THE ROLE OF SCIENCE EDUCATION FOR COMBATING AND PREVENTING DISEASES

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This paper was presented by the corresponding author[†] at COMSATS-UNESCO International Training Workshop on Science Education for Sustainable Development, 27-28 June 2011, Dhaka, Bangladesh

ABSTRACT

In most developing countries, the role of science education for combating and preventing diseases is both minimal and impracticable. There are two main reasons to this: i) lack of medical knowledge; and ii) lack of practical knowledge. These consequences may be a result of exclusion of medically trained people in the education system, e.g. in our education systems, there is no established trend of medical doctors to teach at school, college or even at university levels. There is a provision of medical education at teaching hospitals, but they still lack the right educationists and latest trainings at par with global standards.

In order to consolidate the concept and promotion of science education in the field of health and medicine, this paper discusses four diseases commonly found in developing countries like Pakistan. These diseases are Poliomyelitis, Malaria, Rabies and Typhoid. The disability/mortality due to Poliomyelitis; the morbidity and mortality as a result of Malaria and Typhoid fever, and a very high death rate (up to 5000/year) as a result of dog bites (Rabies) are reported in Pakistan. The study takes into account myths and mysteries related to these diseases and their consequences/ complications leading to mortality. This study is focused on the prophylactic measures (prophylaxis), as an ounce of prevention is worth a pound of cure. Prophytactic measures can only be taken by creating awareness about these diseases and re-evaluation of the role of science education in all sectors.

Keywords: *Medical knowledge, Education system, Different diseases, Mortality, Pakistan.*

1. INTRODUCTION

Public Health (PH) is the science and art of preventing disease, prolonging life and promoting health through organized efforts and informed choices of society, organizations, public and private, communities and individuals (Winslow, Charles-Edward Amory, 1920). Public Health plays an important role in disease prevention efforts in both the developing world and developed countries. It is a modern concept although it has roots in antiquity. The main focus of PH intervention is to improve health and quality of life through the prevention and treatment of diseases and other physical and mental health conditions (Ali, 2000; Heymann, 2006). The other main focus of PH intervention is to prevent and manage diseases and the promotion of healthy behaviours, communities and environments. Many diseases are preventable through simple, non medical methods and this is the main focus of PH. In developing countries like Pakistan, health problems are not addressed on priority basis. Poor hygiene conditions and malnutrition in addition to poor economic condition exposing the mankind to different severe diseases. Although the vaccination for different diseases is excellent preventive measure but to administer these vaccinations and to maintain their cold chains is impossible especially when the vaccines have to be delivered to different communities far away (EPI, 2003; WHO, 2002). The maintenance and promotion of health is achieved through different combinations of physical, mental, and social well-being, together sometimes referred to as the 'health triangle'.

2. SCIENCE EDUCATION FOR COMBATING DISEASES

Epidemics and high endemic disease rates have occurred in the Central Asian Republics, the Indian subcontinent, and across Asia and the Pacific Islands. Another main characteristic of a supply of fresh water is its quality and here the link with health is very direct. One of the most significant improvements in public health came about in the 19th century with the discovery that much illness was caused by polluted water supplies.

To study and evaluate the role of science education for combating and preventing diseases in Pakistan, four diseases have been selected. These are Poliomyelitis, Typhoid, Malaria and Rabies. Out of these four two are viral (Poliomyelitis & Rabies), one is bacterial (Typhoid) and one is a vector-borne disease (Malaria). The details of these diseases are as follows:

2.1 Poliomyelitis

Poliomyelitis, generally known as polio or infantile paralysis, is a highly infectious viral disease that

