



## Epidemiology – The Neglected Tool in National Health Planning

C. R. SOMAN\*  
Trivandrum, India.

**Abstract** – The adoption of the Constitution of India on January 26, 1950, saw the country dedicating itself to a new social order and to the elimination of poverty, ignorance and ill health. An appraisal of the health situation of the country, four decades after, reveals a picture of light and shade. Life expectancy has increased, consequent to the slow but steady decline in overall mortality. Some communicable diseases like small pox and plague have been eliminated, while others like cholera contained. The prevalence of immunizable diseases has registered a decline in recent years. Nevertheless, the overall morbidity pattern remains fairly unchanged. Diarrhoeal disorders, acute respiratory infections, tuberculosis, and viral hepatitis still take a heavy toll of the lives of our people. No significant dent has been made in the problem of malnutrition. Adding to the burden of ill health is the emergence of the new life-style diseases.

An examination of the programmes and policies of the Government, reveal a plethora of programmes specifically targeted at individual diseases, planned to operate with a top down approach. Classical examples are, National Malaria Control Programme (NMCP), later changed to National Malaria Eradication Programme (NMEP), National Filariasis Control Programme (NFCP), National Leprosy Control Programme (NLCP), and National Family Welfare Programme (NFWP). Evaluation of these programmes done many years after their inception have almost invariably revealed that the programmes failed to achieve their objectives. Critical examination of the reasons for failure suggests that the programmes were all conceived and implemented without adequate epidemiologic information. In the absence of an epidemiologic approach regarding the causal factors of diseases in question and the methods of control and prevention, highly technocentric specialised interventions were adopted. The social, cultural and environmental determinants of ill health were neither perceived nor incorporated into the strategies of control. It appears that we have not learnt our lessons as exemplified by the newly launched scheme of Universal Iodisation of Salt to Control Iodine Deficiency Disorders (CIDD) and the proposed Anaemia Prevention Programme envisaging universal coverage of all women and children. The need for strengthening epidemiologic research and approaches in health management cannot be understated.

\* Professor of Nutrition, Trivandrum Medical College, Trivandrum 695 011, India

**E**pidemiology can be defined broadly as a study of the relationship between health and its determinants in populations and the applications of the findings to control health problems. The earliest epidemiologists in the West were perhaps the Greeks epitomised by Hippocrates. However, Indian medicine is replete with classical epidemiologic approaches to health and illness. Ancient Ayurvedic texts emphasized a holistic approach to health and dwelt on the importance of the relationship between environment and disease<sup>1</sup>.

Major advances in the field of epidemiologic methods in understanding human disease and causation occurred in the seventeenth century through the works of Sydenham and Graunt. The former concentrated on careful classification and description of diseases, while Graunt pioneered the analysis of weekly bills of mortality and baptism. Graunt can be considered the founding father of calculations of rates and the method of using population at risk as a denominator<sup>2</sup>.

James Lind's classical observations on the use of citrus fruits in the cure of scurvy launched the scientifically controlled study, an essential attribute of epidemiologic approach<sup>3</sup>. Edward Jenner's limited study on protection offered against smallpox by cowpox vaccination also belongs to the same category.

Modern epidemiology came into its own during the nineteenth century through the meticulous works of Pierre Louis a clinician and William Farr a statistician. It was Farr who organised the first vital statistics registry in the world and who applied mathematical concepts to the analysis of mortality. To cap these efforts came the monumental contributions of John Snow through his studies on cholera deaths in London and its relationship to contaminated water supply. The foundations of modern epidemiology were thus laid firmly.

The current century marked the extensions of epidemiologic principles to the study of numerous diseases, their treatment and preventive measures. To cite one example, Joseph Goldberger's classic investigations on the dietary treatment of Pellagra, using diet knocked the bottom out of the infectious theory of Pellagra. The second half of the twentieth century is replete with numerous studies demonstrating the vital contributions of epidemiology to our understanding of human health and disease. Clinical trials of polio vaccine conducted by the US Public Health Services<sup>4</sup>, community trials linking fluoride levels in drinking water and protection against dental caries<sup>5</sup>, the demonstration by Doll and Hill of the relationship between smoking and lung cancer<sup>6</sup> and the Framingham study<sup>7</sup> are just a few examples. The unravelling of the aetiological agents in AIDS is perhaps the most

recent example of the success of the epidemiologic methods in understanding human health and its deviations.

