1. Water pollution and health: a deadly burden

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1500 million litres/day (mld),that is the amount of sewage generated by each of the 23 macro cities in India and only a fraction of this is treated while the rest flows into the rivers and other dumping grounds. From these grounds emanate death and disease. Who is responsible, the government or the consumers or is it the scarcity of finances that claim such a heavy toll each year. What is it that has enforced the grip of diarrhoea and cholera over mankind? Is it the microbe or is man himself responsible?

Water related diseases are those, which are caused by pathogens or chemicals where water acts as a conveyance or medium. For example, microbes and arsenic present in water caused cholera and arsenicosis respectively to human being. Water related diseases are divided into infectious diseases (biological – bacteria, virus, worms etc) and non-infectious diseases (chemicals – arsenic, fluorosis, nitrates etc). Water related diseases are essentially environmental health related issues as these are linked with polluted water, sanitation and hygiene and these three are intertwined determinants. Water gets polluted with pathogenic microorganisms, parasites, and toxic chemicals mostly due to human intervention. Growing population, lack of sanitary condition, poverty, poor planning, industrial pollution, over exploitation of natural water and natural disasters are the main reasons of pollution of water. Currently majority of Indian rivers are polluted due to drainage of sewerage, solid wastes and industrial effluents into the rivers and streams with out any treatment. Millions of people living along the rivers are exposed to polluted water while taking bath and using them for domestic purposes. Ground water is also becoming unfit for human consumption due to seepage of microorganisms from polluted surface water of rivers, stream and numerous water bodies.

Water borne diseases

Water borne diseases are essentially biological, caused by bacteria, virus and parasites. There are various forms manifestations due to infection of water borne pathogens, most important is diarrhoea. Diarrhoea is defined as the passage of loose stool, liquid or watery stools. The term ‘diarrhoeal diseases’ should be considered only as a convenient expression – not as a nosological or epidemiological entity – for a group of diseases in which the predominant symptom is diarrhoea. WHO/Unicef defines acute diarrhoea as an attack of sudden onset, which usually lasts 3 to 7 days, may last up to 10 – 14 days. It is caused by infection of bowel. In many cases diarrhoea stools are watery but if blood is visible in stools, the condition is called dysentery.

In developing countries, diarrhoea is almost universally infectious in origin. A wide assortment of organisms cause acute diarrhoea, and many of them have been discovered only recent years such as rotaviruses and campylobacters. The following figure shows the common pathogens which cause diarrhoea in different countries. Viruses are probably responsible for about one-half of all diarrhoeal cases aged up to 2 years. Enterotoxigenic E Coli is an important cause of acute watery diarrhoea in adults and children in

developing countries. It mostly spreads by means of contaminated food and water. Shigella is a major cause of diarrhoea in India. Some subtypes of shigella causes dysentery in epidemic form. In 1984, there was report of shigella epidemic in West Bengal and eastern states affecting 350,000 and leaving about 3,500 dead mostly children. Cholera probably accounts for not more than 5 to 10 per cent of all diarrhoeal cases yearly. More than 90 per cent of instances are not clinically distinguishable from other form of diarrhoea. Therefore, all national level cholera reported cases are based on laboratory confirmed diagnosis based on stool examination. Amaebiasis (E. Histolytica) and giardiasis (Giardia intestinalis) and other intestinal parasitic infections are associated with diarrhoea.

Infections of intestine causing diarrhoea

Virus	bacteria	Others
Rotavirus	**Vibrio cholerae**	**E. histolytica**
Astrovirus	**E Coli**	**Giardia intestinalis**
Adenovirus	**Shigella**	**Intestinal worms**
Calcivirus	**Salmonella**	Cryptosporidium
Coronavirus	Vibrio parahaemolyticus	
Norwalk group virus	Campylobacter jejuni	
Enterovirus	Bacillus cereus	

** Major pathogens in Indian context are in bold*

Apart from infections of intestines, other form of systemic infections also leads to diarrhoea, particularly among the children. These include ENT infections, respiratory and urinary infections, malaria, bacterial meningitis, or even simple teething. Besides these, malnutrition may lead to certain nutritional diseases such as kwashiorkor, sprue, celiac diseases, and pellagra which are all associated with diarrhoea. Diarrhoea in the newborn is unusual and may be due to inborn errors of metabolism such as congenital enzyme deficiencies. It may also associate with severe infections like septicaemia and necrotizing enterocolitis. Persistent diarrhoea is one of the main clinical signs of AIDS in tropical regions.

In India the major pathogenic organisms responsible for water borne diseases (both diarrhoea and non-diarrhoea) are mentioned in the table below. These pathogenic organisms are transmitted mostly due to contaminated water, improper sanitation and poor hygiene practice. There are some water borne diseases, which usually do not cause diarrhoea for instance viral hepatitis A, E and typhoid. A number of parasitic diseases (hook worm, other worm infestations) are not water borne diseases. But they are

included, as their presence in human body is essentially linked to poor sanitation and hygiene practice, which are major determinants of water borne diseases. E. histolytica and Giardia are unicellular, microscopic parasites causing diarrhoea. Hookworm and other intestinal worms are multi cellular, usually visible in naked eyes and mostly cause nutritional deficiency. These bigger parasites suck blood from intestinal walls and semi-digested foods. People suffering from large worm infestations usually have anaemia and nutritional deficiency. Several water borne diseases are also food borne, as both are inter linked. Foods (particularly raw) get contaminated by same pathogenic organisms causing water borne diseases while irrigated, washed, cooked with contaminated water or handled by the persons not following proper hygiene practice.

Pathogenic organisms	Major target organs				Major symptom/s
	Intestine	Liver	Nervous system	Other system	
Bacteria					
• E Coli	#				Diarrhoea
• Shigella	#				Diarrhoea/dysentery
• V. cholera	#				Diarrhoea
• Salmonella	#			#	Fever, pain abdomen, constipation, sometimes diarrhoea
Virus					
• Hepatitis A		#			Jaundice
• Hepatitis E		#			Jaundice
• Polio virus			#		Paralysis of limbs
• Rota virus	#				Diarrhoea
Parasites					
• E. histolytica	#				Diarrhoea
• Giardia	#				Diarrhoea
• Hook worm	#				Weakness/anemia
• Other intestinal worm	#				Weakness/anemia sometimes diarrhoea

1.1 Water-related infectious diseases: the global burden

Every day diarrhoeal disease causes an estimated 5,483 deaths, mostly among children. WHO's global estimate of the number of deaths from infectious diarrhoea in the year 2001 amounts to 2 million for all age group, which is equivalent to 20 jumbo jets crashing every day. Health statistics for the year 2000 shows that globally between 1,085,000 and 2,187,000 deaths due to diarrhoeal disease can be attributed to the water

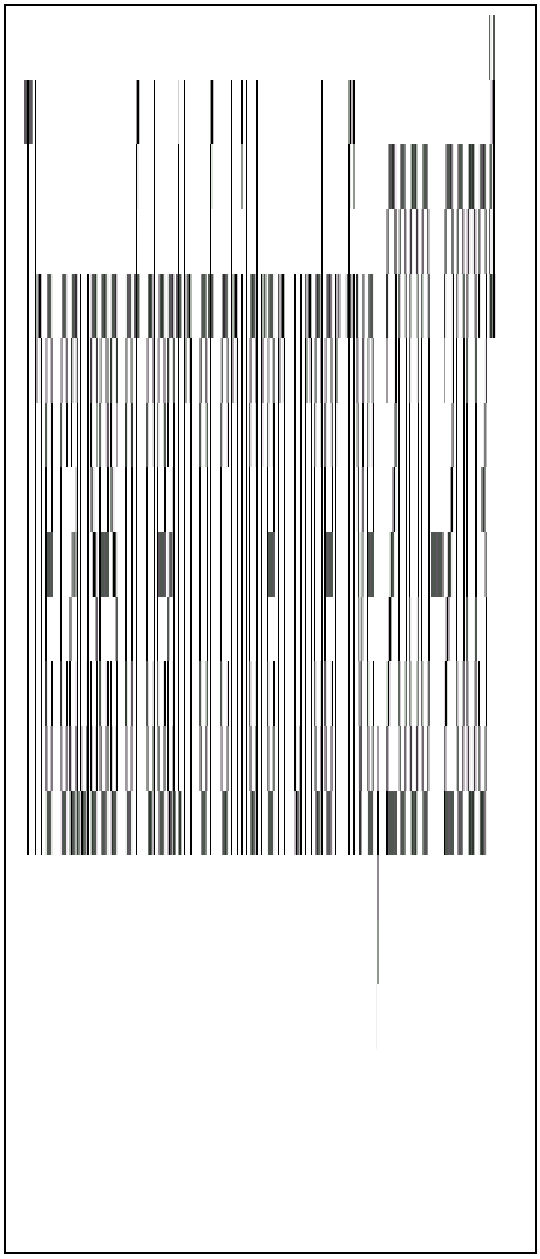
sanitation and hygiene risk factor.[i] Heavy toll mostly found among children under five years of age. In 2001, 58 countries from all regions of the world officially reported to WHO a total of 184,311 cases and 2,728 deaths due to cholera. With a total of 173,359 cases, Africa accounted for 94% of the global total of cholera cases. The situation in Asia remained stable with a total of 10,340 cases reported. Reports from the Americas and Asia declined, and Europe notified only imported cases. However, globally the actual figures are estimated to be higher owing to underreporting and other limitations of surveillance systems and to the increased size of vulnerable populations. According to WHO, typhoid affects around 17 million persons in the world every year. More than 600,000 succumb to it.[ii] Worldwide over 2 billion people are infected with schistosomes parasites and soil transmitted parasites and 300 million of these suffer serious illness as a result. Each year 1000 million people are infected with roundworm and whip worm (variety of parasites visible in naked eyes) with highest rate of infection among school going children. Every year 900 million people are suffering from hookworm infestation. Intestinal protozoa (microscopic and unicellular parasites) of importance to man are *Entamoeba histolytica* and *Giardia duodenalis*. *E. Histolytica* affects about 10% of the world's population or 480 million people; however, this infection can be as high as 25% in certain areas of underdeveloped tropical countries.[iii] About 36 million develop clinical amebiasis and about 40,000 die annually. *G. duodenalis* is the most common intestinal protozoa infection and it is found throughout temperate and tropical regions. Their prevalence varies between 2% - 5% in developed countries and 20% - 30% in developing countries.[iv]

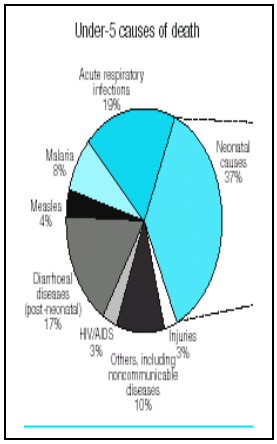
BOX -DALY – Measuring burden of disease

The numerical figures could give the understanding of morbidity and mortality attributed by water related diseases. But impact of diseases in terms of their burden on society cannot be measured by number of sick population and death. In prioritising of disease control measure, disease burden is more important than absolute numbers. It became more important in developing countries, suffering from resource constraint. Hence, this health economic debate led to the development of a number of new indicators linking the costs of interventions to health outcomes in terms of quality of life and well being, while striving for greater equity. In 1993 World Bank formally introduced a new indicator of population health, the Disability-Adjusted Life Year (DALY). The DALY is a summary measure of population health. One DALY represents a lost year of healthy life and is used to estimate the gap between the current health of a population and an ideal situation where everyone in that population and an ideal situation where everyone in that population would live into old age in full health. For each disease DALYs are calculated, on a population scale, as the sum of years lost due to premature mortality (YLL) and the healthy years lost due to disability (YLD) for incident cases of the ill-health condition. DALYs may be used to evaluate health policies, to compare intervention alternatives, and to assess risk factors.[v] Nevertheless, the limitations of DALYs are also recognised. DALYs do not cover multiple causes and long latency periods, nor do they capture discomfort, pain, suffering, stigma or the

social and economic consequences involved in many conditions, such as the burdens that maternal deaths cause in households and communities. The proponents of DALYs acknowledged that certain issues are not reflected, including average levels of population health, reductions in health inequalities.[vi]
Box ends --

DALY (Disability-Adjusted Life Year) is the most popular tool to measure the disease burden, amidst controversy. According to world health report 2001, water, sanitation and hygiene related ill health amounted 3.9 per cent of total global death and 5.6 per cent of total DALYs. According to WHO (world health report 2001), there are more than 2 million deaths and 59.7 million DALYs lost due to diarrhoea. WHO's SEARO contributed highest mortality (i.e. 0.95 million deaths and 23.4 million DALYs lost). In the same region under five children diarrhoea episodes ranged from 0.7 to 3.9 episodes per child per year. Recent UNICEF report shows that 30.7 and 21.1 per cent global children are deprived of sanitation and water respectively. 16.1 and 14.2 per cent children are deprived of proper nutrition and health care respectively, which also contribute to high mortality and morbidity of water related diseases among the children. Moreover, only 31 per cent children get oral rehydration therapy and continued feeding during diarrhoea.[vii] According to world health report 2005, diarrhoea is the third major contributor of death among the children under 5 years (17%). (Below)





Microbiological testing of all stool samples is not feasible. But the proportion of specific pathogens responsible for water borne diseases can be obtained from hospital based data with lab report. Pathogens, which are frequently identified in children with acute diarrhoea in treatment centres in developing countries show that around half or more of the diseases are due to rotavirus, E Coli and Shigella. About one third of the diarrhoea cases showed no pathogens. The possible explanations may be due to poor laboratory techniques, including sample collection procedure, transportation, storage and microscopic techniques. Or, may be due to any non-microbiological causes, for instance any enzyme deficiency or disorder. This proportion may vary from country to country and also with in the country in various ecological locations.

Pathogens		% of cases
Virus	Rota viruses	15-25
Bacteria	E Coli Shigella Campylobacter jejuni Vibrio cholera Salmonella (non-typhoid)	11-25 5-15 10-15 5-10 1- 5
Others	Cryptosporidium	5-15
No pathogens found		20-30

1.2. Water-related infectious diseases and their burden in India

India diarrhoeal diseases are major public health problems among the children under the age of five years. The Planning Commission in its report - *India Assessment 2002 – Water Supply and Sanitation,* acknowledges that mortality and morbidity levels due to water borne diseases in the country are unacceptably high. The report quoting from the National Health Policy 2002 (NHP) also recognizes that these unsatisfactory health indices are a result of the public health system failing to meet the preventive and curative health requirements of the general population. The policy also recognises that common

waterborne infections continue to contribute to a high level of morbidity even though the mortality rate may have been slightly checked.[viii] Ranking of diseases categories in national planning and in different national data sets (1985-89) based on morbidity and mortality show that diarrhoea ranks top in morbidity and 10th in mortality. According to 10th five-year plan document, 70-80 per cent of water related diseases are related to water contamination and poor sanitation and majority of them are children. In India about 80 per cent children suffer from water related diseases every year.[ix] In health institutions, up to a third of total paediatric admissions are due to diarrhoeal diseases and up to 17 per cent of all deaths in indoor paediatric patients are diarrhoea related. Girls are twice as likely to suffer due to lack of attention paid to the well being of girl children.[x] The problem water related diseases are more acute in rural India, where almost 70 per cent of the nation lives.

Central Bureau of Health Intelligence (CBHI) 2002 report shows that among all reported communicable diseases, 29% shared by diarrhoeal diseases. Data collected by the CBHI Ministry of Health and Family Welfare, shows that in 2003 there were 10.5 million cases of diarrhoea with 4709 deaths. In the same year there was 2893 cholera cases. India belongs to high endemic country of enteric fever. There were total 535665 enteric fever cases (typhoid fever) in 2004. Recent surveillance studies from India have shown that the incidence rate of enteric fever may peak as early as 1–5 years of age.[xi] It is a national embarrassment that after Nigeria, India contributes second largest number of polio cases in the world. Even poor neighboring countries like Bangladesh and Nepal wiped out polio. In 2004, there were 136 and 1267 wild polio cases in India and whole world respectively.[xii] Microscopic parasitic infection (amebiasis and giardiasis) is very common in India. But there is no national level figures on extent of amebiasis or giardiasis. In tropical countries, like in India mixed infection (infection by multiple organisms, - particularly the combination of bacteria and microscopic parasites) is very common. Often acute diarrhoeal diseases could not be diagnosed whether it is caused by virus, bacteria or parasites. Therefore, by and large of diarrhoeal cases, caused by parasites are included in acute diarrhoeal diseases. Similarly, there are no records on worm infestations in India. However, most regions like Kerala, West Bengal, Assam are more prone to have worms in soil, than dry regions like Rajasthan. According to CBHI report number of viral hepatitis cases in 2002 was more than 4 lakhs.

