms resulting in low-threshold tolerance; (2) absence of tumour-associated antigens; (3) shielding of tumour-associated antigens. Possibly the currently poorly understood phenomenon of "sneaking through" is caused by the shielding of the neoplasm from attack by immunocytes by the interposition of capillaries. Immunological surveillance should not be investigated by studying tumour immunity in cancer patients, in whom the very existence of neoplasia is proof of the failure of such surveillance. Instead, healthy subpopulations at risk should be investigated, since they may include individuals who have effectively rejected a neoplasm. Direct cell-membrane interactions, mediated through specific markers characterising the various types of differentiated cells, may underlie a powerful non-immunological mechanism of surveillance. This currently unexplored mechanism could provide new perspectives on the behaviour of tumours and normal differentiated tissues.

INTRODUCTION

IN Burnet's [1] hypothesis of immunological surveillance, clones of malignant cells are thought to arise at regular intervals in all individuals; but such cells hardly ever survive because they are rejected as allografts, unless some unspecified defect in the immune response permits these spontaneously arising clones of malignant cells to be tolerated. This stimulating idea has provoked much attention. For the past fifteen years, numerous observations have confirmed that many neoplasms in laboratory animals and in man do indeed elicit some tumour-specific immunity, but it is still not clear how efficiently we are protected from oncogenic events by this mechanism.

EVIDENCE FOR SUCCESSFUL IMMUNOLOGICAL SURVEILLANCE

Successful immunological surveillance may be inferred indirectly from situations in which immunological deficiencies, congenital as well as acquired, are associated with an increased incidence of neoplasia.[1] In acquired immunological deficiency, induced to protect a renal allograft transplant from rejection, for instance, the incidence of neoplasia is eighty times higher than in the general population.[2] Immunological deficiencies may also contribute to the increased incidence of neoplasms in infancy and old age.

Klein [3,4] observed that potentially oncogenic viruses, ubiquitous in wild (i.e., non-inbred) animals, hardly ever induce overt neoplasms in their host. Examples of these are *herpesvirus saimiri* in the squirrel monkey, polyoma virus in mice, and Marek's disease (herpesvirus) in certain strains of chicken. Also, Epstein-Barr virus (E.B.V.), strongly implicated in the ætiology of Burkitt's lymphoma in man, is innocuous in most individuals. Immunosuppressed adult animals are susceptible to oncogenic viruses by simple room infection; relatively small doses of immunosuppressive agents, acting for a short time, can allow the establishment and growth of small, antigenic tumour inocula in immunologically competent animals that, under normal circumstances, would be rejected.[5]

Everson and Cole [6] studied 176 cases of cancer showing spontaneous regression. More than half fell into four categories—neuroblastoma, carcinoma of the kidney, choriocarcinoma, and malignant melanoma. Malignant melanoma is notorious for its unexpected regressions, which are, however, often partial and restricted to one site, whereas the tumour progresses in other areas. Although these observations do not prove unequivocally that these spontaneous regressions are induced by a tumour-specific immune response, this is the most probable explanation.

FAILURE OF IMMUNOLOGICAL SURVEILLANCE

Oncogenesis in Precancerous Lesions

In man precancerous lesions can antedate the emergence of a frank malignancy by years—e.g., solar keratosis and leucoplakia preceding invasive squamous carcinoma; lentigo maligna preceding frank malignant melanoma; intestinal polyps preceding colonic adenocarcinoma; dysplastic squamous epithelial lesions of the cervix and of the bronchial tree preceding squamous carcinoma of the cervix and of the lung, respectively; atypical endometrial hyperplasia preceding endometrial carcinoma; and hydatidiform mole evolving into choriocarcinoma. In all these examples, histologically recognisable cellular disturbances, widely recognised as being precancerous by clinical experience, exist for a long time. No immune response is effectively mounted to destroy such lesions "in the bud", despite the fact that lesions such as solar keratosis may elicit a pronounced chronic inflammatory infiltrate. Neither does the immune response effectively interfere once the lesion has become frankly malignant. It appears that immunological surveillance may not play any role at all in preventing the development of tumours in these instances. Precancerous lesions would simply turn malignant when oncogenic stimuli had persisted long enough to precipitate intracellular metabolic disruption. However, possibly the immunological system successfully eradicates a succession of nascent malignant clones of cells in these premalignant lesions. Only if the clone is poorly antigenic does immunological surveillance fail.[7] Both explanations are compatible with the fact that these