#### AIMS OF EPIDEMIOLOGY

The chief aims of epidemiology are (a) to describe the distribution and size of disease problems in human populations (b) to identify aetiological factors in the pathogenesis of disease and (c) to provide essential data needed for planning, implementation and evaluation of services for the prevention, control and treatment of diseases.

Three different approaches viz. descriptive studies, analytical studies and experimental/intervention studies are employed to fulfil these objectives.

#### EPIDEMIOLOGIC MEASUREMENTS

The major measurements in epidemiology are:

1. Measures of mortality.
2. Measures of morbidity.
3. Measures of disability.
4. Measures of natality.
5. Measurements of presence and distribution of the characteristics of a disease.
6. Measurements of medical needs, health care facilities, utilisation of health services and other health related events and,
7. Measurements of the presence, absence or distribution of the environment and other factors suspected of causing disease.

#### THE INDIAN SITUATION

India was never in the mainstream of epidemiologic research, while major advances were being made in this field in Europe and the Americas. However, some of the early works later leading to signal contributions in epidemiology were carried out in India. The discovery of the malarial parasite by Sir Ronald Ross, the Leishman Donovan bodies in Kala Azar, by Sir Donovan and the classical works by Sir Robert Macarrison on urinary stones and goitre are just a few contributions. The 1930s also saw the contributions by Asa Chandler on intestinal worm infestations in Indian states<sup>8</sup>.

Since independence, we cannot claim any major contribution in epidemiologic research excepting two studies. These are National Sample Survey on the incidence of tuberculosis conducted in the period



1955-58 and studies on the growth and development of the Indian children held in 1958-62. We now propose to examine the prevailing situation with regard to epidemiologic measurements in the country.

#### MEASURES OF MORTALITY

Until the 1970s there were predominantly only two sources of information on mortality. These were the data from the decennial census and death reports from hospitals. Though registration of deaths was mandatory, deaths are notoriously under-reported and cause of death seldom recorded. From 1971 onwards, data available through the Sample Registration System (SRS) introduced by the Registrar General of India are recorded. Information is provided on an annual basis on Crude Death Rate (CDR), Crude Birth Rate (CBR) and Infant Mortality Rate (IMR). All the States and Union Territories of India are covered for both rural and urban areas. Periodically, the data collected are analysed into its components like age specificity, perinatal and neo-natal mortality rates, its influencing factors. Since sampling methods and measurement techniques are standardised, reliability of the data is of a high order.

As medical certification of cause of death is neither insisted on nor practicable in our country, estimating cause of death at the population level is difficult. However, crude estimates are available from select hospitals. These are neither representative of the community situation nor validated by scientific scrutiny. Such data are of little use in planning.

#### MEASUREMENT OF MORBIDITY

Though four decades have elapsed after independence, institutional mechanisms have not yet been set up in the country to provide reasonably accurate measures of morbidity. Available data suffers both qualitative and quantitative inadequacies. The Indian Council of Medical Research periodically orchestrates efforts to determine the prevalence of select morbidities<sup>9</sup>. In these studies, national coverage is seldom attempted and the design of the study often falls short of rigorous scientific requirements. Some examples of such efforts are the investigations into the prevalence of blindness and tuberculosis. The National Sample Survey Organisation (NSSO) occasionally enlarges the scope of its enquiry to collect health related information. Nationwide morbidity surveys and disability surveys carried out by the National Sample Survey Organisation are examples. The findings are

to be interpreted with caution since the investigators were untrained and the involvement of medical professionals was meagre. The National Nutrition Monitoring Bureau (NNMB) has been monitoring the nutritional status in ten of the twenty five Indian States since 1973. The data suffers from inadequate coverage and design defects.

Certain diseases like malaria, gastroenteritis, vaccine preventable diseases, tuberculosis and leprosy are notifiable in the country. However, except for diseases where vertical programmes exist, the reporting is very inadequate and unreliable. No mechanisms for cross checking exist.

Mechanisms of the measurement of disability are similar to those of morbidity and therefore unsatisfactory.

#### MEASUREMENT OF NATALITY

Crude measurements covering both rural and urban areas are furnished by SRS. Indirect assessment is possible through actuarial measurements. Institutional data is of little use for contemporary purposes, though retrospective analysis from the major obstetric centres provide ample opportunities to understand the mode of fertility transition occurring in the country.