Burden of water related infectious diseases in India

Each episode of diarrhoea costs household's and nation's economy as well. At household level economic loss includes cost of treatment, wage loss during sickness period. Lose of working days affects the productivity of the nation. On the other hand, government spends on treatment of sick and providing other supportive services, which incurred huge expenditure. According to government of India, these all adds up to Rs. 6700 crore annually (i.e. approximately Rs 60 per head per year). Public health expenditure in India has declined from 1.3% of GDP in 1990 to 0.9% of GDP in 1999. The national rural

health mission (2005-2012) of Government of India has target of rising public spending on Health from 0.9% of GDP to 2-3% of GDP.

According to world health report 1999, 8.2 per cent of DALYs lost in India is contributed by diarrhoeal diseases. Same report also stated that 30.1 per cent of global DALYs lost due to diarrhoeal is contributed by India alone. Comparing with other low and middle-income countries, India's position is worse. While in low and middle-income countries, 5.7 per cent of DALYs lost due to diarrhoeal diseases; India lost 8.2% of its total DALY. Intestinal nematodes (parasites) contribute 0.3 per cent of global burden of diseases and also same proportion with India. By global comparison, 18.6 and 31.3 per cent of all nematodes and hookworm (a kind of nematodes) infection are contributed by India only. Hookworm infection is the most important intestinal parasitic infection, as it can cause severe chronic anaemia, physical growth retardation among the children.

% of DALY of individual region					
	World (100%)	High Income countries (100%)	Low and middle income countries (100%)	India (100%)	India / World
Diarrhoeal diseases	5.3	0.3	5.7	8.2	30.1
Intestinal nematode infections	0.3	0	0.3	0.3	18.6
Hookworm disease	0.1	0	0.1	0.2	31.3

When estimation is more reliable than printed report

While government data gives gross under estimation of mortality and morbidity, some estimated data by international agencies expose startling figures. These estimations are usually done by pooling of the data of multicentric population based survey. WHO and World Bank estimated that around 5 lakh populations in India die due to diarrhoea. Community level study conducted jointly by WHO and UNICEF, which was published in planning commission's India assessment report 2002, shows that every child below 5 years of age has 2-3 episodes of diarrhoea every year. It means many hundred million cases of diarrhoea occur every year and only a small percentage of diarrhoeal diseases are reported every year.[xiii] According to Scott Wittel of Program for Appropriate Technology in Health (PATH) estimated 125,000 Indian children die each year from Rotavirus diarrhoea.[xiv] According to the planning commission report "To advocate the development of water supply and sanitation infrastructure and increased efficiency within the sector, health authorities will need to improve their information base. This can be achieved by linking disease surveillance with environmental surveillance programmes, by strengthening research capacities on Epidemiology of water related disease and economic analyses, and by improving information management and communications capabilities. Health authorities must take action to ensure inter-programme collaboration, where water supply and sanitation concerns intersect with programmes for disease prevention and

control."[xv] The question is why under reporting? – whether deliberate attempt, or lack of motivation or systemic failure. (See box below)

Box-
Under reporting – stumbling block to get right picture
Low reporting - Groping in the dark
It is worth to mention that the reports of disease incidence in India are grossly under reported. State wise report shows many states are showing no report or nil. There is no system to keep an eye on the situation in the country either. The morbidity data is a tip of the iceberg, as CBHI report is merely a compilation of annual reports sent by the concerned state health authorities. State authorities collect reports from only government hospitals including medical colleges and specialized hospitals, district hospitals and primary health centres. But apart from CBHI, there is no other agency to be relied upon, as it is directly under directorate general of health services, Ministry of Health and Family Welfare. The private practioners and private hospitals are always outside the reporting networks.
Report from Central Bureau of Health Information (CBHI) on water borne disease was with out inputs from important populous states like Uttar Pradesh, Bihar and also Chattisgarh, Jharkhand, Arunachal Pradesh, Assam and Uttaranchal. Report regarding cholera Bihar and Uttar Pradesh mostly showed nil or no report. These two states contribute around one fourth of countries population. Therefore non-availability of reports grossly under estimate the state of the affair. But NICD's own report shows cholera out break in Muzzafarpur district in Bihar during flood in 2000.[xvi] But CBHI report shows no evidences. CBHI reports also show that several southern states, Maharashtra, Delhi, Himachal Pradesh and West Bengal having higher prevalence rate of all water borne diseases. But high prevalence is not necessarily the indication of poor public health services of these states; rather several studies show completely reverse pictures. Public health services and reporting qualities of these states are better than Bihar, Uttar Pradesh, Rajasthan, Jharkhand, Orissa and Madhya Pradesh. Poor quality of public health service is linked with poor reporting and hence it wrongly portrays lower prevalence. Dr Rajib Dasgupta from JNU, New Delhi and former epidemiologist of MCD, said that under reporting in CBHI has been common features, as the concerned agency was totally dependent on state government to receive report. Often the state health agencies do not send regular report to CBHI. More over the quality of report collected by the states from their districts were also questionable. Similar to CBHI, State health authority is also dependent on district health authorities. Erratic reporting of district authorities makes the compilation of state level report very difficult. Condition of certain states, for instance Bihar, UP, Jharkhand, Chattisgarh, MP and NE India are poor. District authority is also dependent on concerned Primary Health Centre to get prompt report. Eventually whole reporting network and it quality depends on availability of manpower and motivation in every level. In several districts, many posts of doctors and health workers are lying vacant for years due to paucity of funds and lack of political will to fill up. Hence the absence of reporting authorities at grass root level grossly hampered the reporting of actual figures as mentioned by Dr

Dasgupta. He said despite better quality reporting system and constant administrative pressure, there is also data discrepancy between MCD and CBHI. MCD data mostly shows higher figure than CBHI data, probably due to irregular reporting from MCD to CBHI.[xvii]

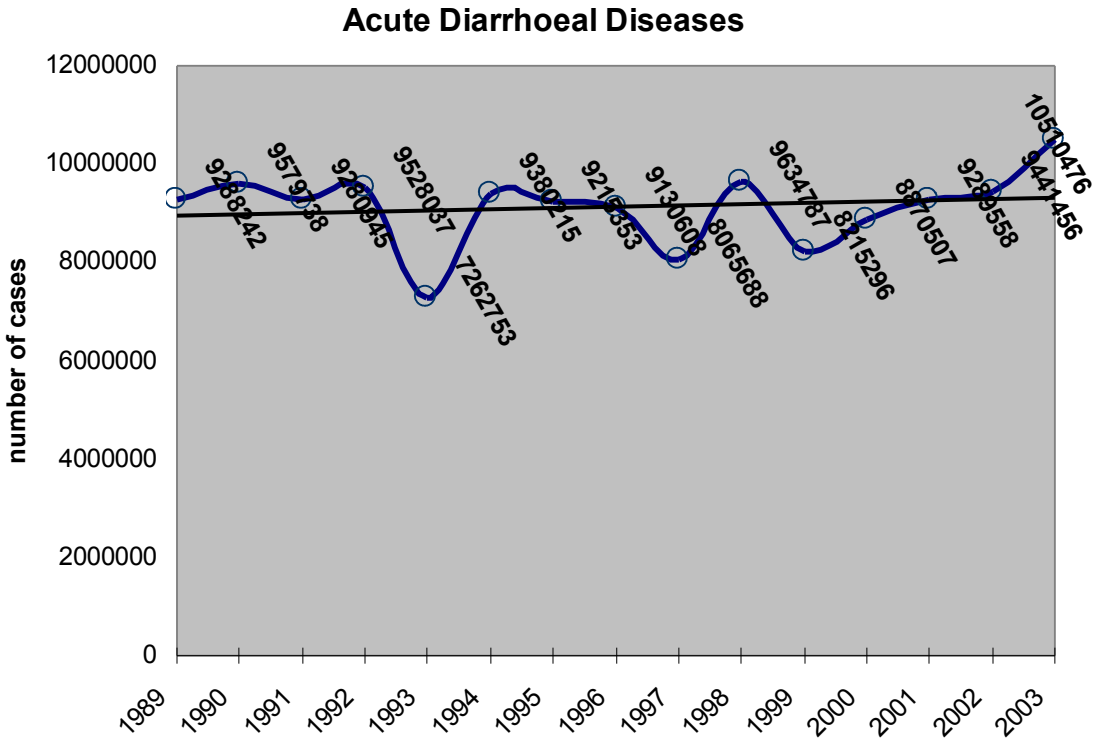
Commenting on the lack of data available for diarrhoeal diseases in the country, Sudhansh Malhotra, with the WHO's Child and Adolescent Health and Development Section, says, "Unless it becomes legally binding on states to provide health information and data, health systems in the state will continue to remain at a rudimentary stage and continue to malfunction." Malhotra says it is high time a stringent surveillance system was developed. According to Dr Dipika Sur of National Institute of Cholera and Enteric Disease, Kolkata, cholera is always under-reported so that is a major obstacle.[xviii] According to Dr AK Pande, AD (UIP) of Uttar Pradesh, there is always information gap among various authorities and no unified policy to collect data. Moreover there are several government agencies, which ask similar kind of report from same health authorities, which cause confusion. Department of women and child development, social welfare department, department of health, international organizations as partner agencies ask report in various occasions. Also the method of collection of reports, collation, compilation and dispatch are not prompt. Poor health infrastructure hinders to collect right report.[xix] Often the concerned doctors and health staff include all kinds of water borne diseases in one heading i.e. diarrhoea or acute gastro enteritis in order to avoid separate compilation of data. Cholera is notified disease and any suspected cases to informed to higher authority. But often, prompt reports from sincere doctors bring backlash in the form of show cause notice or unpleasant situations on account of controversial and conflicting reports in media. These possible eventualities prohibit the concerned doctors and health workers to give right pictures. On the other hand there are large number of private hospitals and dispensaries that cater larger chunk of patients in India. More over due to expansion of privation of health services, the quantum of patients in private sectors are on rise. But unfortunately there is little network between govt and private sectors. Hence several cases, visited to private sectors are not reported to govt authorities. Neither private sector takes any effort to report all infectious diseases (except during epidemics) to local authorities nor local authorities approached rightly to sensitise the private doctors including quacks, who examine large number of cases. Self-medication is also under reason of under reporting. People straight away ask the chemists to give antibiotics for any kind of waterborne diseases and remained unreported. As per law any antibiotics and anti diarrhoeal drugs belong to schedule H category and cannot be sold with out prescription of registered medical practitioner. In a nutshell, under reporting is perennial problem both in rural and urban areas, which is result of lack of accountability and motivation of medical community and poor implementation of law regarding dispensing of drugs.

Box ends

1.3. Acute diarrhoeal diseases: a profile

In India, acute diarrhoeal diseases are mostly caused by multiple pathogenic organisms and with out proper serological tests causative organisms could not be isolated. Therefore, in several occasions acute diarrhoeal diseases cater all bacterial, viral and parasitic infections. By looking the nature of stool, possible cause of infection can be guessed. But in real practice, it not always practical.

National level reports (CBHI) since 1989 show that there is not much significant change of number of reported cases. Indeed, this is grossly under estimated data. Moreover, several states never reported a single case, for instance Bihar. Some states are very irregular in reporting like, Arunachal Pradesh, Assam etc.



Source:
Anon 2002, *India assessment 2002: Water supply and sanitation- a WHO-UNICEF sponsored study*, Planning Commission, Government of India, p 67.
Anon 2003, *Health Information of India 2000 and 2001*, Central Bureau of Health Intelligence, Government of India, p 179 & p 184.

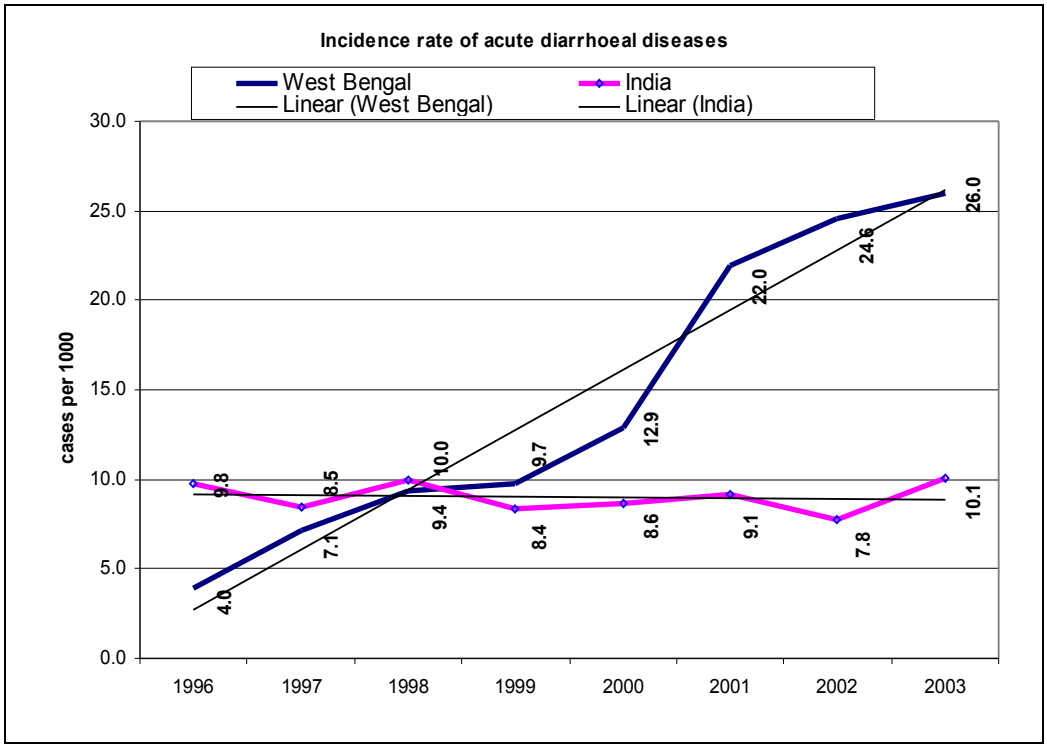
Despite this reporting related problem, there are some important findings, noticed after analysis of the government data. The table (below) shows the eight years average (1996 to 2003) annual incidence rate of acute diarrhoeal diseases after adjusting yearly population of each state. Some states are perennially endemic to acute diarrhoeal diseases, such as Dadra and Nagar Haveli, Sikkim, Andaman and Nicobar Islands, Lakshadeep, and Pondicherry and showing higher average annual incidence rate. All these states are smaller in terms of area and population. Their water and sanitation

coverage are poor, but it cannot be the explanation of chronically higher incidences, because the other large states with high population and poorer water and sanitation coverage showed lower incidence rate of acute diarrhoeal diseases. Possibly, the smaller states could manage the reporting system more efficiently than larger states. Relatively better government health service infrastructure in smaller states may be the reason of getting higher proportion of cases as compared to the states, which are larger, populous and having poorer infrastructures. Average hospital bed number per million populations of these smaller states are 1613. In rest of the India (except Kerala) the average beds per one million populations are 862. As by and large numbers of the cases are reported from government hospitals, the capacity of the government hospitals to cater population at large may be the strong determinant of quality of reporting. For example, the states like, Assam, Haryana, Jammu & Kashmir, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh and West Bengal lack proper water and sanitation coverage along with poor health service facilities (beds per one million population) and low rate of acute diarrhoeal diseases. A number of paradoxical features are being found while linking average disease incidence rate and water and sanitation facilities. Dadra Nagar Haveli has highest rate of acute diarrhoeal diseases, but also shows good sanitation coverage. Indeed, it is not logical to establish linkage between disease incidence and water and sanitation coverage based on the national level reports. Rather several small population based in-depth surveys can give better insight. Nevertheless, the CBHI reports show some major trends over the last several years, for instance despite no significant change of incidence rate at national level, West Bengal, shows steady rise of rate (from 4 per 1000 population in 1996 to 26 per 1000 in 2003). (Figure below) Surprisingly, in the state of Uttar Pradesh, there is decline in incidence rate (from 8.9 per 1000 to 0.9 per 1000 during the corresponding period). But state has poor record in sanitation coverage (33%) and health infrastructure. Probably declining health service infrastructure of state leading to poorer quality of reporting. Another possible reason may be the state's emphasis on hand pumps as principle source of drinking water. The state had highest growth rate of hand pumps in India and it also received lot of international, bilateral agencies to improve the water supply by means of sinking hand pumps.