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attacks the central nervous system (CNS) and is characterized by symptoms that range from a mild nonparalytic infection to total paralysis in a matter of hours. There are three known types of polioviruses (called 1, 2, and 3), each level causes a different kind of the disease. These types are members of the family of enteroviruses (Heymann, 2006; Mueller, Wimmer and Cello, 2005). Type 1 is the leads to epidemics and many cases of paralysis, which is the most severe manifestation of its infection. The virus is usually a harmless parasite, using human beings as its hosts. Some statistics quote that one in 200 infections leads to paralysis, while others state that one in 1,000 cases reach the central nervous system (CNS). When it reaches the CNS, inflammation and destruction of the spinal cord motor cells (anterior horn cells) occurs, which prevents them from sending out impulses to muscles. This causes the muscles to become limp or soft and they cannot contract. This is referred to as flaccid paralysis and is the type found in Polio. The extent of the paralysis depends on where the virus strikes and the number of cells that it destroys. Usually, some of the limb muscles are paralyzed; the abdominal muscles or muscles of the back may also be paralyzed, affecting posture (Figure-1). The neck muscles may become too weak for the head to be lifted. Paralysis of the face muscles may cause the mouth to twist or the eyelids to droop. Life may be threatened if paralysis of the throat or of the breathing muscles occurs (Aylward, 2006; Fine, 2009).

Source: *UNICEF/NYHQ2011-0198/Zaidi*

Figure-1: Children are Still being Disabled by Polio in Pakistan Despite Years of Efforts to Eradicate the Disease

Humans are the only natural host for polioviruses that most commonly infect younger children, although older children and adults can be infected as well. Crowded living conditions and poor hygienic conditions spur the spread of poliovirus. Poliovirus can spread by direct exposure to droplets (respiratory or saliva), and more commonly, by contact or eating foods contaminated with viruses from waste products from the intestines and droplets of moisture (saliva) from an infected person. Thus, the major route of transmission is feco-oral, which occurs primarily due to poor sanitary conditions. The infection is passed on to others when poor hand washing allows the virus to remain on the hands after eating or using the bathroom. The virus is believed to enter the body through the mouth with primary multiplication occurring in the lymphoid tissues in the throat, where it can persist for about one week. During this time, it is absorbed into the blood and lymphatics from the gastrointestinal tract where it can reside and multiply, sometimes for as long as 17 weeks (Falconer and Bollenbach, 2000). Once absorbed, it is widely distributed throughout the body until it ultimately reaches the CNS (the brain and spinal cord). Transmission from infected person is possible while the virus is being excreted from gestro-intestinal/ respiratory tracks and it can be transmitted till the source is disposed of. The incubation period ranges from 3 to 21 days, but cases are most infectious from 7 to 10 days before and after the onset of symptoms (Paul, 1971; Pearce, 2005).

There are two basic patterns to the virus: the minor illness (abortive type); and the major illness (which may be paralytic or nonparalytic). The minor illness accounts for 80-90 % of clinical infections and is found mostly in young children. It is mild and does not involve the CNS. Symptoms include a slight fever, fatigue, headache, sore throat, and vomiting, which generally develop three to five days after exposure. Recovery from the minor illness occurs within 24 to 72 hours. The symptoms of the major illness usually appear without a previous minor illness and generally affect older children and adults (Trojan and Cashman, 2005).

About 10 % of the people infected with polio-virus develop severe headache, pain and stiffness of the neck and back. This is due to an inflammation of the meninges (tissues which cover the spinal cord and brain). This syndrome is called "aseptic meningitis." The term "aseptic" is used to differentiate this type of meningitis from those caused by bacteria. The patient usually recovers completely from this illness within a few days.

About 1 % of the people infected with poliovirus develop the most severe form of Polio. Some of these patients may have two to three symptom-free days between the minor illness and the major illness but the