#### MEASUREMENT OF THE PRESENCE, ABSENCE OR DISTRIBUTION OF THE CHARACTERISTICS OF THE DISEASE

These measurements generally involve two approaches viz. population survey and reporting from health institutions. Crucial for the success is the establishment of a continuous machinery for surveillance and reporting. Periodic assessment of the reliability of information is vital. Unfortunately in our country, necessary mechanisms are yet to be established.

#### MEASUREMENT OF MEDICAL NEEDS

Broadly, this falls under the area of health services research. The validity of such measurements depend on the availability of reliable information; the attributes are discussed earlier. In the prevailing situation of data scarcity and unreliability medical needs measurements cannot be properly carried out.

#### MEASUREMENT OF THE ENVIRONMENTAL ATTRIBUTES AND DETERMINANTS

Today, the epidemiology of infectious diseases has been well established. Naturally, the focus of



epidemiology shifts towards the relationship of the environment to diseases. The emergence of the life-style diseases of the twentieth century, as major contributors to morbidity and mortality, highlight the importance of information in these fields. However, we are only making feeble efforts in this vital area.

#### WHY THIS PREDICAMENT ?

It is time that we make an honest appraisal of the benign neglect of epidemiology in the fields of medical education, health planning and health care delivery in our country. A look at the evolution of health care and health research in India reveals that after independence, the main thrust was on establishing institutions for providing medical care to the people. Original enquiries into the causation and determinants of disease were seldom encouraged; neither was the importance of such studies recognised. We were content to borrow heavily from the insights derived from Western medical discoveries. To an extent it was inevitable and even justified, since providing the people with the fruits of modern medicine was an important priority. Medical research was mostly carried out by clinicians oriented more towards the individual and whose training and expertise did not equip them to imbibe a broader perspective on health and its societal attributes.

Even in the West, epidemiology as a science was nurtured through the interaction and co-operation of scientists representing diverse fields. Particularly noteworthy are the contributions of mathematicians, sociologists and anthropologists whose insights have helped the medical profession in their understanding of health and human disease. In India, however, we did not have such a tradition, either during the colonial rule or after independence. Medical research was confined to the realms of the Medical Colleges or specialised research institutions where the role of the non-medical professional was restricted to making statistical sense, often out of ill-conceived and shabbily executed research. Even the special research institutions were dominated by the medical profession, whose training and perceptions did not equip them to develop epidemiologic perspectives.

Against such a backdrop, one can understand why the entire planning process in health care and delivery was based upon information, which at best, were of questionable reliability. In our hurry to deliver the goods, inconvenient questions were either not raised or pushed under the carpet. As there was a general consensus on the magnitude of the problems, particularly of infectious diseases and malnutrition, little concern was expressed about the nuances of the

reliability of the estimates. The situation has changed very little over the years. The mechanisms of furnishing regular reports to the central health authorities have been streamlined and such data are published annually under the title *Health Information of India*. The truth is that the data are of dubious quality, seldom cross-checked for reliability, are passed on as gospel truth and find their way into official publications. These data would now be used for planning purposes. A few examples would illustrate the point. The *Health Information of India* 1986<sup>10</sup>, provides data on the reported cases of communicable diseases for the various Indian States. To cite the example of measles, Kerala with a population of 25.4 million reported 24,640 cases of measles while Uttar Pradesh with a population of 110.8 million reported only 2,381 cases. It should be noted that infant mortality in Uttar Pradesh during that period was above 120 per 1000 while that of Kerala was only below 30. Obviously, the reported statistics cannot be reconciled with the realities of the health situation in these two States. However, these are the very statistics recommended for use both at the State and National levels for health planning. The author has more intimate knowledge of the health situation of Kerala and would point out yet another anomaly sanctified through the official publication of health statistics. The number of cancer patients treated in Kerala during 1985 is reported as 1,335 in the Health Information Book referred to, while the report of the Regional Cancer Centre operating in the Thiruvananthapuram Medical College complex, informs that the institution treated more than 3,500 new cases during the period. To put it mildly, the information which is dutifully printed and circulated to institutions and individuals is at best categorised as misinformation with honourable intentions.

Though epidemiology is a part of health science, our medical curriculum does little to excite the young medical students on its fascinations. The subject is taught just as another uninviting chapter to be learned under Community Medicine, in a neutral manner. This results in creating within the minds of the medical students a total apathy to epidemiology. They emerge as doctors, unaware of its central role, and unconcerned about the quality and manner of data gathering and reporting. With the exception of the community medicine departments, epidemiology attracts no attention in postgraduate medical training. Few postgraduate courses are offered in this subject in our country, with the result that we do not yet have a nucleus of trained professionals who could be the harbingers of the science of epidemiology in this country. It is imperative that we adopt measures



to institute training programmes in epidemiology to create this critical mass. Such training shall be offered to candidates from other non-medical disciplines also without which significant new insights are unlikely to emerge.