Average incidence of Acute diarrhoeal diseases, drinking water facilities, sanitation facilities and beds in hospital per one million population

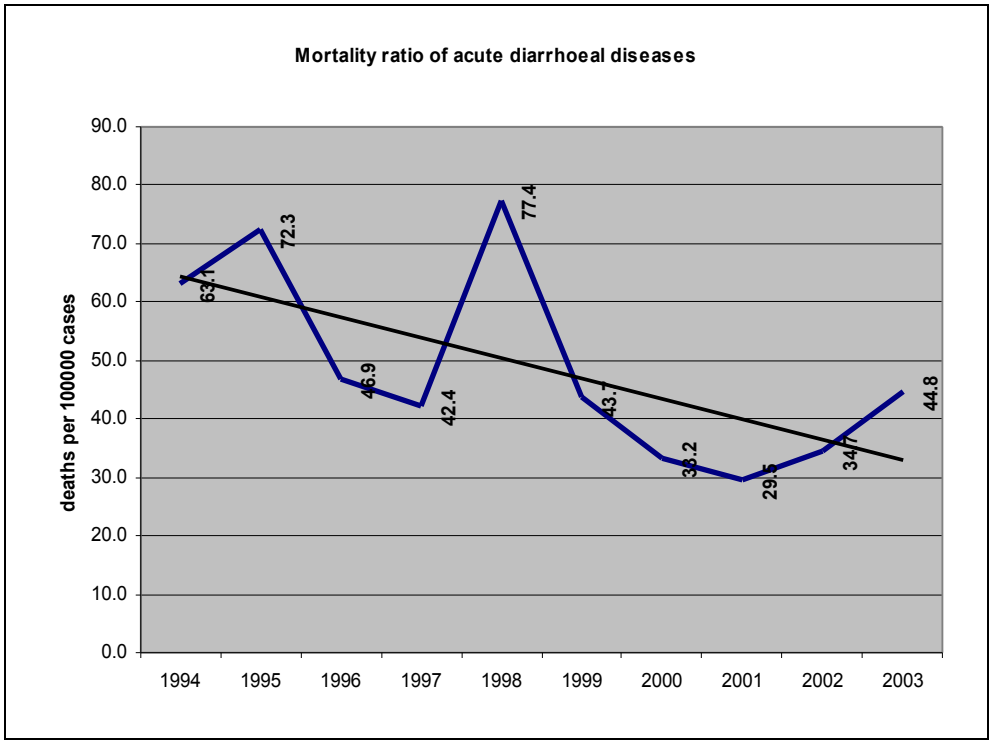
state	ave incidence rate 96-03	drinking water facilities	sanitation facilities	Hospital beds per one million Beds
Andaman & Nicobar Islands	85.0	76.7	85.56	1922
Andhra Pradesh	20.0	80.1	35.06	946
Arunachal Pradesh	10.9	77.5	85.84	2889
Assam	23.3	58.8	6.44	565
Bihar		86.6	58.14	322
Chandigarh	7.7	99.8	100	649
chattisgarh				
Dadra & Nagar Haveli	315.1	77	95	646
Daman & Diu	21.8	96.3		1630
Delhi	9.9	97.2	72.62	1575

Goa	5.7	70.1	13.89	2555
Gujarat	5.3	84.1	66.74	1392
Haryana	12.2	86.1	60	371
Himachal Pradesh	68.8	88.6	43.22	835
Jammu & Kashmir	42.6	65.2	9.61	214
jharkhand		42.6		
Karnataka	16.3	84.6	90.14	758
Kerala	17.7	23.4	73.05	3059
Lakshadweep	101.4	4.6	37.84	1014
Madhya Pradesh	4.6	68.4	7.87	268
Maharashtra	7.8	79.8	64.13	1099
Manipur	11.4	37	12.41	690
Meghalaya	51.8	39	26.61	802
Mizoram	14.8	36	80	1107
Nagaland	5.8	46.5	4.34	737
Orissa	16.8	64.2	9.46	337
Pondicherry	115.3	85.9	76.05	3008
Punjab	6.4	97.6	66.68	641
Rajasthan	4.6	68.2	65.4	407
Sikkim	71.3	70.7	52.8	1479
Tamil Nadu	2.3	85.6	37.13	885
Tripura	18.3	52.5	46.72	527
Uttar Pradesh	2.8	87.8	33.15	385
uttaranchal		86.7		
West Bengal	14.7	88.5	50.91	688
India	10.4	77.9	**49.32**	



Case fatality ratio of acute diarrhoeal diseases gradually declined as concept of oral re-hydration had been picked up over last two decades. (figure below) The major cause of death of acute diarrhoeal diseases is the severe dehydration and circulatory collapse. If fluid balance is maintained, many acute diarrhoeal diseases can be cured even with out antibiotics. In fact, the role of antibiotics in several types of acute diarrhoeal diseases is still controversial. When WHO initiated the diarrhoeal diseases control programme in 1980, approximately 4 million children in the world were dying each year of the dehydration caused by diarrhoea. ORS is now preventing about 1 million dehydration deaths a year. Now a days, the women in villages are given training on how to make cheap but effective home based oral rehydration solution. ORS packets are now freely available in several health centres. Women are taught how to use ORS packets. Properly made ORS solution is isotonic and ideal for fluid replacement. Several empirical studies show that the mortality ratio is inversely proportion to knowledge. Better mothers' knowledge less mortality and duration of illness. Several studies found the remarkable improvement of mortality and recovery due to introduction of home based care. The diagnosis of acute diarrhoeal diseases is relatively easy as the most obvious symptom (i.e. diarrhoea) is easily visible. Even the trained health workers can easily manage the common acute diarrhoeal diseases at village level. Despite the effort, the number of deaths (particularly of children) due to diarrhoeal diseases are still high due to number of reasons, for instance delayed treatment, wrong diagnosis and treatment by quacks, poor immunity and malnutrition, wrong cultural practice (no food and water during illness). If children are promptly given proper oral rehydration solution in the beginning of symptoms along with balanced diet, the mortality will be very low. In severe dehydration, parenteral (intravenous drip) rehydration is required to restore the normal fluid balance,

and once that is achieved switching over to ORS will take care of rest of the illness period.



The following table shows top five states in terms of total average incidence of acute diarrhoeal diseases, average incidence rates, case fatality ratio and increasing in trend.

Top **five states in total incidence of acute diarrhoeal diseases, incidence rates, case fatality ratio and increasing in trend over the past years (96-03)**

No	Average incidence	Average incidence rates	Case fatality ratio	Increasing in trend
1	Andhra Pradesh	Dadra & Nagar Haveli	Chandigarh	Nagaland
2	West Bengal	Pondicherry	Delhi	Daman & Diu
3	Karnataka	Lakshadweep	West Bengal	West Bengal
4	Uttar Pradesh	Andaman & Nicobar Islands	Mizoram	Jammu & Kashmir
5	Maharashtra	Sikkim	Tamil Nadu	Tamil Nadu

Cholera is an acute diarrhoeal disease caused by bacteria Vibrio Cholera 01. The bacteria have two biotypes - classical and El Tor. It is now commonly due to El Tor biotype. Cases range from symptomless to severe infections. The majority of infections are mild or asymptomatic. The ratio of severe cases to mild or inapparent infections has been shown to be about 1:25 to 1:100 for El Tor cholera.

As per case definition by National Institute of Infectious Diseases, New Delhi, the presumptive cases are those severe dehydration or death from acute diarrhoea in a patients 5 years of age or older in non-endemic areas or acute watery diarrhoea in a patient 5 years of age or older in an area where an epidemic is occurring. This definition is applicable during out break of cholera. When Vibrio cholerae is isolated from the stool samples of any patient with diarrhoea, considered to be confirmed cases.[xx] American Public Health Association (APHA) defined cholera as an acute bacterial enteric disease characterized in its severe form by sudden onset, profuse painless watery stools (rice-water stool), nausea and profuse vomiting early in the course of illness. In most cases infection is asymptomatic or causes mild diarrhea, especially with organisms of the El Tor biotype; asymptomatic carriers can transmit the infection. Typical overt cases are characterised by sudden onset of profuse, effortless, watery diarrhoea followed by vomiting, rapid dehydration, and suppression of urine. Unless there is rapid replacement of fluid and electrolytes, the case fatality may be as high as 30 to 40 percent.[xxi] Case definition of cholera and also other diseases are important step towards epidemic control. Whole epidemic control strategy depends on number of cases diagnosed either clinically or based on laboratory findings. Most cholera outbreaks in India and Bangladesh have been found to occur after the annual floods. But in Delhi, flood only occurs in the low land areas along the river Yamuna during the rainy season and it cannot corroborate with distribution and time trend of cholera incidence in the city. In Delhi is known as cholera endemic zone. In more developed countries undercooked seafood is the major source of infection. In less developed nations it is water and food contaminated by faecal matters of infected persons.[xxii]

Human is the only host. The dose of Vibrio cholerae required to produce illness depends on the susceptibility of the individual. It can be affected by the level of acidity in the stomach and the immunity produced by prior infection. In endemic areas, breast feeding protects infants and young children. Patients remain infectious usually for a few days after recovery from symptoms. Occasionally the carrier stage may persist for several months. Antibiotics, to which the strain is susceptible, shorten the period of communicability. But the vibrios can survive for long periods in the environment and can live in association with certain aquatic plants and animals, making water an important reservoir for infection. (See box below)

Box begins
Aquatic environment, climatic change and cholera
During last 35 years, cholera has again emerged in areas outside its endemic home in Asia, causing pandemics in Africa and South America, geographic areas not

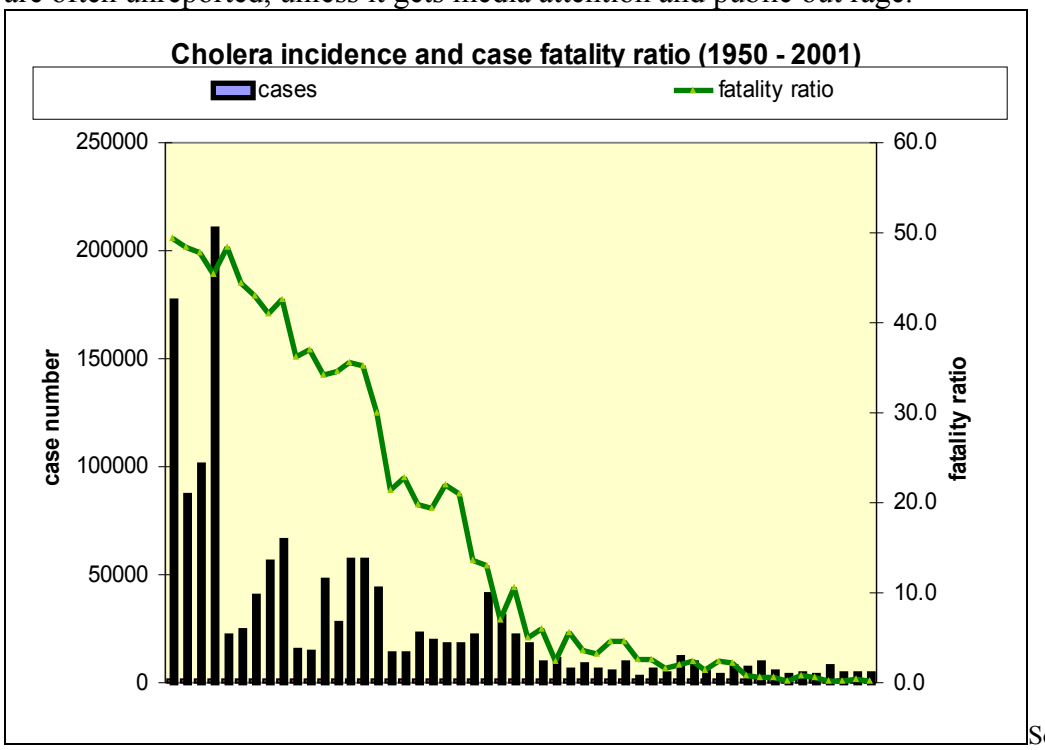
experiencing the disease for almost 100 years. Although there is no facile explanation for these phenomena, it was widely assumed, until relatively recently, that the disease was spread only by infected humans to others susceptible persons via faecal contamination of water and food and global movement of human populations accounted for global 'movement' of the disease. Recent studies of the aquatic environment, however, have shown that Vibrio cholera is a normal inhabitant of surface water and survives and multiplies in association with plankton, quite independently of infected humans. Plankton are tiny open-water plants, animals or bacteria. Plankton generally have limited or no swimming ability and are transported through the water by currents and tides. Plankton can be divided into three major size classes: *phytoplankton*–microscopic plants and bacteria, *zooplankton*–microscopic animals and *macro-zooplankton*–larger fish eggs and larvae and pelagic invertebrates. It was demonstrated that there is correlation between the incidence of cholera and presence of increased number of chlorophyll bearing organisms in water. This correlation was further explained as being the result of elevated pH and increased concentration of dissolved oxygen caused by photosynthesis of plankton, conditions supporting growth of V Cholera. The mucilaginous sheath (outer coverage) of plankton was found to serve as a site of attachment of V Cholerae cells and can persist for about 15 months. The association of V Cholerae and zooplanktons was found to be important because of the chitin composition of the zooplanktons outer coverage. Chitin is kind of protein, which gives nutrition and protection to the V Cholerae in adverse environment and helps in survival. The seasonality of cholerae has been directly linked the seasonal population variation of both phytoplankton and zooplankton. Since *'climate'* affects the growth of plankton, it is reasonable to assume that growth of vibrios associated with plankton also will be influenced. Results of studies conducted during the past 20 years on the ecology of V cholerae and recently recognised significance of global climate in human health suggest that the continuing presence of cholera in the Indian subcontinent and the re-emergence of cholera in other countries or continents may be significantly related to environmental factor. In fact Anwar Huq from Bangladesh suggested that the old hypothesis of faecal contamination from infected person causing epidemic does not fit always. Rather there are some evidence, where beginning of endemics of cholera in multiple sites at the same time, with out a clear chain of personal transmission (example: cholera in virgin area like Peru in 1991, occurs almost simultaneously in several locations along the pacific coast, suggesting other than simply the dissemination of the disease by infected persons). In Australia, transmission of cholera traced to rivers that were not faecal contaminated. Ship ballast has been a factor in the rapid distribution of marine vertebrates and invertebrates globally. Examination of ballast water revealed transmission of a wide variety of phytoplankton and zooplankton in the marine environment. Within last 15 years, several species of zooplanktons have been introduced in North America and thus cholera.[xxiii] [xxiv]