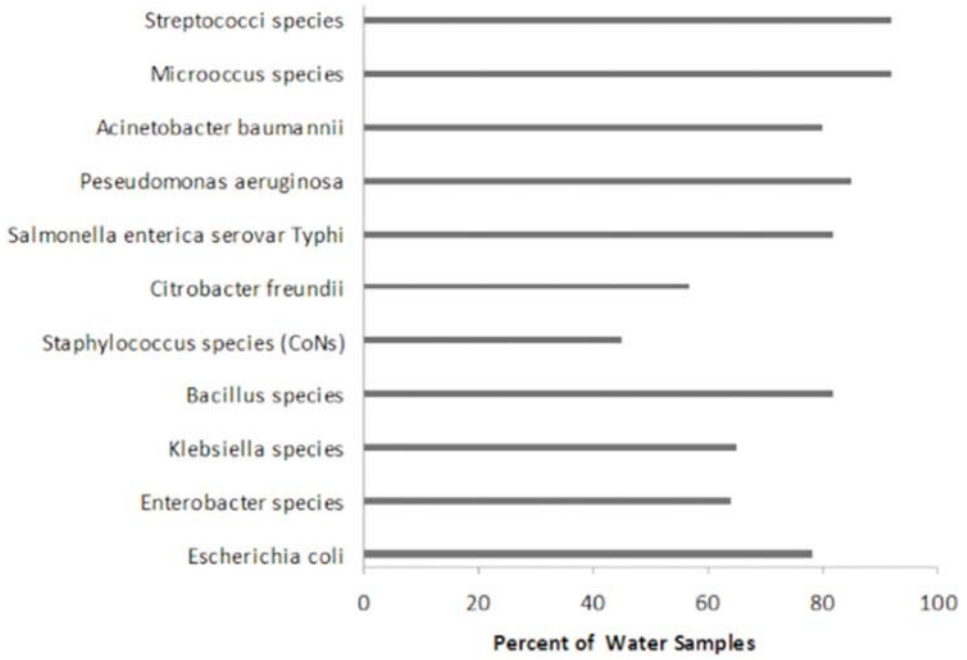


Figure-2: Different Bacterial Species Responsible for Outbreak of Typhoid Fever Associated with Drinking Water (Farooqi, Khan and Kazmi, 2009)

symptoms often also appear without any previous minor illness. The symptoms again include headache, and back and neck pain (Trevelyan, Smallman Raynor and Cliff, 2005). The major symptoms, however, are due to invasion of the motor nerves, which are responsible for movement of the muscles. This viral invasion causes inflammation, and then destruction of these nerves. The muscles, therefore, no longer receive any messages from the brain or spinal cord. All muscle tone is lost in the affected limb and the muscle becomes soft (flaccid), floppy and paralyzed within a few days, and begins to decrease in size (atrophy). The affected muscles may be on both sides of the body (symmetric paralysis), but are often unbalanced within the body (asymmetric paralysis). Sensation or the ability to feel is not affected in these paralyzed limbs (Richard, 2002; Paul, 1971).

2.2 Typhoid

Typhoid fever is the clinical disease caused by *Salmonella typhi*. This infection is endemic in developing countries where sanitation is poor. Unlike dengue or rickettsial infections, typhoid fever can evolve insidiously. According to World Health Organization (WHO), more than one billion people in low and middle income countries lack access to safe water for drinking, personal hygiene and domestic use (Figure-2). These numbers represent more than 20% of the world's population. In addition, almost 2 billion people do not have access to adequate sanitation facilities. Water-borne diseases, according to the WHO, are those generally arising from contamination of water by feces or urine infected by pathogenic viruses or bacteria. These are directly transmitted to new hosts when such contaminated water is ingested or used in the preparation of food. Worldwide, typhoid fever affects roughly 17 million people annually, causing nearly 600,000 deaths (Crump, Luby and Mintz, 2004; Acosta, et al., 2004; Bahl, et al., 2004). The causative agent, *Salmonella typhi*, is an obligate parasite that has no known natural host except humans. This gram-negative enteric bacillus belongs to the family Enterobacteriaceae. It is a motile, facultative anaerobe that is susceptible to various antibiotics. Currently, 107 strains of this organism have been isolated; many containing varying metabolic characteristics, levels of virulence, and multi-drug resistance genes that complicate treatment in areas where much resistance is prevalent (Farooqi, et al., 1991; DeRoek, et al., 2005).

Infection of *S. typhi* leads to the development of typhoid, or enteric fever. This disease is characterized by the sudden onset of a sustained and systemic fever, severe headache, nausea, and loss of appetite. Other

symptoms include constipation or diarrhea, enlargement of the spleen, possible development of meningitis and general malaise (Robbins, et al., 1996). Untreated typhoid fever cases result in mortality rates ranging from 12-30 %.