#### SOME INSTANCES OF NEGLECT OF EPIDEMIOLOGY IN HEALTH PROGRAMMES

The virtual neglect of epidemiologic principles has resulted in the launching and eventual failure of many national health programmes. A few examples are cited below.

##### 1. National Goitre Control Programme

From the beginning of this century, it was perceived that the regions in the sub-Himalayan belt had high endemicity of goitre. The relationship of goitre to dietary iodide deficiency was never doubted. The famous Kangra valley experiments by Soodh and Ramalingaswamy<sup>11</sup> demonstrated the efficacy of supplementation of common salt with iodide as an effective measure to control goitre. As a result, the government decided to launch the National Programme of Goitre Control through an approach of legislative compulsion and increased manufacture of iodised salt. The programme was allowed to run for twenty years, when murmurs of dissent appeared and evaluations suggested that the programme had failed<sup>12</sup>.

During the same period, however, goitre was being reported from isolated pockets in different areas of the country. The non-goitrous manifestations of iodine deficiency were also being appreciated. Iodide deficiency was therefore considered a problem of national urgency. Isolated observations on select groups were projected as representing whole districts and the magnitude of the problem scaled up. Scrutiny of the published reports on newly discovered groups with iodine deficiency suggests that the surveys were done on communities either vulnerable for iodide deficiency on account of the geography of habitation or having already been discovered by individual researchers. In either case when official statistics on iodide deficiency are put out, the entire district is projected as suffering from IDD. To cite an example, meticulous observations on the prevalence of goitre in the coastal districts of Alleppey and Quilon had indicated the prevalence to be less than one per cent<sup>13</sup>. However, since the launching of the National Goitre Control Programme (NGCP) a survey conducted in the adjacent coastal district of Ernakulam reports a prevalence rate of 44.47 per cent. The tragedy is that the very investigators who reported low prevalence initially in

Kerala are now uncritically accepting the inflated figures. The author had the chance to see the original report and found that the sample was not representative of the population and had an unusually large representation of children in the age group 10–20 years.

Despite the reported failure of the NGCP, no serious questions were asked about the failure or attempts made to learn from our lapses. It was conceded that the administrative machinery failed to monitor the supply of iodised salt to the needy States. However, instead of asking why the machinery failed the policy makers decided to overcome the failure by recommending iodisation of the entire edible salt requirement of the country by 1992. The simplistic assumption is that once all the salt is iodised there is no need to monitor the quality of the salt. Little do they realise that the edible salt requirement of the country is only less than 5 million tons, while the annual salt production exceeds 9 million tons. There is still a need for monitoring the quality of the salt sold to the people. The entire philosophy of iodisation is based on the assumption that the salt consumption of the average Indian ranges from 10–15 grams per day. The levels of iodisation have been arrived at on the basis of a minimum consumption of 10 grams. However, a survey of the literature reveals very few studies on the salt consumption of the people of India and the few studies located have been carried out after the launch of the revised NGCP. The programme has failed to take into account the logistic difficulties in storage, transportation, distribution and quality monitoring of the iodised salt. Only through a miracle can this programme succeed; let us hope such miracles do happen.

##### 2. Anaemia Prevention Programme

Soon after independence, it was realised that nutritional anaemia is a major problem in the country. Action, however, was slow to emerge. In 1968, the expert committee constituted by the Nutrition Society of India recommended the launching of a National Nutritional Anaemia Prophylaxis Programme to cover all anaemic, pregnant and lactating women of the country. A supplement containing 60 mg of elemental iron and 500 µg of folic acid was advised for pregnant and lactating women. The supplement was to be given for 100 days. The programme was launched on an all-India basis in 1970.

After 14 years of existence, the government decided to evaluate the programme. The evaluation report<sup>14</sup> makes sad reading. The programme did not make any impact on the prevalence of anaemia. It was also concluded that the information provided by the



health services establishment on the functioning of the programme was at variance with that provided by the people. The actual coverage of beneficiaries was less than 10 per cent of the target in many States, though the entire quantity of iron-folic acid was accounted for in the health centres. Thirty three per cent of the tablets tested contained less than the stipulated 60 mg of elemental iron and 99 per cent tablets contained substantially less than the required amount of folic acid. The evaluation team also lists numerous other shortcomings.