Box ends

1.4. Cholera

Trend in independent India

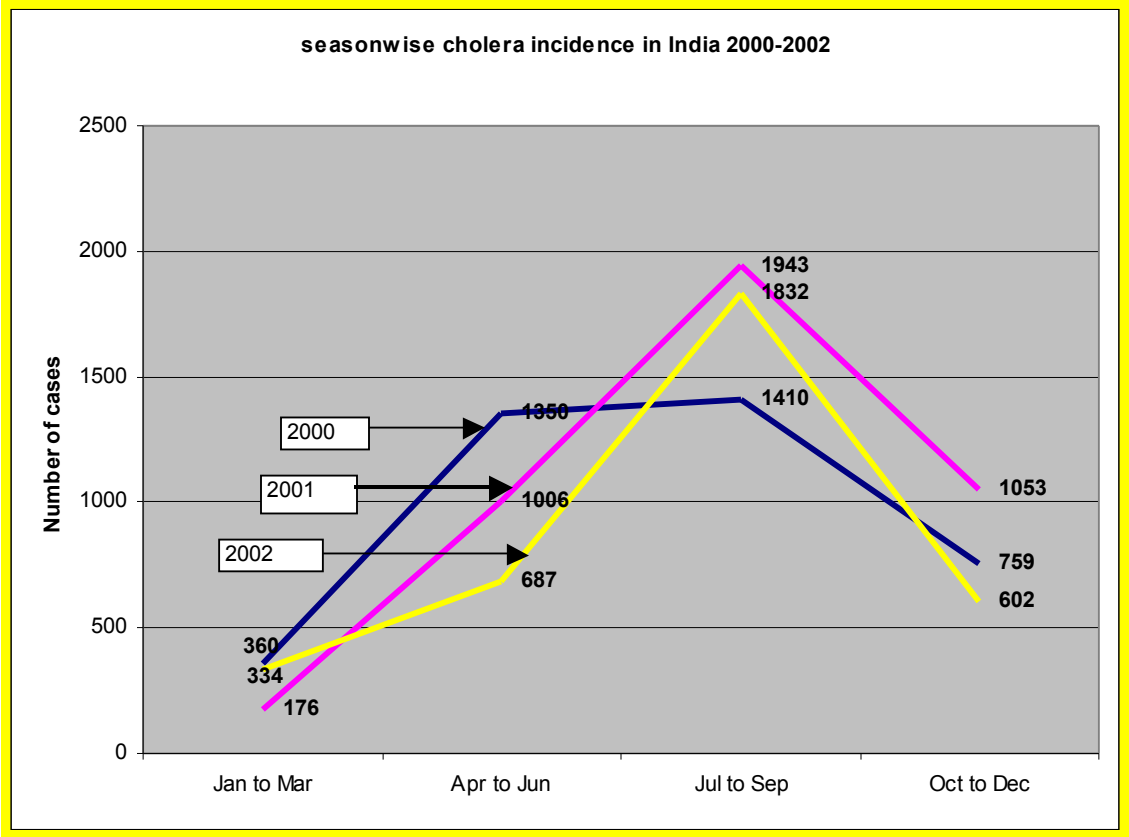
Figure below shows that since 1950 there has been gradual decline of cholera cases (from 176307 cases in 1950 to 4178 in 2001) except few peaks in initial period and sharper fall of case fatality ratio (from 49.3% in 1950 to 0.1% in 2001). Sharp decline of case fatality ratio possibly due to wide spread use of oral rehydration therapy. Continuous effort on public awareness on use of ORS is thought to be major reason of reduced mortality. At present, there is no sharp peak of cholera incidence, rather showing more stable features. Comparing to country's 1 billion populations, 3 to 4 thousands of cholera cases seems to be negligible. But the fact remains, huge number of cases get under reported, particularly from private practioners and private hospitals. Majority of the victims are poor and resort to quakes, who could not diagnose as cholera and treat them as any other acute gastro intestinal disorders. More over due to improvement of communication system, any cholera epidemic during flood or any other natural disaster gets immediate attention. Hence, report of cholera associated morbidity and mortality during natural disasters declined. But local out breaks due to sudden collapse of water and sanitation conditions or continuous transmission of infection due to perennial problem of water and sanitation are often unreported, unless it gets media attention and public out rage.



Source:
Anon 2002, India assessment 2002: Water supply and sanitation- a WHO-UNICEF sponsored study, Planning Commission, Government of India, p 67.
Anon 2003, *Health Information of India 2000 and 2001*, Central Bureau of Health Intelligence, Government of India, p179 & p184.

Cholera is both an epidemic and endemic disease. The epidemicity and endemicity depend on pathogenic organism and environment. Global experience shows that the

introduction of cholera cannot be prevented; cholera can create a problem only in areas where sanitation is poor. The cholera is abrupt and causes acute public health problem. But in a community it is self-limiting. It tends to decline after reaching its peak essentially due to temporary immunity and large number of sub-clinical cases (due to high immunity or low infective dose or both). According to some experiments around 10^4 - 10^6 organisms per millilitre (infectious dose) of water are required to cause clinical disease. Both epidemicity and endemicity have seasonal fluctuation. For example, the disease used to be more common in summer in Kolkata and early winter in Bangladesh; now it is most frequent in the autumn. In the Indian subcontinent, cholera epidemics have a link with the monsoon. Monsoon brings heavy rain, wind, and flooding. Season wise, cholera incidence in India reaches peak from July to September.



Box starts
Hotspots in history
Cholera was clearly defined in the Susruta Samhita, an Ayurvedic text from the 7th century BC. Outbreaks of cholera were earlier confined to Bengal and Bihar; the disease was normally associated with saline water. The ferocity of the disease spread number of myths during the period. A lot of stories depicted cholera (*ola-otha* – in colloquial Bengali) as annihilator of whole village/s. Mother *'Shitala'* was worshipped as Goddess of cholera and village women used to fast and offer prayer to please the

goddess to save them from cholera. However, the British Empire provided it with the means to spread globally. It began with an outbreak in Kolkata in 1817. Infected persons travelled to Haridwar (in the upper Ganga region), for a Maha Kumbh mela, a three-month long festival, that drew pilgrims from all over the country. The act of performing a holy dip in the river is an essential part of the pilgrimage. Cholera spread rapidly through the crowded camps on the riverbanks, and the pilgrims carried it back to their homes, triggering a massive outbreak. The casualties included 10,000 British troops and hundreds of thousands of civilians. The disease was also carried to other parts of the world: along trade routes to Iran, Baku, Astrakhan in central Asia and up the river Volga into Russia, where merchants gathered for the great autumn fair in Nijni-Novgorod. Infected travellers and contaminated kegs of water sailed from port to port spreading the disease. Steam-powered trains and ships also contributed to faster transmission, as did unhygienic living conditions. By 1827 cholera had become the most feared disease in the world. Six of the seven pandemics arose from the Indian subcontinent, usually from the Ganga delta region, from where it reached other countries. Currently, the seventh pandemic (continuous or sequential worldwide spread of a disease) of cholera is in 1operation, which started in 1961 from an epidemic in the Sulawesi Island in Indonesia, and reached India in 1964.[xxv]
Box ends

The hotspots

Trends suggest that diseases are shifting base from their centres of origin. Cholera and rotaviruses that were confined to the West Bengal region have now invaded new areas – chiefly the western coasts. New strains are also being reported as in cholera. There are 206 known *V. cholerae* strains (called serogroups). The most important and virulent new strain, the *Vibrio cholerae O139* that emerged in West Bengal during 1992-1993 was associated with large epidemics of cholera in both India and Bangladesh. In early months of 1993 caused estimated one-lakh cases and 10000 deaths in southern Bangladesh. Increasing international travel has contributed to the introduction and dissemination of new pathogens.[xxvi] After India and Bangladesh, it subsequently invaded Thailand, Malaysia, China and Pakistan. It temporarily displaced of the existing *V. cholerae O1*. However, the *O1* strains re-emerged in 1997 and initiated a series of disappearances and re-emergences amongst these two types. Other new variants of cholera are being increasingly isolated and characterised. Rapid mutation of the *O139* strain appears to be a response to out-compete the *O1* strain. The emergence of *V. cholerae O139* provides a unique opportunity to witness genetic changes in *V. cholerae* that may be associated with displacement of existing types with new. Surprisingly cholera has quickly adapted to freshwater bodies and therefore several new cases are being reported away from the conventional epicentres in West Bengal area.[xxvii] [xxviii] Many of the states, which never had cholera or were free from it for a long time got infected and became endemic foci of El Tor infection. Currently (2001), the larger endemic foci of cholera are found in Maharashtra, Tamil Nadu, Karnataka, Delhi (highest), Gujarat and West Bengal. These

states account for 97% of reported incidences in the country.[xxix] According to NICD, majority of recent cholera out break were due to Vibrio Cholerae 01 type.[xxx]

The following table shows the state wise incidence of cholera from 1994 to 2002. Delhi, West Bengal, Tamil Nadu, Karnataka, Kerala, Maharashtra, and Gujarat are the main hot spots with regard to cholera. It is important to note that Uttar Pradesh and Bihar, two populous states have not reported any single case of cholera despite poor record in water and sanitation and management of repeated floods. Under report of cholera is a serious issue. There is mixed trends in various states due to differences in local environmental condition. Some states, for instance Tamil Nadu showing rising trend on the other hand Gujarat showing declining trend. But no conclusive inference with regard to changing situation can be drawn from the table, as several local issues are associated. For instance, cholera in Delhi is essentially linked to quantity of water supply in the slum areas during summer and damage of water supply and sewerage system during developmental work. On the other hand cholera in West Bengal mostly linked with floods in various parts of the state. Similar to Delhi, cholera in Maharashtra, Gujarat and Tamil Nadu are mostly linked with haphazard urbanization, migration and development of unauthorized slums with out basic amenities. In 2000 and 2002 Delhi held second highest position in cholera cases. In 2001, capital was top with 1273 reported cases (30% of whole country's figure). Tamil Nadu contributed 41% of total cases of India in 2002. It is interesting to note that around 77% of total cases of cholera occurred in the coastal states on India (Gujarat, Maharashtra, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, West Bengal). According to Dr Rajib Dasgupta, Assistant Professor of centre of Social medicine and Community health, JNU, New Delhi and an expert on cholera, said that there is possibility of linkage with saline water of seashore. Saline water is very good media of cholera bacterial growth. Several studies showed the link of cholera with sea ingress. But he pointed out that cholera incidence is more associated with local environmental factors such as water and sanitary condition.[xxxi] [xxxii]

Cholera state wise

States	1994	1995	1996	1997	1998	1999	2000	2001	2002
Andhra Pradesh	82	186	172	107	43		2	2	8
Arunachal Pradesh	0		0						
Assam			0	0	0				
Bihar	0								
Goa	3	0	0	0	10	2	12	0	0
Gujarat	578	58	200	31	113	80	185	88	74
Haryana	64	58	12	21	87	27	1	11	3
Himachal Pradesh	25	2	0	0	0	16	1	6	0
Jammu and Kashmir	0	0	0	0	0	0	0	0	0
Karnataka	103	0	657	725	388	118	354	347	341
Kerala	36	6	152	14	60	8	146	15	105
Madhya Pradesh	289	50	0	16	0	240		4	1
Maharashtra	76	273	2098	737	2423		778	1100	587

Manipur	2	22	0	0	19		0	0	9
Meghalaya	..	..	0	0	0		0	0	
Mizoram	0	0	0	0	0		0	0	0
Nagaland	0	0	0	0	0		0	0	0
Orissa	2	69	85	0	0	13	0	32	0
Punjab	84	41	0	1	7	1	14	16	43
Rajasthan	3	0	25	103	33		13	0	2
Sikkim	0	0	0	0	0		0	0	0
Tamil Nadu	728	391	453		1763	1630	1248	1100	1426
Tripura	0	0	0	0	0		0	0	0
Uttar Pradesh	485	292	59	21		356			
West Bengal	125			369	448	240	222	178	146
A & N Islands	0	0	0	0			0	0	0
Dadra and Nagar Haveli	0	0	0	0	0		0	0	0
Daman and Diu	0		0	0	0		0	0	0
Delhi	2243	1984	512	956	1754	1396	959	1277	843
Lakhswadeep	0	0	0	72	0		0	0	0
Pondicherry	0	0	0	0	0		0	0	0
Chandigarh	45	0	0	0	3		0	6	47
Chattisgarh									2
Jharkhand									
Uttaranchal								0	0
Total	4973	3432	4425	3173	7151	3839	3879	4178	3455

Sanitation and Cholera

Cholera outbreak in cities is linked with contamination of drinking water with either sewage or polluted water bodies. In 2002, there were spurts of cholera epidemic in Chandigarh. CBHI data shows that from 0 incidence of cholera in 2000 it increased to 6 in 2001 to 47 in 2002. Published report from the city shows that all cases were from slums at the periphery of the cities where migrant labourers lived. Two rehabilitation colonies located at the periphery of Chandigarh were mainly affected. Drinking water supply was contaminated by damaged sewage system. Thirty one of 88 (35.2%) water samples showed evidence of faecal contamination. The outbreak was controlled by providing safe drinking water to the people and correcting the defects in the sewage and water pipelines.[xxxiii]

NICED and ICMR conducted investigation of Cholera outbreak in Ahmedabad in 2001 due to the contamination of drinking water with sewage. The nature of outbreak of acute diarrhoea in Ahmedabad was unusual in the sense that two major enterotoxic enteropathogens, namely, Vibrio cholerae and Enterotoxigenic E Coli (ETEC) were simultaneously involved. Usually one particular type of organism is responsible for

disease out break at a time. To their knowledge, this is the first report describing the involvement of more than one enteric pathogen in a single outbreak setting in India. Involvement of more than one pathogen during outbreaks has been reported elsewhere and was usually attributed to gross contamination of food or drinking water. More over, the outbreak occurred in January 2000,which was also unusual (in Ahmedabad, the seasonal peak of cholera is generally recorded between summer and early monsoon season, i.e., from April to August).[xxxiv]

The poor are more at risk because they live on the fringes of the environment. This doesn't mean the rich have acquired immunity. However they have the means to buy this protection. A review of several investigations into the outbreaks of cholera by the National Institute of Communicable Diseases (NICD), New Delhi suggests that almost every segment of society is at risk.[xxxv] Delhi is in fact becoming a hotbed for cholera, accounting for 1,396 cases in 1998, just a behind Tamil Nadu were 1,763 cases were reported. With a larger number of people residing in unauthorized shanties, with no proper arrangement for safe drinking water, the prevalence of the disease increases. Open field defecation is the common practice in these areas. K N Tiwari, municipal health officer, New Delhi admits the problem has two faces. On one hand there is a need to increase the level of awareness among people regarding issues of water, sanitation and health. On the other hand there is a problem of poor quality of water being supplied. "The people there depend on tube wells and hand pumps for drinking water, the water they yield may not be potable. At the same time, the awareness level among people is very low," he says. [xxxvi] Experts blame the lack of good drainage facilities for the spread of cholera in slum areas.[xxxvii] Refugee camps and destitute homes in particular are vulnerable to cholera outbreaks. Often cholera organisms lurk in water supply and cause persistent morbidity. Often aging sanitation facilities break down under stress and overuse. They can contribute to an outbreak of cholera too. In May 2000, a cholera outbreak took place in the beggars' home at Lampur in Delhi. Investigations revealed that the septic tanks had broken down. The sewage overflowing from it had got into the water supply and was the reason behind the outbreak. It is possible that the sub-soil water got contaminated as a result. The local people depended on the hand pumps in the area for drinking water. No one bothered to check whether this water was contaminated. As a result the infection was transmitted to those who drank the water.[xxxviii]

Control programmes and vaccination

It is now considered that the best way to control cholera is to develop and implement a national programme for control of ALL diarrhoeal diseases because of similarities in the epidemiology, patho-physiology, treatment and control of cholera and other acute diarrhoeal diseases. In fact in 1980-81 the earlier cholera control programme was termed as diarrhoeal disease control program. (Described in detail latter) But, as cholera is a notifiable disease, any clinically suspected cases to be reported to health authority. Treatment of cases mostly includes fluid replacement orally or intravenously in severe

cases, normal diet and measurement of water quality. Antibiotic has limited role in recovery, but it may shorten the infectivity of sufferers.