The encounter of humans with *S. typhi* occurs via fecal-oral route from infected individuals to healthy ones. Poor hygiene of patients shedding the organism as well as consumption of shellfish from polluted water bodies can lead to secondary infection. The most common source of infection, is drinking water and food tainted by urine and feces of the infected individuals. The estimated inoculum size necessary for infection is 100,000 bacteria. Typhoid fever also represents the second most commonly reported laboratory infection. Once ingested, the organism multiplies in the small intestine over the period of 1 to 3 weeks, breech the intestinal wall and spread to other organ systems and tissues. Transmission of *S. typhi* has only been shown to occur by fecal-oral route, often from asymptomatic individuals. Two to five of previously infected individuals become chronic carriers who show no signs of the disease, but actively shed organisms capable of infecting others (Parry, et al., 2002; Bahl, et al., 2004). The key to avoiding infection by S. typhi is prevention of fecal contamination in drinking water and food supplies. Since the only source of this agent is infected humans, it is possible to control transmission through measures, such as proper hygiene, waste management, water purification, and careful treatment of the sick. These measures are suitably taken in developed societies, resulting in the lower incidence of the disease (WHO, 1986).

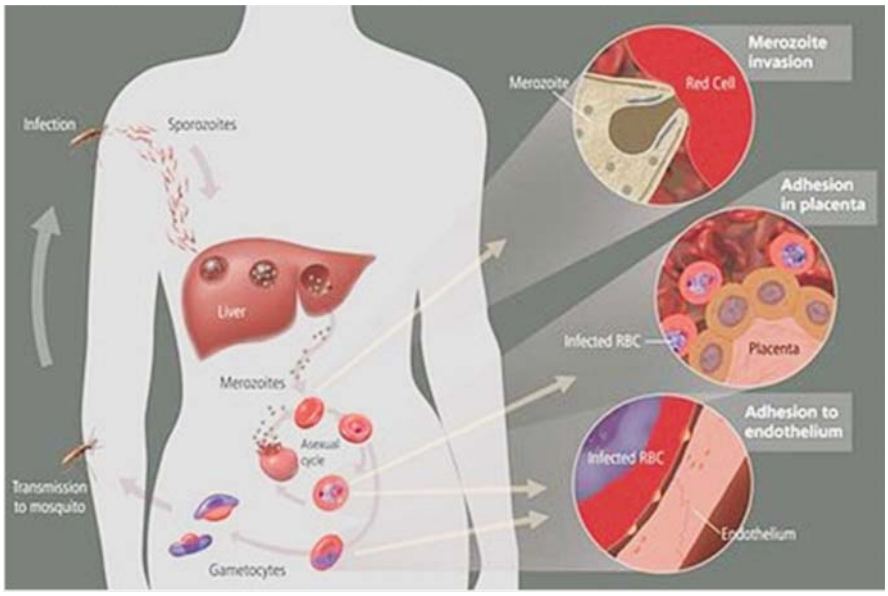
2.3 Malaria

Malaria is a mosquito-borne infectious disease caused by eukaryotic protista of the genus Plasmodium. It is widespread in tropical and sub-tropical regions, including much of Sub-Saharan Africa, Asia and the Americas. Malaria is prevalent in these regions because of the significant amounts of rain-fall and consistent hot temperatures. This warm humid climate provides mosquitoes with perfect environment to breed continuously. The disease results from multiplication of the malaria parasite within red blood cells (Figure-3), causing symptoms that typically include fever and headache, in severe cases progressing to coma and death (Andrej, et al., 2003; Hoffman, Goh and Luke, 2002). Four species of Plasmodium can infect and be transmitted by humans. Severe disease is largely caused by Plasmodium falciparum. Malaria caused by Plasmodium vivax, Plasmodium ovale and Plasmodium malariae is generally milder and rarely fatal. Fifth sub-species is Plasmodium knowlesi, which causes malaria in macaques but can also infect humans (Hanscheid and Grobusch, 2002).

In developing countries, outbreaks of malaria can be contained by preventing mosquito bites through distribution inexpensive mosquito nets and insect repellents, and taking mosquito-control measures, such as spraying insecticides inside the houses and draining stagnant water that facilitates mosquito breeding. Although many vaccines are under development, the challenge of producing a widely available vaccine that provides a high level of protection for a sustained period is still to be met. Two prophylactic drugs are also available that can prevent malaria while traveling to malaria-endemic countries (Humphreys, 2001; Lin, et al., 2001). Pakistan's Roll Back Malaria (RBM) strategy has been undermined by the country's weak health infrastructure, poverty, shortage of qualified doctors and inadequate data for monitoring the high mortality rate of the infection. For the RBM initiative, the Government of Punjab the largest province of Pakistan, approved Rs. 39.750 million for 2003-2008 and increased this to Rs. 185.680 million for the years 2009-2014.