One would naturally expect the programme to be scrapped or modified substantially in view of its failure to fulfil the avowed objectives. To our surprise, we find that a new working group has recommended expansion of the programme to cover all the women in the reproductive age group, in addition to adolescent girls<sup>14</sup>. Questions like why women who had received the full complement of iron did not possess improved haemoglobin status and what happens to the iron and folic acid, reportedly distributed to the beneficiaries, but never reaching them, were skirted by the committee. The committee goes a step further and suggests fortification of common salt with iron as an approach for anaemia control. Sadly, no research findings justifying such sweeping recommendations is provided.

### **3. National Tuberculosis Control Programme**

Mention has already been made of the National Survey of Tuberculosis held in 1955–58 and the consequent launch of the National Tuberculosis Control Programme. The initial surveys indicated the prevalence of 1.8% as radiologically positive. The targets for treatment were fixed accordingly for the programme implementors. Even thirty years after the initial survey, no effort has been made to assess the prevalence of tuberculosis in this country. Even the limited morbidity surveys relating to tuberculosis number less than six for the whole country<sup>15</sup>. With such a yawning gap in our data requirement the planners seem to have decided to accept the figure of 1.5% as prevalence of radiologically positive cases in the late 1980s. In other words we are fixing targets on the assumption of uniform prevalence rate of tuberculosis, in States with extreme diversity in health status as Kerala with a crude rural death rate of 6.2 and Uttar Pradesh with a crude rural death rate of 16.9. In the absence of valid, nationally representative prevalence studies, continuation of the National Tuberculosis Control Programme based on presumptions would only result in considerable wastage of scarce resources.

The history of our National Programmes in health

has been one of light and shade. There has been total success like conquest of smallpox as part of a global phenomenon and qualified success as in the case of Malaria Control. But most of our programmes are just limping on, making little dent on the severity or magnitude of health problems, despite being in existence for more than two decades. The harsh realities and impediments in the implementation of the programmes are faced not with a determination to overcome the obstacles. Rather, criticisms are contemptuously brushed aside and hurdles pretended not to be existing. Inconvenient questions are seldom asked and timely and objective evaluations never encouraged. Huge resources, both material and manpower, are meanwhile squandered and our scientists are only too eager to jump into the international bandwagons with their universal prescriptions for Third World maladies. It is time that we sit back and look at the mirror, on our own roles and contributions to the present state of affairs. A willingness to admit our failures and a generosity to learn from our mistakes alone, can help remedy the situation. Epidemiology, certainly, has a crucial role in this effort.

### **ACTION – THE NEED OF THE HOUR**

All that has been said above may pass off as empty rhetoric, so typical of arm chair, academic cynics. It is fashionable to be a doomsday critic who finds the tunnel dark with no end in sight. The present author does not like to shirk his responsibilities in this regard. Offered below are some suggestions aimed at stimulating further discussions and possible actions on this front.

### **ESTABLISHMENT OF A NATIONAL HEALTH SURVEY AGENCY**

The existing problems of the country have to be assessed quantitatively through nationwide surveys. Only through such surveys can we build up epidemiologically valid disease maps of the country. One cannot underestimate the enormity of the task, but for a nation which expends atleast 18 per cent (probably more) of its revenue to maintain peace through defence expenditure, mobilising resources for such endeavours for health and family welfare is only around 3 per cent of the central revenue. More challenging, however, will be the creation of the infrastructure and mechanisms needed to sustain such surveys. It is proposed that we create a central agency with jurisdiction all over the country, to plan and



undertake health surveys on a national scale. The organisation may be set up on the lines of the National Sample Survey Organisation. The question of manpower naturally arises, but the country has a surfeit of experts capable of nurturing such an institution through its infancy.

The planning and targeting of National Interventional Programmes aimed at specific diseases should be based on the results obtained from these surveys. One cannot expect miracles to happen overnight, but we would be taking the right steps in our efforts to contain the major public health problems, at least by the turn of the century.

#### EVALUATION OF ONGOING PROGRAMMES

It is imperative that National Health Programmes are evaluated at regular intervals by independent agencies not involved with implementation, but with proven expertise in carrying out such evaluations. The evaluation formats may be prepared and approved by experts, so that fundamental aspects like sampling and methodology are not criticised later. The goal of such evaluations should be to seek answers primarily to the question: how far have we achieved the basic objectives of the programme and at what cost? The present pursuit of target-oriented evaluations may be best left to the implementing agencies.