There are two types of cholera vaccine injectable and oral. Injectable vaccine contains killed classical vibrios and it also protects from El Tor variety. Two doses of vaccines are given, injected subcutaneous at an interval of 4 to 6 weeks. Booster dose to be given in every 6 months. It gives 50 percent protection against cholera. Oral vaccine is given in two doses, 10-14 days apart. On an average it may give 50-60 percent protection for at least 3 years. But there is doubt on vaccine's efficacy in control of cholera. Because there is no proven documents showing reduction of cholera transmission and introduction of cholera due to vaccination. World Health Assembly in May 1973 abolished the requirement of a cholera vaccination certificate for international travel.[xxxix]

1.5. Rotavirus diarrhoea

Rotaviruses are the single most important cause of severe acute diarrhoea in young children throughout the world. It was first discovered in 1973 in South and Southeast Asia. Rotavirus diarrhoea is endemic and has been observed throughout the year in India and Bangladesh. Like cholera, rotavirus originated from the Ganga delta in West Bengal and Bangladesh in early seventies.[xl] Within a decade, its prevalence and incidence has increased across India. India accounts for the highest diversity of the rotaviruses strains. It is a cause of significant morbidity and mortality among children younger than 5 years of age in India. Extrapolated data shows that around 11 million people in India suffer from rotavirus infection.[xli] Of the approximately 600,000 annual deaths due to rotavirus worldwide, more than 150,000 occur in India.[xlii] The rotavirus family, a true globetrotter has spread worldwide in two decades. Children in developing countries account for 82 per cent of deaths due to rotavirus. Every year 20 to 30 per cent of the children, who come to hospitals for treatment of severe diarrhoea, have rotavirus infections. Nearly all children are infected at least once before the age of two years and repeat infections are common.[xliii]

Purohit and his team from Department of Statistics, Abasaheb Garware College, Pune, conducted a study in Pune, on hospital admissions from July 1992 to June 1996 and analysed weather parameters to correlate the occurrence of infections. The analysis confirmed that daily minimum temperature, humidity and easterly wave, a characteristic feature of tropical weather, are the principal factors for the "winter diarrhoea". Observing these three climatic factors can be useful in predicting the peak of hospital admissions and the geographical sequence of outbreaks of the disease in tropical India. The reason behind this is not fully understood. The existing belief is that winter warmth and humidity in continental and coastal are ideal for rotavirus proliferation and capture niche of other disease pathogens to infect humans.[xliv] Rotavirus is found in every Indian state even though states like Bihar do not report any cases, this could be due to lack of data and research. There is no national level program so far to control Rotavirus, as there is no

standard clinical definition to diagnose the cases. The treatment of Rotavirus usually follows the standard guideline of diarrhoea control programme.

Rotavirus vaccine is thought to be one effective measure to curb incidence of infection. Rotashield, the world's first rotavirus vaccine, was licensed for use in the United States in 1998. Prior to licensing, clinical trials in the United States, Finland, and Venezuela had found it to be 80 to 100% effective at preventing severe rotavirus diarrhoea, and researchers had detected no statistically significant serious adverse effects. But the manufacturer of Rotashield withdrew the vaccine from the market in 1999, after it was discovered that it might have contributed to an increased risk for intussusception (kind of intestinal obstruction), in one of every 12,000 vaccinated infants. The experience provoked intense debate among public health officials, scientists, vaccine manufacturers, and others about the relative risks and benefits of a rotavirus vaccine. As the debate continued, so did deaths, disease, and hospitalizations caused by rotavirus. Today both multinational pharmaceutical companies and companies in developing nations are testing a new generation of rotavirus vaccines.[xlv]

1.6. Typhoid (Enteric fever)

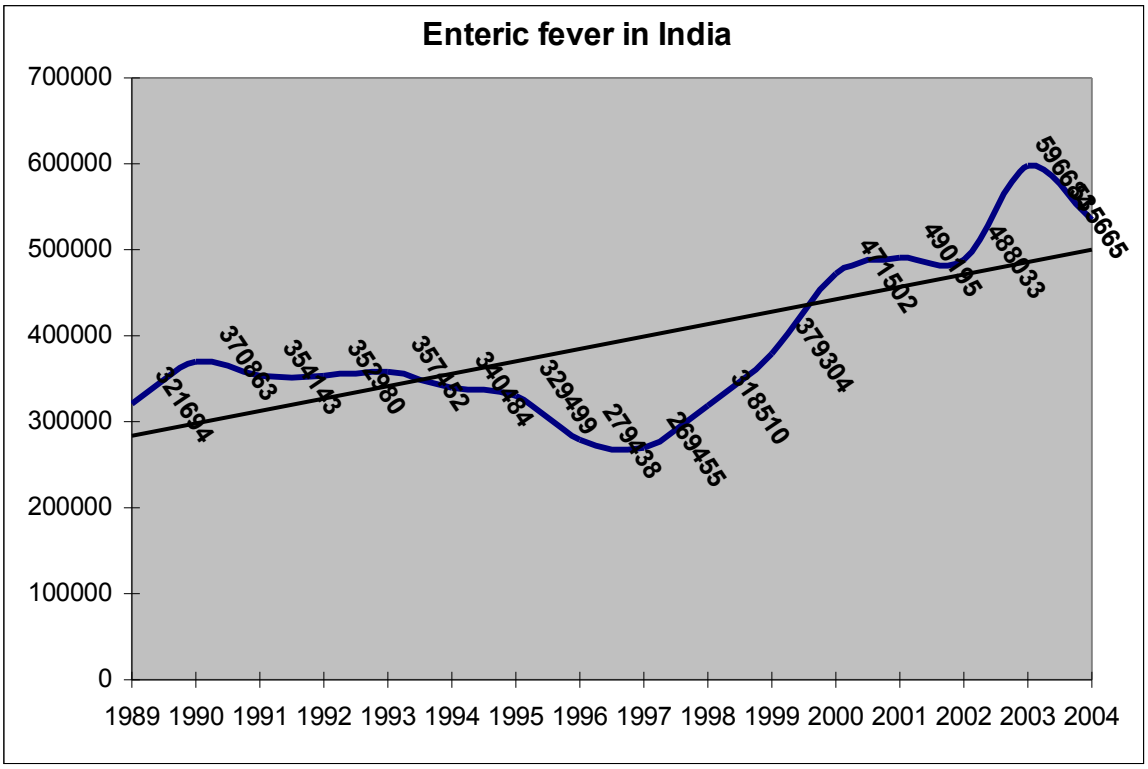
According to WHO, typhoid affects around 17 million persons in the world every year. More than 600,000 succumb to it.[xlvi] India has the highest incidence, around three million cases each year.[xlvii] The world community is so concerned of typhoid in India that Europe and USA public health departments advise all travellers to get typhoid vaccination before reaching India. Typhoid is mostly caused by the bacteria *Salmonella typhi.* On entering the human gut, the bacteria multiply and spread from the intestines into the bloodstream. Chills with high fever, anorexia, headache, constipation or diarrhoea and rose-coloured spots on the chest are the common features. The fever ascends in stepladder pattern and 7 to 10 days latter, the fever reaches plateau. The patient has an enlarged spleen and liver. If there are no other systemic complications, patients recover with in 7 to 10 days. But relapse may occur for up to 2 weeks after termination of therapy. Complication occurs in about 30% of untreated cases and account for 75% of all deaths in typhoid fever. Complications mostly include intestinal perforation, pneumonia, urine retention, blocking of blood vessels, heart failure, and psychosis.[xlviii]

Typhoid is known to occur during the rainy season (July to September), now occurs throughout the year. Outside the human body, the organisms are found in water, ice, food, milk and soil for varying period. They do not multiply in water and may perish with in 48 hours. But they may survive for up to 70 days in soil irrigated with sewage under moist winter conditions and for half that period under drier summer conditions. The organisms can multiply in contaminated food and milk. Vegetables grown in sewage farms and washed in contaminated water are a positive health hazards. These factors are compounded by such social factors as pollution of drinking water, open-air defecation and urination, low standard of food and personal hygiene and health ignorance. Therefore, environmental sanitation is extremely important to control typhoid

transmission. Typhoid fever may therefore be regarded as index of general sanitation in any country.[xlix]

The disease is transmitted through faeces and urine of patients. A person can become infected after eating food or drinking a beverage that has been handled by someone who is infected. Drinking water that has been contaminated by sewage containing the bacteria. In May 2000, there was typhoid outbreak in the campus of All India Institute of medical Sciences, New Delhi - the most reputed medical institute in India. There were 26 cases and all were resistant to chloramphenicol, the preferred drug (drug of choice) to treat typhoid. The outbreak was essentially due to contaminated water, as water was not treated with chlorine. As a control measure, the water was chlorinated the outbreak was controlled. Similarly there was typhoid outbreak in Alappuza town in Kerala in May 2001. Palace canal, which passes through the affected wards of town, was considered responsible for this outbreak. The canal drains the wastewater and sewage. It was blocked for last 2 years due to construction of a bridge. Due to scarcity of drinking water and its irregular supply, local residents used the canal water for washing cloths and utensils, bathing and sometimes drinking. S Typhi was isolated from the canal water.[l]

The figure shows that despite poor reporting, there is steady rise of enteric fever particular by 1997. According to CBHI data, from 1997 till 2004 typhoid incidence in India increased by 98% (from 269455 in 1997 to 535665 in 2004). Rapid deterioration of sanitary condition, contamination of food with polluted water, population migration and growth of urban slums, drug resistance are thought to primary reasons of rise of typhoid cases.



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Anon 2002, *India assessment 2002: Water supply and sanitation- a WHO-UNICEF sponsored study*, Planning Commission, Government of India, p 67.
Anon 2003, *Health Information of India 2000 and 2001*, Central Bureau of Health Intelligence, Government of India, p179 & p184.

The following table shows almost every state in India reported enteric fever. But some states are particularly vulnerable. CBHI data of 1997 to 2003 show that in several states number of vulnerable states, for instance Himachal Pradesh, J&K, Karnataka, Nagaland, Punjab, Sikkim, West Bengal, Andaman & Nicobar Islands, Delhi, and Chandigarh etc. Similar to cholera, Delhi is also a hot spot of typhoid due to poor sanitary conditions, inhospitable living condition in slums and unauthorized colonies, poor maintenance of food hygiene. From 1997 to 2004 there is rise of typhoid in Delhi from 3161 to 21158 (5.6 times more). Study in Delhi in 1995 shows that nearly 44% of typhoid cases were below 5 years of age.[li] Interestingly, Chandigarh is also becoming endemic area of typhoid. Same report shows that there is rise of typhoid cases in Chandigarh, from 2000 to 2002 by 312% (from 78 cases in 2000 to 322 in 2002). Punjab showed 383% rise of typhoid during same period of time. In 2002, Karnataka contributed highest number of typhoid cases (100996) followed by West Bengal (50235). In fact Karnataka also held highest position in 2000 and 2001. In 2003 and 2004, Andhra Pradesh contributed highest number of cases (151876 and 148827 respectively) followed by West Bengal and Karnataka. But tiny Himalayan state of Sikkim, showed highest rise of typhoid cases from 1997 to 2002 (7 to 397). Possibly due to rapid tourism development causing

massive tourist inflow from neighbouring typhoid endemic states like West Bengal and poor urban planning unable to manage water and sanitation measure in the city. During field visit in Sikkim, Programme Officer of Catholic Health Association of India (CHAI), noticed the civic authority could not manage the rapid inflow of families from surrounding villages to cities. Haphazard settlement with out sanitary facilities resulted several epidemic of waterborne diseases. Adjacent streams have turned into sewage dumping ground of rapidly growing urban sectors. Sikkim, earlier known to be clean and pollution free state is fast becoming endemic area of several water borne diseases including typhoid. State wise report shows that average rate of enteric fever (1997 to 2004) per 100000 population is highest in Meghalaya (356) followed by Himachal Pradesh, Andaman Nicobar, Nagaland, Jammu & Kashmir, Arunachal Pradesh, Dadra Nagar Haveli and Poindicherry. Meghalaya is one of the states in India with lowest water and sanitation coverage (39 and 26 per cent respectively).

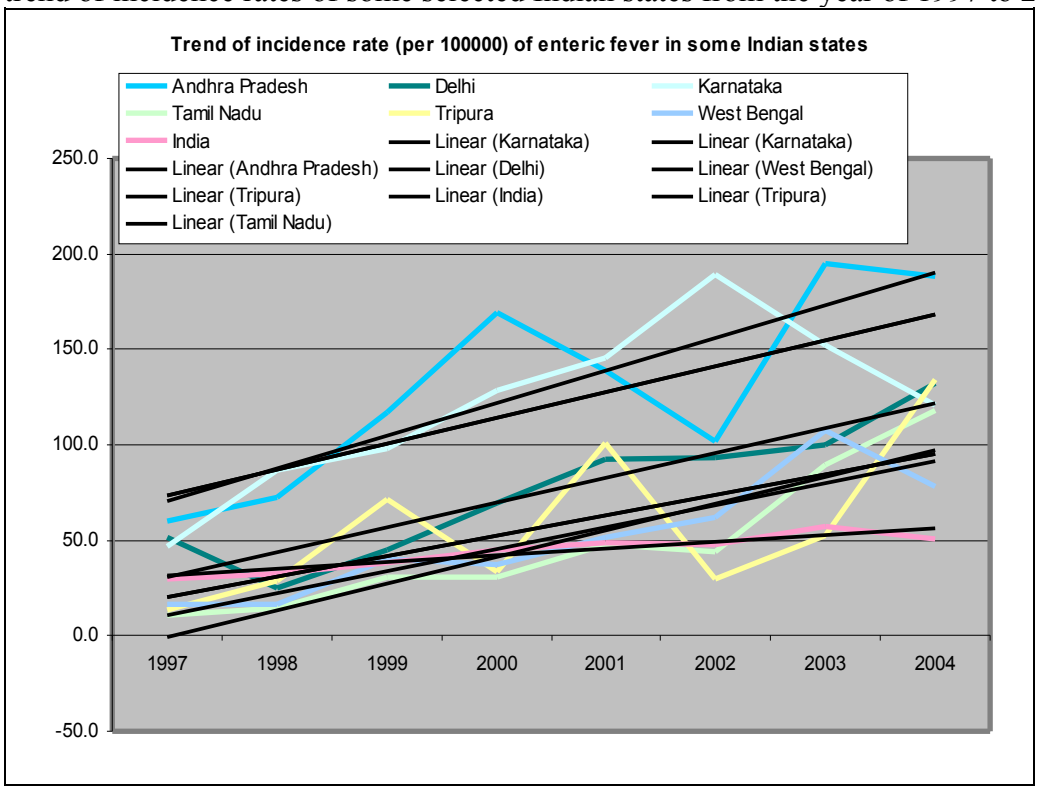
Enteric fever state wise

States	1997	1998	1999	2000	2001	2002	2003*
Andhra Pradesh	47982	53252	87315	127662	106417	78352	151876
Arunachal Pradesh	26					3437	2418
Assam	15448	15330					
Bihar							
Goa	253	44	183	354	210	81	177
Gujarat	3203	3617	3740	5019	3931	2585	4453
Haryana	670	988	2970	3475	5236	2947	4459
Himachal Pradesh	16669	13203	14598	16181	21501	23820	28890
Jammu and Kashmir	10237	7595	24795	25157	25020	31284	33654
Karnataka	20437	43894	50473	66745	76603	100996	75678
Kerala	5549	9817	15239	10633	7339	8776	12818
Madhya Pradesh	53052	39084	19948	27950	32979	31218	36856
Maharashtra	11162	16004	20092	25305	15275	16105	14988
Manipur	1783	3373	4197	8765	4349	5353	1435
Meghalaya	6156	11302	3037	29149	42193	2454	3822
Mizoram	445	255	503	477	466	447	520
Nagaland	1077	3947	2659	1968	3917	18187	1712
Orissa	31051	35084	36059	32486	24396	24743	17341
Punjab		2827	6254	4119	4573	19901	12265
Rajasthan	1933	8113	3037	4689	5466	4058	4468
Sikkim	7	0	3	42	496	397	179
Tamil Nadu	7931	9067	18729	22476	29844	27649	
Tripura	117	1015	2619	1263	3889	1171	1545
Uttar Pradesh	8712	20929	19400	15666	18135	14230	15154
West Bengal	20168	12930	31547	29156	41637	50235	88048
A & N Islands	285	620	3408	558	697	1211	777
Dadra and Nagar Haveli	228	211	3			1224	870

Daman and Diu	46	59	53	19	0	6	6
Delhi	3161	3219	6023	9750	13291	13864	15539
Lakhswadeep	35	80	45	89	99	129	78
Pondicherry	1522	2641	2283	2271	2030	2851	2458
Chandigarh	110			78	206	322	242
Chattisgarh							
Jharkhand							
Uttaranchal							
Total	269455	318510	379304	471502	490195	488033	451934

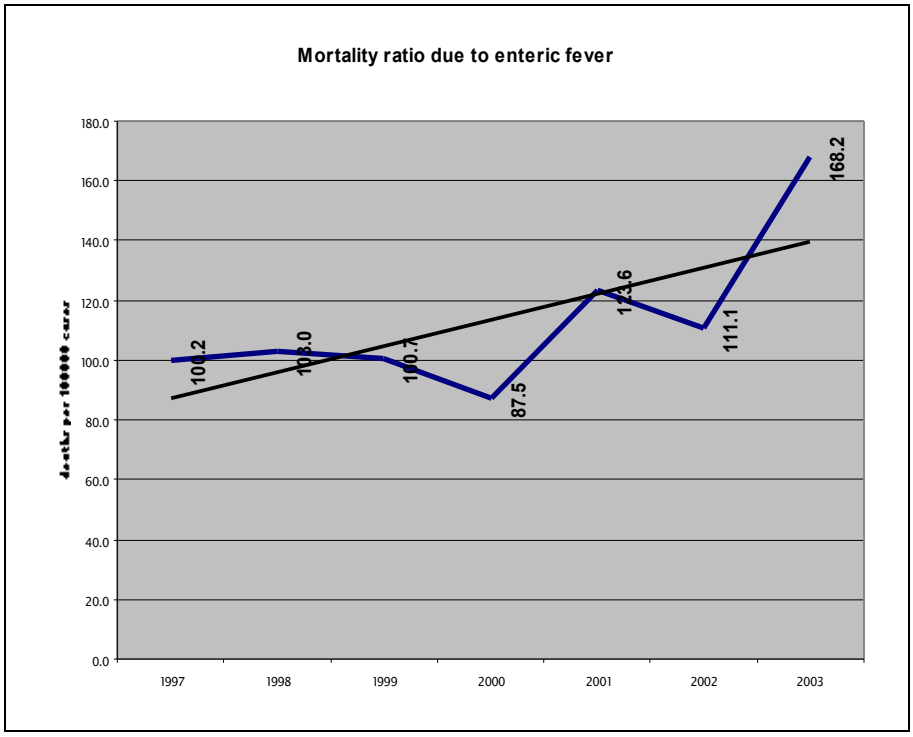
** Incomplete report*

Analysis of national level report of enteric fever shows that since 1997 to 2004 there is gradual rise of incidence rate of enteric fever (from 29 per 100000 to 50 per 100000). Several individual states show the similar trends, for instance Andhra Pradesh, Delhi, Karnataka, Tamil Nadu, Tripura and West Bengal. The following figure shows the rising trend of incidence rates of some selected Indian states from the year of 1997 to 2004.