The Malaria parasite's secondary (intermediate) hosts are humans and other vertebrates. Female mosquitoes of the genus Anopheles are primary hosts and transmission vectors. A mosquito becomes infected when it takes a blood meal from an infected human (Pattanasin, et al., 2003; Moody, 2002). Once ingested, the parasite gametocytes taken up in the blood will further differentiate into male or female gametes and then fuse in the mosquito's gut. This produces an ookinete that penetrates the gut lining and produces an oocyst in the gut wall. When the oocyst ruptures, it releases sporozoites that migrate through the mosquito's body to the salivary glands, where they are then ready to infect a new human host. This type of transmission is occasionally referred to as ‘anterior station transfer’. The sporozoites are injected into the skin, alongside saliva, when the mosquito takes a subsequent blood meal (Lee, et al., 2002; Meis, et al., 1983; Moody and Chiodini, 2000).

Only female Anopheles mosquitoes feed on blood while male mosquitoes of the genus feed on plant nectar. Thus, the male Anopheles do not transmit the disease. The females of the Anopheles genus of mosquito prefer to feed at night. They usually start searching for a meal at dusk, and will continue



Source: *wikipedia.org*

Figure-3: The Life Cycle of Malaria Parasites

throughout night. Malaria parasites can also be transmitted by blood transfusions, although this is rare (Lon, Tsuiuoka and Phanourong, 2006; Nguyen, et al., 1995).

2.4 Rabies

Rabies virus is neurotropic virus that can be fatal to humans and animals. Rabies transmission can occur through the saliva of animals. The rabies virus has a cylindrical morphology and is the typical species of the Lyssavirus genus of the Rhabdoviridae family. These viruses are enveloped and have a single stranded RNA genome (WHO, 2006).

From the wound of entry, the rabies virus travels quickly along the neural pathways to the CNS. The retrograde axonal transport of the rabies virus to the CNS is the key step of pathogenesis during natural infection. The exact molecular mechanism of this transport is unknown, although binding of the P protein from rabies virus to the dynein light chain protein DYNLL1 has been established. P protein also acts as an interferon antagonist, thus decreasing the immune response of the host (Hong and Banta, 2005).

From the CNS, the virus further spreads to other organs. The salivary glands located in the tissues of the mouth and cheeks receive high concentrations of the virus, thus allowing it to be further transmitted (McEwen, 2006). Fatality can occur from two days to five years from the time of initial infection. This however, depends largely on the species of animal acting as a host. Most infected mammals die within weeks, while strains of a species such as the African Yellow Mongoose (Cynictis penicillata) might survive an infection asymptomatically for years (Badrane, et al., 2001; Hong and Banta, 2005). Rabies is a serious and long neglected disease, mainly affecting the poorer strata of our society.

3. MATERIALS AND METHODS

This study is based on the data collection from 2001-2005. The following institutions of Lahore (one of the most populous cities of Pakistan), were selected for this purpose;

i. Institute of Public Health (IPH), 63 Shadman;
ii. Sir Ganga Ram Hospital, Queen Road; and
iii. The University of the Punjab.

For Rabies, all day-to-day matters at IPH and the cases of Rabies during 2001-2005 all over the Punjab province were discussed with the Punjab Medico-legal Officer because IPH was overseeing with the whole Province. For Malaria and Typhoid cases, patients as well the duty doctors were interviewed. A total of 500 indoor patients (100/year) and 2,000 out-door patients (400/year) were interviewed. The University of the Punjab was selected for studying 110 disabled persons and different Polio campaigns in the periphery

of Lahore city. In addition to this, 70 general practitioners (GPs) in Lahore city were interviewed. Moreover, the latest information about the current trends was also gathered from the people serving in different vaccination companies in the countries, such as Aventis, Amson, Berna and Galaxo Welcome.