#### STRENGTHENING THE REPORTING SYSTEM FROM THE STATES

Mention has already been made of the chaos prevailing in the matter of collection, processing and reporting of health information from the States. Urgent steps should be made to improve and strengthen the mechanisms at all levels. Efforts should be made to improve the quality of institution-based data gathering and also to ensure prompt reporting. The entire country has been brought under a computer network through the National Informatics Centre. Every district, in every State, has been linked with the headquarters at New Delhi. The State Health Agencies can utilise the facilities for regular transmission of data from the Districts or the State to Central Agencies of Health.

#### STRENGTHENING EPIDEMIOLOGICAL TEACHING IN MEDICAL EDUCATION

No national organisation can take over total responsibility in providing epidemiological observations for

planning purposes. In the ultimate analysis, every doctor has, though in a limited fashion, a responsibility to record and report accurate information on diseases coming to his notice. A doctor can play such a role only if his training in the medical school has prepared him to appreciate the relevance and need for epidemiological information. Medical education should liberate itself from being restricted to confining epidemiological learning to a few pages of Park's delightful text book of Social and Preventive Medicine. Epidemiological perceptions should be imparted to the students throughout their course, preferably by supplementing pedagogic learning with participatory learning. To achieve this we have to create core manpower trained in epidemiological methods in the Medical Colleges of India. Such manpower can be generated through providing short term training for the teachers of Medical Colleges, particularly of the department of Community Medicine. Nodal institutions capable of providing such training exist in different parts of the country. The manpower, thus trained, may catalyse among the students, a resurgence of interest in epidemiology by providing opportunities for creative involvement in epidemiological data gathering.

#### EPIDEMIOLOGY – A MULTIDISCIPLINARY EFFORT

As mentioned earlier, epidemiology should attract able workers from different academic backgrounds. The earlier we liberate epidemiology from the shackles of medical imperialism, the better for the country. It is therefore vital that we establish a central institute devoted to epidemiological training and research. The institute should also draw into its faculty distinguished non-medical scientists representing many disciplines. In turn, such institutes should gather around them young scholars with diverse backgrounds, committed to a career in epidemiology.

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### Ornidyl – a new drug for trypanosomiasis

Sleeping sickness caused by trypanosome parasites transmitted by the notorious tse-tse fly is found in most of sub-Saharan Africa. Between 20,000 and 30,000 people are infected every year and more than 50 million people in thirty-six countries are exposed to this disease thus posing an important public health problem. The first symptoms of sleeping sickness are malaise, fatigue and mild fever followed by somnolence, high fever, pain in the joints and enlarged liver. The next stage is when the parasites invade the central nervous system causing mental deterioration, seizures, coma and finally death. The only drug that crosses the blood-brain barrier along with the trypanosomes is Melarsaprol, which is based on arsenic and is known to cause serious side-effects.

This gloomy picture has been brightened recently by the first new drug approved for general use by FDA (USA) and WHO in the last forty years. It is Ornidyl (alpha difluoromethyl ornithine) developed by Marion Merrell Dow which has been hailed as the "resurrection drug". The effect of this drug on 600 critically ill patients who were near death's door has been dramatic. All patients completely recovered.

The mechanism by which this drug acts is very different from that of other drugs used for this sickness. It blocks the action of ornithine decarboxylase, the enzyme that makes "polyamines", which are needed for decoding genetic messages. Without these polyamines, the parasites can no longer make new cell materials, as a result of which they die.

Trypanosomes invade the human immune system by varying their surface antigens. Normally the immune system identifies parasites as foreign and attacks them but because of the camouflage, a few of these parasites escape.

The search for a drug to prevent cancer of the colon led to the discovery and development of alpha difluoromethylornithine (DFMO), (now called Ornidyl). Research at St. Mary's Hospital, London has shown that DFMO can stop virus replicating which gives the human immune system a chance to eliminate any pre-existing virus when no more viruses are being made. A difficulty earlier workers felt they would meet, was that since human cells translate genetic messages in the same way as trypanosomes do, they would also be potentially vulnerable to Ornidyl (DFMO). This did not take place, probably because the parasites absorb food through their surfaces and so absorb Ornidyl much more rapidly than human cells.