Case fatality ratio of enteric fever is rising possibly due to drug resistance. Unlike, acute diarrhoeal disease, treatment of enteric fever is comparatively complicated. Appropriate antibiotics are the only mode of treatment. But, due to resistance of antibiotics, the recovery becomes slow or nil and severely affected patients die due to toxemia, intestinal perforation. Conventional antibiotics are becoming ineffective due to their frequent and inappropriate use. Clinically the diagnosis is not always possible due to lack of classical

signs and symptoms. Only laboratory diagnosis (vidal test) can pin point the diagnosis. Delayed reporting and diagnosis often make the cases complicated and ineffective antibiotics further aggravate the situation.



The following table shows top five states in terms of total average incidence of acute diarrhoeal diseases, average incidence rates, case fatality ratio and increasing in trend.

Top five states in total incidence of enteric fever, incidence rates, case fatality ratio and increasing in trend over the past years (97-04)

No	Total incidence	Average incidence rates	Case fatality ratio	Increasing in trend
1	Andhra Pradesh	Meghalaya	Chandigarh	Meghalaya
2	Karnataka	Himachal Pradesh	Mizoram	Tripura
3	West Bengal	Andaman & Nicobar Islands	Delhi	Nagaland
4	Madhya Pradesh	Nagaland	Rajasthan	Punjab
5	Tamil Nadu	Jammu & Kashmir	West Bengal	Andaman & Nicobar Islands

Vaccination

The old parenteral-killed whole-cells vaccine was effective but produced strong side effects (for example shock). Today, two safe and effective vaccines are currently licensed and available, based either on defined subunit antigens or on whole cells live attenuated bacteria. One is composed of V polysaccharide given in one single dose by parenteral route, eliciting protection seven days after injection. In endemic areas the protective efficacy provided is 55% five years after a single dose. This vaccine is licensed in more than 63 countries in Africa, Asia, Europe, Australia and the Americas. The other vaccine is composed of a live attenuated mutant Ty21a given by oral route in three doses two days apart, eliciting protection seven days after the final dose. The protective efficacy, seven years after the last dose, is still 67% in endemic areas. This vaccine is currently licensed in 56 countries in Asia, Africa, Europe, USA, and South America.[lii]

There is not any specific program in India to control typhoid only. But childhood typhoid control is part of the child health programme. Also the disease is included in diarrhoeal disease control program. Mass vaccination program is not recommended due to high cost and lack of manpower. Rather it is suggested that water and sanitation measure and health education will significantly reduce typhoid incidence.

1.7. Viral hepatitis

Infectious viral hepatitis A and E are essentially water borne diseases. Water contaminated by faecal matters from infected persons is the major source of infectious. Viral hepatitis B and C also cause similar pattern of symptoms and these are not water related diseases. But national level data on hepatitis includes all kinds of hepatitis. Until and unless specific serological tests are done, the typology of hepatitis could not be possible. The disease is self limiting (anti-microbial is not usually required) and diagnosis is expensive and not easily available, hence the doctors limit their intervention up to conservative treatment. Therefore diagnosis remains as jaundice, main clinical feature of viral hepatitis. Due to paucity of diagnostic facility and resource constraint, getting exact figure of Hepatitis A and Hepatitis E is not possible. Nevertheless, estimations are being made based on sample based sero-epidemiological studies.

Hepatitis A

Hepatitis A (formerly known as infectious hepatitis) is an acute, usually self-limiting infection of the liver caused by hepatitis A virus (HAV). The virus has a worldwide distribution and causes about 1.5 million cases of clinical hepatitis each year. Humans are the only reservoir of the organism. Transmission occurs primarily through the faecal-oral route, and is closely associated with poor sanitary conditions. The most common modes of transmission include close personal contact with an infected person and ingestion of contaminated food and water. The virus is shed in the faeces of persons with both asymptomatic and symptomatic infection. Under favourable conditions HAV may

survive in the environment for months. Bloodborne transmission of HAV occurs, but is much less common. The disease is heralded by non-specific symptoms such as fever, chills, headache, fatigue, generalised weakness and aches and pain followed by anorexia, nausea, vomiting, dark urine, jaundice. The disease spectrum is characterized by the occurrence of numerous sub-clinical or symptomatic cases. The disease is benign with complete recovery in several weeks. The average incubation period is 28 days, but may vary from 15–50 days. Approximately 10–12 days after infection the virus can be detected in blood and faeces. In general, a person is most infectious from 14–21 days before the onset of symptoms, through to 7 days after the onset of symptoms.

Hepatitis A infection is very common in India. Antibodies against HAV develop in response to infection and seroprevalence can be used as a marker of viral transmission in a community. Sero-epidemiological studies carried out in India, Bangladesh, Bhutan and Nepal demonstrated that 85 – 95 percent of children have been infected and are immune to HAV infection by 10 years of age. It is responsible for 10 to 25 percent of the total cases of hepatitis in children (in adults it is only 1 to 5 percent). Human faeces (and also urine) are the main infective materials. The virus shedding starts through faeces for about two weeks before the onset of jaundice and continues up to one week thereafter. As mentioned earlier that poor sanitation and over crowding favours the spread of infection and gives rise to epidemics. In India the disease tends to be associated with periods of heavy rainfall.[liii]

Hepatitis A vaccines

Several vaccines against hepatitis A are now available that are highly efficacious and provide long-lasting protection in adults and in children above one to two years of age. In countries where clinical hepatitis A is an important health problem, immunization is likely to be a cost-effective public health tool to control the disease. Although usually a self-limiting disease without serious sequelae and with a low case-fatality rate, human suffering may, as a result of infection, be considerable. In addition, direct and indirect medical costs including the infection control measures involved, may impose a considerable economic burden on society. In the long term, socio-economic development will reduce transmission of hepatitis A, particularly through improved sanitation and health education.

Hepatitis A vaccines are all highly immunogenic. Nearly 100% of adults will develop protective levels of antibody within one month after a single dose of vaccine. Similar results are obtained with children and adolescents in both developing and developed countries. Although one dose of vaccine provides at least short-term protection, the manufacturers currently recommend two doses to ensure long-term protection. In studies evaluating the duration of protection of two or more doses of hepatitis A vaccine, 99%–100% of vaccinated individuals had levels of antibody indicative of protection five to eight years after vaccination. Kinetic models of antibody decay indicate that the duration of protection is likely to be at least 20 years, and possibly lifelong. Post-marketing

surveillance studies are needed to monitor vaccine-induced long-term protection, and to determine the need for booster doses of vaccine.

According to WHO, in countries where hepatitis A is highly endemic, exposure to HAV is almost universal before the age of 10 years. In such countries, clinical hepatitis A is usually a minor public health problem, and large-scale immunization efforts against this disease should not be undertaken. In developed countries with low endemicity of hepatitis A and with high rates of disease in specific high-risk populations, vaccination of those populations against hepatitis A may be recommended.[liv]

Hepatitis E

The infection caused by the hepatitis E virus (HEV), which was discovered in 1990 (formerly it was known as hepatitis non A and non B), is essentially a waterborne disease. Contaminated water is believed to be major cause of hepatitis E out break, particularly in hot climate. It is a self-limiting disease affecting the age group of 15 to 40 years. In addition, HEV has a propensity to induce a fulminating form of acute disease (mortality ranges between 0.5% to 4%), particularly in pregnant women, up to 20% of whom may develop fulminating hepatitis E, with mortality may reach about 80% of such cases.[lv]

The first major epidemic was reported in New Delhi in the winter of 1955-56. After the flood of Yamuna, 30000 cases of jaundice were described and retrospectively attributed to hepatitis E. Hepatitis E appears to be wide spread problem in developing countries where there is problems in providing safe drinking water and adequate sewage disposal.[lvi] According to NICD report, most of the outbreaks of viral hepatitis in India were caused by hepatitis E virus. Majority of cases were above 15 years of age. NICD investigated 10 hepatitis outbreaks in India since 1989 to 1996 and all of them were due to hepatitis E virus. All of them were due to contaminated pipe waters. Scarcity of water, uses of on-line booster pumps (which can suck sewage into the water line), and poorly laid and maintained water and / or sewer lines were identified as important aggravating factors. Outbreak subsided in a few weeks once the leakage were identified and corrected. There was Viral hepatitis E epidemics in Kota and Jhalawar district in Rajasthan in 1999, due to contaminated pipe water. There were leakage of water pipes and many used booster pumps even when the water lines were not charged. In both districts, the out breaks subsided after identification and repair of leakage. There were total 526 cases in Kota and 5 died (all of them were pregnant). In Jhalawar out of 5 deaths, 2 were pregnant.[lvii] Between February and March 1981 an epidemic of hepatitis occurred in Kolhapur City, Maharashtra State, India. Approximately 1200 cases of jaundice were reported; more than 300 patients were hospitalised and three died. The epidemiological investigations conducted by National Institute of Virology, Pune showed a distinct concentration of cases in municipal ward of the city. Investigations of the ward water supply system disclosed gross contamination of raw water with sewage at source. The serological studies revealed that the etiological agent responsible for this epidemic was neither

hepatitis A virus nor hepatitis B virus but was likely to have been due to hepatitis E virus.[lviii]

There is neither specific treatment for hepatitis E, nor any vaccine available. But research is going on and effective vaccine is expected to arrive in market soon.

1.8. Parasitic Infestation

There are two kinds of parasitic infestations - protozoal (unicellular microscopic) and helminthic (multi-cellular, visible in naked eyes). Protozoan parasite (Entamoeba histolytica, giardia), soft-bodied worms like roundworm, whipworm and hookworm being the most common parasitic infestations in India. It is estimated that Amebiasis affects about 15% of Indian population and it has been reported from every states in the country. Round worm (Ascaris lumbricoids) is cosmopolitan in distribution. It is the most common Helminthic infestation. Hookworm infestation is widely prevalent in India. Necator Americanus in predominant in south India and Ancylostoma duodenale in North India. More than 200 million people are estimated to be infected in India.

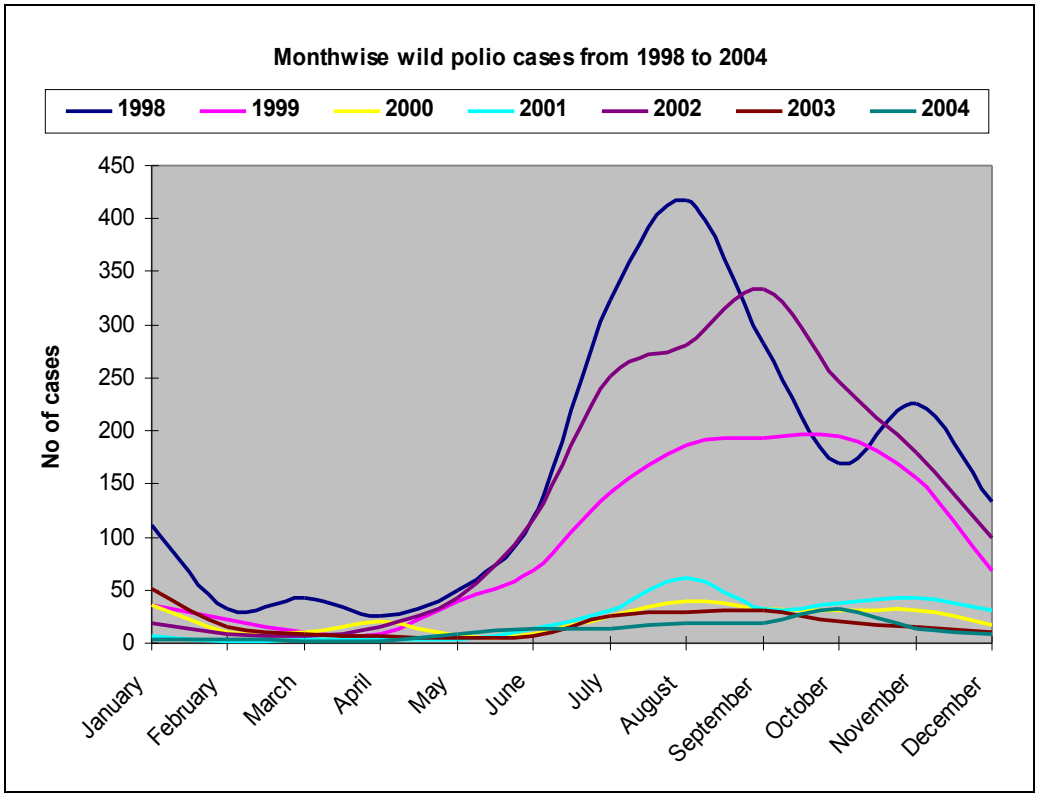
These parasites are transmitted via faecal contamination of soil, food and water. The eggs are shed in faeces. Therefore poor sanitation and hygiene, open field defecation is the main causes of parasitic infestation. The eggs of the parasites can survive more when soil remains damp and moist. Clay soils are favourable for the development of eggs, in contrast to moist porous soils for hookworm. Once intestinal worms enter the human body, they either feed on semi-digested food in the intestine (like the roundworm) or on blood through the intestinal walls (like the hookworm).

Hook worm infestation one on the major causes of childhood anaemia and anaemia of general population. People while walking in the field used for open field defecation with bare foot get infection. Hookworm sucks blood from intestinal wall and reproduces thousands of eggs, which come out from faeces.