4. RESULTS AND DISCUSSIONS

It has been established that contaminated water is one of the biggest source of spreading commendable diseases. All except the most carefully protected sources of fresh water must therefore be treated before they are considered fit for human consumption (Sinha, et al., 1999). It is important to know the quality and characteristics of any water source so as to design appropriate treatment, and also monitor the quality of the supply continuously for immediate response to any unexpected pollution. Wastewater draining from urban and industrial areas must also be treated before it is returned to the environment so that it does not become a threat to human health (Wain, et al., 1997; Wain, et al., 2001). Again, there is a need to monitor, not only the wastewater, but also the quality of the waters into which it drains, because reduced water levels can concentrate pollutants and pathogens in both surface-water and groundwater.

According to discussion in National Assembly of Pakistan (2010), out of the total 150 cases of Polio reported in the country, 107 were the children who were given the Polio drops. The Health Minister stated that polio drops given to children suffering from diarrhea were ineffective. The other issue identified was the maintenance of cold temperature required for preserving the vaccine, while delivering it to far-off areas. The third most important reason behind the vaccine's ineffectiveness as found to be its direct exposure to sunlight. However, the staff administering the vaccine did not know the specification that Polio drops given in sunlight activates Poliovirus in the vaccine causing the disease instead of eradicating it. For this purpose, 110 people affiliated with the University of the Punjab and affected by polio virus were interviewed, including enrolled students of different departments under the age of 30 years; they all admitted that they had been given the Polio drops two to three times under the age of five years but they got infected anyway.

According to WHO, 50,000 cases of Malaria are reported every year in Pakistan. Malaria eradication campaign was launched in 1961 yet Malaria continues to be a major public health problem in Pakistan. Extensive agriculture practices, a vast irrigation network and monsoon rains have considerably added to malariogenic potential in many areas. Moreover, more manifestations of mosquito-borne diseases are seen in the form of dengue fever. Secondly, there is no difference in the symptoms of Malaria and Typhoid fever. Severe and sometimes wrong medication for Malaria, if a person having malaria is given treatment for and vice versa, causes further complications.

More than 70 % doctors do not use the lab. facility at the beginning of treatment, rather they only rely on medication that leads to more complications. Moreover, most general practitioners use the medicines both for Malaria and Typhoid at the same time as the apparent symptoms of Malaria and Typhoid are the same (i.e. high fever and shivering) in both cases. This overdose of medication results in many post-treatment complications. Similarly, there is no availability of laboratory facility in OPDs, at government hospitals, and doctors only recommend lab. tests to indoor patients, which do not account for more than 5 % of the total patients.

The reported dog bite cases do not give the exact and real picture of the Rabies infection. Only the reported cases i.e., that visit different big hospitals, are around 30,000-50,000 annually. In most hospitals, dog bite cases are treated with first aid (washing the wound with spirit) and administration of tetanus vaccine to satisfy the patients coming from far-flung areas. A very limited number of patients is given the Rabies vaccine prepared by National Institute of Health (NIH) and its efficacy is doubtful. Patients have to visit hospitals fourteen times as 14 injections are administered subcutaneously, which is a very painful, time-consuming and inconvenient process. A meagre ratio of 1 out of 500 patients very influential are given the privately marketed vaccine that is originally purchased by the Government to support and save the lives of the poor people. These results and discussions show that more has to be done for combating and preventing even the common diseases in the country.

5. CONCLUSIONS

The Public Health programme should be re-evaluated according to the new trends of public demand. In Pakistan, only the diploma courses have been initiated but the higher degrees like Ph.D in public health are in progress and the minimum number of trained staff is insufficient to create the desired level of awareness. The most important point in this regard is that a person lacking enough information should not make

suggestions of any sort. In developing countries, however, complications start from self medication – non-medical personnel, uncertified and less certified doctor. A degree programme in biometeorology at university level can help address many public health problems if the university has a trained and well-informed faculty for teaching and research in the relevant field, addressing the new and contemporary health challenges.

6. RECOMMENDATIONS

- The subject of science at school levels should be revised according to new demands of public health.
- The subject of biology at high school levels should include a satisfactory portion regarding the public health.
- The subject of biometeorology should be included in colleges and universities addressing the common health problems with the help of applied research at community levels.
- Extensive trainings on public health policies must be initiated.
- Public Health departments at hospital should be sensitized and made responsible to provide services at the door steps of even the farthest communities.
- A patient must be made aware about common diseases and encouraged to consult a well qualified doctor only.

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