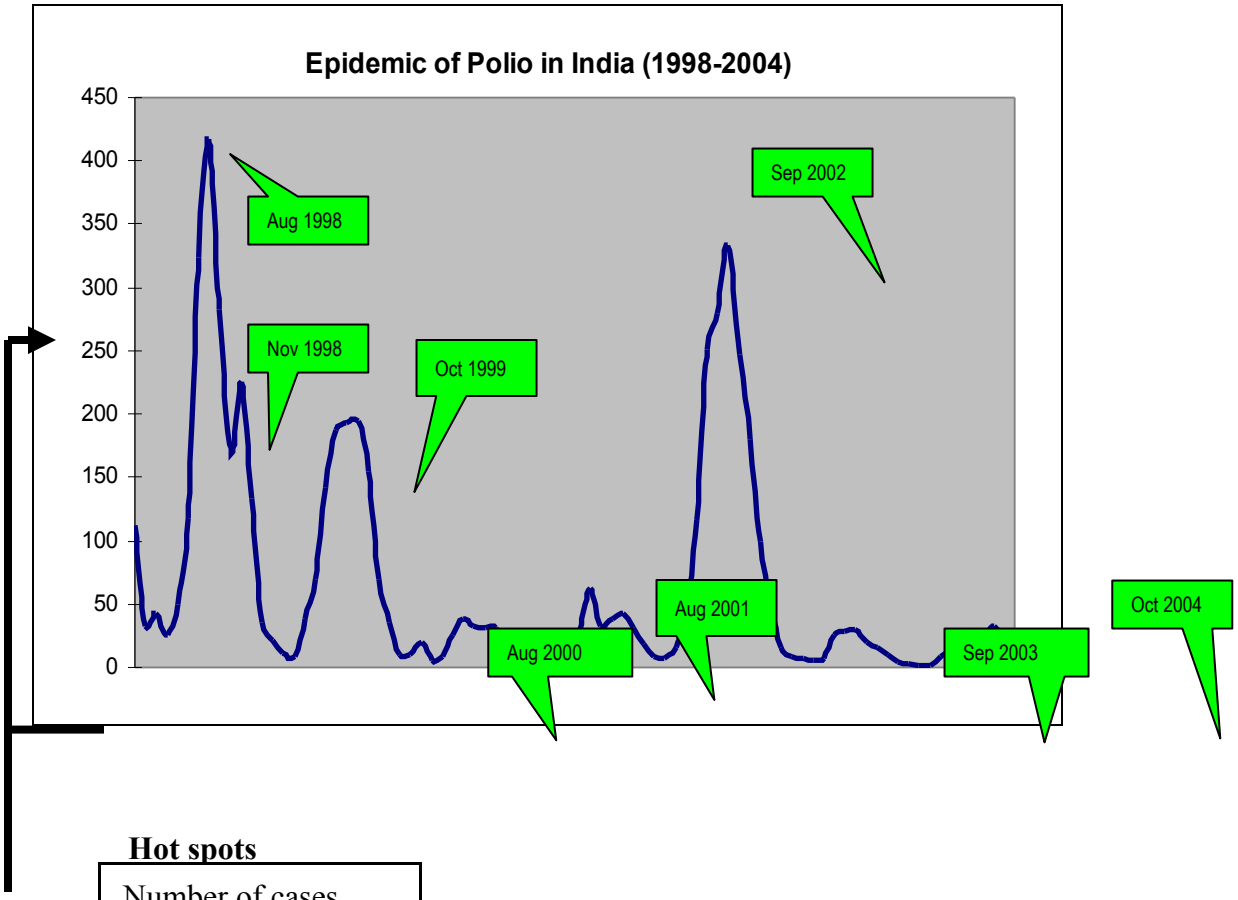
1. 9. Polio

Polio is a highly contagious infection that is caused by three related virus types, P1, P2 and P3. But since 1998 there is no report of polio caused by P2 virus. The virus destroys the cells of the nervous system, causing paralysis. Some cases (5-10 per cent) result in short-lived minor infections or temporary stiffness. Paralysis is a rare manifestation, seen in less than two per cent of polio-infected cases. However, the majority of infections (95 per cent) do not show any symptoms, but the infected person continues to shed the virus in faeces, potentially transmitting it to others.[lix] Fifty per cent of the victims are children, less than three years old.[lx]

It is transmitted to humans when sewage or faecal matter enters drinking water. There has been no case of the poliovirus being transmitted through animals to humans. Polio can strike anytime during the year. Data from 1998 to 2004 shows majority of the epidemic peaks occurred during the months of August to October. (Figure below)

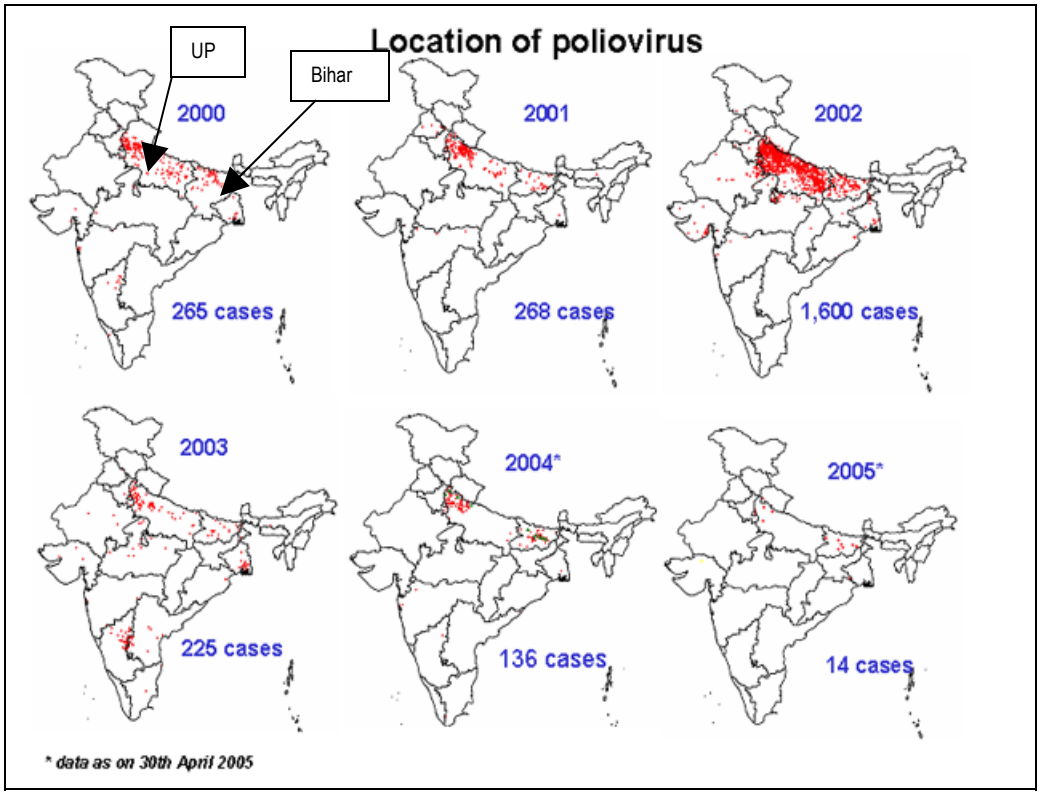


The following figure shows the continuous time trend (month wise incidence) of polio incidence in India from 1998 to 2004. All epidemic peaks took place between August to October. But it is interesting to note that polio cases occurred through out the years. In other words there was no period or month of 0 incidence. The last 7 years data shown in the figure shows considerable progress in polio eradication. But 2002 was major setback in polio eradication program. There were 1600 cases (six times more than previous year) of polio cases through out the country. But in the following years the number again reduced drastically. In 2005, till April there are reports of 14 polio cases so far.



Hot spots

that Uttar Pradesh (particularly western UP) and Bihar are known hot spots of polio. The maps of polio incidence from 2000 to 2005 show the endemic states and the location of polio in the respective states. Apart from that Delhi, West Bengal, Mumbai, North Karnataka are also known hot spots. But sudden explosion of polio in 2002 had shaken the traditional concept of hot spots. Since then several new states, earlier known as polio free states started reported polio cases. For instance – Tamil Nadu, Andhra Pradesh, Jammu & Kashmir, Orissa etc. Investigation by Govt of India and National Polio Surveillance Project (WHO) had shown its link with poor routine immunization coverage, poor pulse polio coverage and natural history of disease. The following figure shows the location of polio cases (each dot represents each case) in Indian states from the period of 2000 to 2005 (April). Polio cases were predominantly found in UP and Bihar. While the number of cases dropped drastically the next year in 2003, a new trend emerged as polio had spread to three more regions, other than the usual hotspots UP and Bihar. There is spill over of polio to number of southern states. But from 2004 onwards, mostly polio cases confined with in western UP and Bihar.



Control strategy of is essentially vaccination with oral polio vaccine. First polio eradication started in 1974 as a part Expanded programme of immunization. Latter it was renamed as Universal Immunization Programme in 1985. But polio could not be eradicated from several countries. In world health assembly resolution 1988, eradication of polio was pledged by all UN member countries. In 1995, pulse polio programme started in India to eradicate polio by means of immunizing all children less than five years of age through out the country. It was also known as supplementary immunization programme, as this has been additional to routine immunization program. Since 1995 several rounds of supplementary immunization programs were conducted in India. But still now, the country is struggling to eradicate the deadly virus. Using the same strategy, the neighboring countries, for instances Bangladesh, Nepal and Sri Lanka became polio free. Most populous country - China required only two rounds of pulse polio programme to eradicate polio from the whole county. At present, whole of Europe, Americas and Far East Asia are polio free. Apart from India, Pakistan, Afghanistan and Iraq in Asia and Nigeria, Niger and some African countries are still under the grip of polio.

Government of India, WHO, UNICEF and several international experts admitted that the failure attribute to poor coverage of vaccination during pulse polio in several places, despite huge money and man power investment in social mobilization. Hence polio cases were found mostly in those poorly performing areas. Moreover, poor routine immunization programme in the backward states like in Bihar, Uttar Pradesh also contributed high virus transmission in high risk areas. In fact, in relatively developed states in southern India, for instance Tamil Nadu, Andhra Pradesh, Karnataka and Kerala

polio cases were found in comparatively poorly performing districts. For instance, North Karnataka was considered most backward area in terms of health indicators and routine immunization and cluster of polio cases was found only in the region. In Kerala, last polio case was fond in malapuram district – most backward district in Kerala.

How Polio crippled the whole health system

The whole polio programme started with the aim to eradicate crippling disease. But ironical enough - instead of eradicating polio, the pulse polio program could able to cripple whole routine immunization program. Routine immunization program has been aim to protect the children from six killer diseases including polio. But too much attention to only supplementary polio programme, other routine activities became less important. Pulse polio programme takes place in every one and half month. But it takes nearly two to three weeks to prepare. During the preparatory period whole district health machinery becomes busy and other health activities get postponed. Routine immunisation is weekly affair, but pulse polio program grossly interrupted it. It is almost common opinion of all concerned doctors, health workers and public health researchers. But unfortunately, higher authority failed to acknowledge the consequences of pulse polio program openly. Frequent pulse polo programme also caused fatigue among the health workers and health official. Now pulse polio program, which was initially conceived as supplementary immunization program has turned into routine activity by replacing routine immunization program to secondary activity. Several paediatricians expressed dissatisfaction over pulse polio program. There is suspicion among several paediatricians that rising number of other vaccine preventable diseases, for instances diphtheria, measles, and whooping cough are result of declining immunisation coverage due to lesser attention paid to routine immunisation. In addition to that, several schoolteachers were asked to participate in vaccination programme and hampered the normal school activities. Pulse polio program also gives rise to wide spread corruption among health officials. Huge funds regularly reach state and districts to organize the pulse polio programme. Several components of funds are unaccounted, for instance money for training, printing posters and banners, diesel for running generators and vehicles. Siphoning off these funds has become major attraction of dishonest officials. Major funds of polio programs are arranged by borrowing from international banks as soft loan. Unfortunately, huge amount of borrowed money drained due to corruption, lack of accountability and failure to reach the objective, i.e. polio eradication. More saddening, the programme destroyed the routine immunization and put life of millions of children at risk.

Oral polio vaccine contains live polioviruses of all the three types and is administered by mouth in form of drops. The polioviruses contained in the vaccine are in weakened form, which do not cause disease but generate antibodies, which provide protection against the disease. There are about 17 lakh attenuated (weakened) polioviruses in each dose of two drops of OPV. These viruses multiply and replicate in the gut of the vaccine recipient, and generate antibodies. During replication some of these attenuated or weakened viruses mutate and re-acquire properties like wild polioviruses and cause paralysis, which is

called vaccine, associated paralytic polio (VAPP). The mutant viruses are called vaccine derived wild-like polioviruses (VDWL). Both weakened and mutant vaccine polioviruses are passed out with faecal material and can reach other individuals in community through secondary spread. There is no proper document on actual number of vaccine associated paralytic polio cases. Global estimation shows 1 case of VAPP per one million doses. It seems to be very less, but comparing the number of children is vaccinated in single occasion of pulse polio programme, the number would be significantly higher. In each national level pulse polio programmes around 60 to 70 million children are vaccinated. By using the global estimation the expected number of such cases for India would be 60-75 cases per round. There are several rounds in a year. Therefore total expected VAPP would be 300 to 400 (i.e. ***much higher than the total number of wild polio cases in 2003 and 2004!!***). Only way to control VAPP or VDWL is replacing OPV with IPV (injectable polio vaccine). IPV contains killed viruses, which can generate similar kind of immunity with out any mutation. Because killed virus cannot replicate. IPV is essentially used in developed countries like USA and in several European countries. But in India, current government policy is to continue with OPV, as it is cheap, easy to administer and gives community protection through herd immunity. On the other hand IPV is expensive, needs special as it injectable and can bring other injection related hazards.

1.10. National Diarrhoeal Disease Control Program

The diarrhoeal disease control programme started in 1978. It was a part of the World Health Assembly (1978) resolution by WHO to establish a global programme on Control of Diarrhoeal Diseases (CDD) aimed at reducing mortality and morbidity from diarrhoeal diseases and their associated ill-effects, particularly malnutrition in infants and young children. Since, 1985-86, with the inception of the national oral rehydration therapy programme, the focus of activities has been on strengthening case management of diarrhoea for children under the age of 5 years and improving maternal knowledge related to use of home available fluids, use of ORS and continued feeding. From 1992-93, the program has become a part of the child survival and safe motherhood (CSSM) program. Presently diarrhoeal disease control programme is being implemented through reproductive and child health (RCH) programme.

Unlike other vertical health programs (for instance TB, malaria etc), this program was integrated with general health services. All the services are community-based approach and implemented through primary health centre, sub centres and anganwadi centres. The programme placed within the reach of the community a simple, safe and effective tool to combat a serious public health problem. Supply of ORS is the major component of this program and it is organized by central government to assist state government. Twice a year ORS packets are supposed to be provided to all sub-centres. The programme also emphasizes the rational use of drugs for the management of diarrhoea, adequate nutritional care of the child with diarrhoea and proper advice to mother on feeding are the

two important areas of the program. The effectiveness of oral rehydration therapy (ORT) was unmatched in its simplicity and accessibility to even the poorest families.

Apart of erratic supply of ORS packets, the major problem related to the program is that its success is dependent on quality of general health service. Therefore all the existing problem pertaining to general health services affect the programme, for example, lack of manpower and motivation, corruption and poor community mobilization determined the quality of service. Nevertheless, there is indeed some improvement of in awareness of home-based diarrhoeal management program. Improvement in management strategies resulted in a dramatic fall in mortality. The program runs well where concerned ANMs and anganwadi workers are motivated and proactive.

1.11. Impact on vulnerable groups

Women

Women and water

In any developing country, India is no exception; it is women who have to literally walk on water all their lives. The rural sector has witnessed a plethora of schemes to take care of its drinking water and sanitation needs. However a major shortfall still remains.[lxi] Women spend two hours to even 7 hours a day to fetch water, depending on the amount of water available in the region and how far the source is situated. At Bhihi tola (hamlet) in Tantar village in Bajag taluka of Dindori district, Madhya Pradesh, Ramutinbai says, "The river is far away and we have to walk about three km each time we fetch water." Similarly, in the villages of the desert district of Banaskantha, in Gujarat, women spend up to six hours a day bringing water from distant sources to their homes. They carry up to 15 litres on their heads on each trip, often walking barefoot.[lxii]

Studies shows household consumption of water drastically reduces with increasing travel time, from home to water source and back. It is a global phenomenon and particularly applicable in developing world. Cairncross provides an example from Mozambique that demonstrated that water consumption in a village with a standard with in 15 minutes was 12.3 litres per capita per day compared to 3.24 litres per capita per day in a village where it took over five hours to collect a bucket of water. This meagre water was used for drinking and cooking purpose with out than human being cannot survive. The '*excess'* water is essentially used for hygiene related activities. Hence, the access to water is directly linked to personal hygiene. Cairncross found that once the time taken to collect water source exceeds a minutes (typically around 5 minutes or 100 metres from house), the quantity of water collected decreases significantly. There is well-defined plateau of consumption that appears to operate with in boundaries defined by distances equivalent to around 100 to 1000 metres or 5 to 30 minutes collection time. Beyond it consumption further decreases.

Although women bear the brunt the perennial water scarcity, yet the national water policy does not recognise women's role. It seems national water policy moves away from considering water as a social good to an economic good. Consequently, it has reinforced the intrinsic link between land and water rights. This is a total denial of women's right to water. Women spend most of their waking hours collecting water, with little time for other income generating work. This impacts on the education of the girl child, for if the girl is herself not collecting water she is looking after the home and her siblings when her mother is away. It also affects her personal hygiene.

Women and sanitation

It is women who have to fetch and manage water; and it is women who have the greatest need for a private and safe place in which to defecate. The absence of toilets is devastating for women. It severely affects their dignity, health, safety and sense of privacy, and indirectly their literacy and productivity. For certain physiological reasons women have to answer the call of nature more frequently than men. They also take a longer time to relieve themselves owing to anatomical and sartorial factors. Yet, the facilities they have are fewer and inadequate. As a result in certain areas women and girls have to wait until dark before they can answer the call of nature. At times this exposes them to harassment and even sexual assault. In areas where open defecation is still practiced the rapid rate of deforestation has affected women more than men. It has led to women losing their privacy and with it their sense of dignity. The millions of women who defecate along railway tracks, on footpaths, on empty plots, between buildings, over storm water drains and in makeshift privies of sticks and gunny sacks are shouted at, molested, exposed to indignities, insulted and beaten. For many women, there exists no choice and no option. They are forced to endure punishing restraints and devise their own methods of dealing with this problem. The only solution for many is to ensure that their need to use a toilet is reduced as far as possible. So, most do not even drink water when thirsty or eat when hungry. For these access to a toilet is a dream.

Gender disparity in seeking treatment

Discrimination against women with regard to treatment is very common practice in Indian society. Male children and adults get immediate attention to any form of diseases including water borne disease. On the other hand, girl children gat lesser attention and hence morbidity and mortality are more among girls. More over, lesser food intake among women makes them more vulnerable to infection on account of low immunity.[lxiii] Statistics provided by the United Nations Development Program (UNDP) show that about 80 per cent of children suffer from diarrhoeal diseases in India, every year.[lxiv] However, when it becomes a question of access to medical treatment, parents rush to a doctor when it involves a male child.[lxv]

School drop out among girls and linkage with sanitation

Lack of adequate sanitation affects the education of girls too. Says V Balakrishnan, state convener of the Tamil Nadu Primary Schools Improvement Campaign (TanPIC): "The lack of proper toilet facilities in schools increases the dropout rate of girl children, particularly around the time they reach Class VIII. Despite this barely 10 per cent of the 40,000 government schools in Tamil Nadu have toilet facilities -- and where they do, they are hopelessly inadequate. As a result parents prefer to keep their teenage daughters at home, because they feel they cannot send them to a school where they have no privacy when it comes to answering the call of nature.[lxvi]

Globally too, it is the same story. In 1995, a survey of 14 countries found that many primary schools could not provide more than one latrine per 50 students, and that none of the surveyed countries had increased the number of school toilets by more than eight per cent since 1990. These findings confirm the general conclusions of the School Sanitation and Hygiene Education (SSHE) Programme (a joint initiative between UNICEF's Education, and Water, Environmental Sanitation Programmes in partnership with IRC – International Water and Sanitation Centre and participating countries, launched in 2000), which finds that the sanitary conditions of schools in both rural and urban areas in developing countries are often appalling, creating health hazards. The WASH in schools campaign, launched in 2003 by UNICEF and WSSCC, aims to provide water and sanitary facilities in schools to improve health and encourage girls to attend school.

Children

Malnutrition-infection vicious cycle

While all children are more at risk from waterborne diseases because their immune systems are not well developed, girls are twice as likely to succumb to infections. Repeated episodes of severe diarrhoea in early childhood may have permanent effects on brain development.[lxvii] The lack of clean drinking water exacerbates malnutrition, in turn leading to depressed immunity and lower resistance to infections. This creates a vicious diet-infection cycle. The nutrients that should support the body’s growth are diverted to supporting its immune response rather than physical growth and development.[lxviii] Inadequate intake of protein and micronutrients, which is characterised by frequent bouts of infections and diseases, results in malnutrition which could be in the form of stunting (low height for age), wasting (low weight for height) and underweight children. Each day of illness due to diarrhoea produces a weight deficit of 20-40 gm. Poor nutrition is associated with more serious prolonged diarrhoea. 'Catch-up growth' often does not occur in malnourished children. Malnutrition, particularly wasting, is a strong predictor of diarrhoeal duration and the prolonged illness could exacerbate nutritional faltering, thereby increasing the subsequent risk of death. Poor appetite, vomiting, deliberate withholding of food resulting in poor intake; malabsorption of macro and micronutrients; hastening of intestinal transit time; disturbance of metabolic and endocrine functions; and direct loss of protein and other nutrients in gastrointestinal tract are some of the known mechanisms which have an impact on the nutrition during an episode of diarrhoea. Pre-

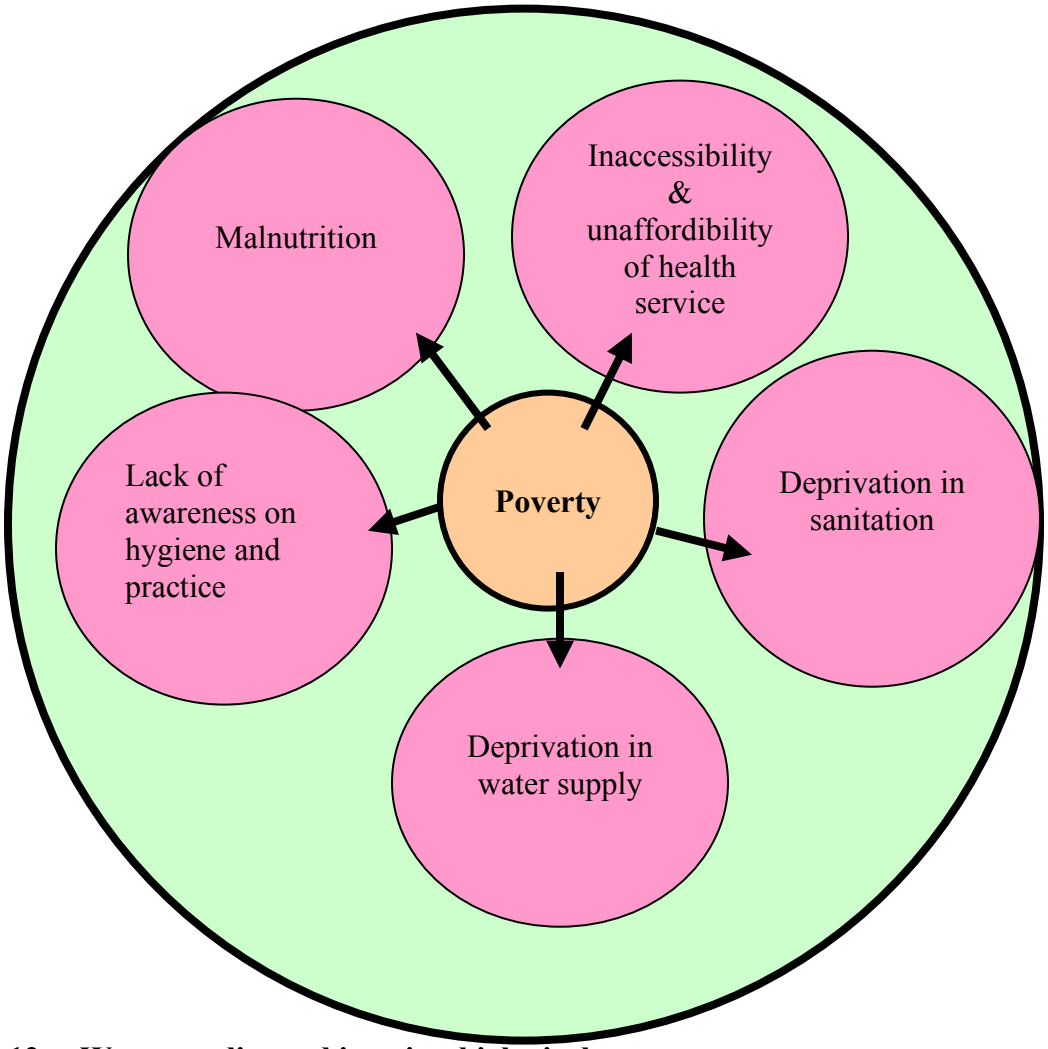
existing malnutrition is associated with decreased turnover of epithelial cells resulting in delayed recovery, which may prolong an episode of infectious diarrhoea by itself as well as by promoting tissue invasion by other enteropathogens. Malnutrition may also alter protective host factors and thereby favours intestinal colonization by the pathogenic microbes. Mucosal damage varying from moderately severe changes to flat lesions indistinguishable from those of celiac disease may occur in kwashiorkor.[lxix]

Box begins
Role of micronutrient
Zinc is an essential mineral and deficiency results in abnormal immune function and higher rates of infectious diseases. Randomized controlled trials of zinc supplementation have been conducted in children in developing countries to determine effects on infectious disease morbidity and mortality. Zinc-supplemented children have been found to have lower rates of diarrhea, pneumonia and malaria in comparison with children not given zinc. Zinc used as an adjunct to fluid and dietary management of acute and persistent diarrhea has been found to reduce diarrheal duration and severity. Preliminary evidence suggests that zinc supplementation in children in poor developing country settings may also reduce infant mortality, but larger trials are needed to address this important issue. Preventive and therapeutic interventions should be implemented in developing countries where zinc deficiency is likely to be prevalent.[lxx] Studies show that children who receive zinc supplementation have less chances of getting a renewed attack of diarrhoea, and this was more apparent in children with stunted growth than in those with normal growth.[lxxi] Archana Patel's study on economic evaluation of zinc and copper use in treating acute diarrhoea in children: a randomised controlled trial, cost effectiveness and resource allocation mentioned earlier also found that micronutrient supplementation reduces the duration and severity of diarrhoea and compares favourably with other health interventions.[lxxii]
Box ends

The poor

It is poor who bears the brunt of water borne diseases. Majority of the disease out break in urban areas occurs in slums areas. In rural areas the out breaks often occurs among poor people who do not have access to potable water and sanitation facility. More over, access to health service is often denied to them. Preventive measures are desperately required to ensure that proper water and sanitation are available to all including the poor. All the present day models, with a few tiny exceptions, leave the poor out of their scheme of things. Even when it comes to seeking curative measures, the poor, who are more vulnerable, have very limited access to medical relief. Out of 10 children that get diarrhoea in a poor household, only three are given oral rehydration therapy (ORT). World Bank economist Davidson Gwatkin estimates that there is a wide gap in access to medical treatment between the rich and the poor. According to him 52 per cent of those in the poorest segment seek medical treatment, as compared to 78 per cent in the richest.[lxxiii] The following figure shows how the poverty of people living in the

unfavourable environment in urban slums or rural areas are linked to the factors responsible for water borne diseases. (described earlier)



1.12. Water quality and its microbiological aspect

Presence of pathogenic microorganisms in drinking water is an important parameter of water quality. WHO developed guidelines for drinking water quality intended for use by countries as a basis for the development of standards which if properly implemented, will ensure the safety of drinking water supplies. As far as microbiological indicators are concerned, it has three aspects – bacteriological, virological and biological. Ideally, drinking water should not contain any microorganisms known to be pathogenic. (See table below) Ineffective treatment and disinfection of drinking water will expose the community to the risk of outbreaks of intestinal and other infectious diseases.

The primary bacterial indicator recommended for this purpose is the coliform group (E Coli and other coliform) of organisms as a whole. Supplementary indicator organisms, such as faecal streptococci and clostridium perfringens, may sometimes be useful in determining the origin of faecal pollution as well as in assessing the efficiency of water

treatment processes. The absence of either coliform or faecal coliform bacteria means that the water is bacteriologically suitable for drinking.[lxxiv] It is also recommended that drinking water should be free from any viruses infectious to human and any pathogenic intestinal protozoa. A single mature larva of helminth or fertilized egg can cause infection and such infective stage should be absent from drinking water.

Table: Guideline value of microbiological quality of water

Type of water	Micro organism	Guideline value
All water intended for drinking	E Coli and other Coliform	Must not be detectable in any 100 ml sample
Treated water entering the distribution system	E Coli and other Coliform	Must not be detectable in any 100 ml sample
Treated water in distribution system	E Coli and other Coliform	Must not be detectable in any 100 ml sample

Why coliform

The coliform group includes faecal and non – faecal organisms. Typical example of the faecal group is E. Coli and the non – faecal group, *Klebsiella* aerogens. There are several reasons why coliform organisms are chosen as indicators of faecal pollution rather than the water-borne pathogens directly: (a) the coliform organisms are constantly present in great abundance in the human intestine. It is estimated that an average person excretes 200-400 billion of these organisms per day. These organisms are foreign to potable waters, and hence their presence in water is looked upon as evidence of faecal contamination, (b) they are easily detected by culture methods – as small as one bacteria in 100 ml of water, whereas the methods for detecting the other pathogenic organisms are complicated and time-consuming, (c) they survive longer than the other pathogens, which tend to die out more rapidly than coliform bacilli, (d) the coliform bacilli have greater resistance to the forces of natural purification than the water borne pathogens. If the coliform organisms are present in a water sample, the assumption is the probable presence of intestine pathogens. In other words a positive faecal coliform indicates direct sewage contamination. Bacteriologically water is classified as either satisfactory or unsatisfactory based on the analysis of total coliform. The results assume that the only water suitable for human consumption is that containing zero coliform-type bacteria per 100 ml of sample. [lxxv]

Other parameters

Faecal streptococci: Faecal streptococci in small number regularly occur in faeces, and it may be valuable for routine control testing after laying new mains or repairs in distribution systems or for detecting pollution by surface run-off to ground or surface waters.

Clostridium. Perfringens: They also occur regularly in faeces. The presence of spores of Cl. perfringens in natural water suggests that faecal contamination has occurred, and their presence, in the absence of the coliform group, suggests that faecal contamination occurred at some remote time. Its presence in filtered supplies may indicate deficiency in filtration practice.[lxxvi]

1.13. The environmental link

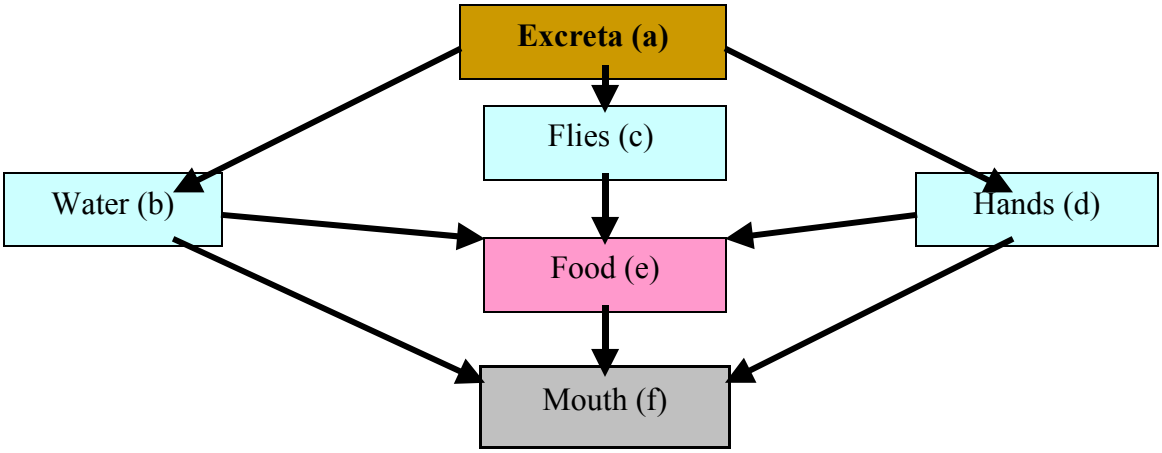
Transmission: The faecal-oral route

Water borne diseases are the result of adverse environmental condition, which favours the pathogenic microorganisms to survive in the environment and entry in to the human body through contaminated water and food. Water borne diseases are the outcomes of complex faecal oral transmission (described below). Infected human beings shed pathogenic microorganisms through faecal matters. The faecal matters can spread diseases to other family members or community if the environment is contaminated due to their improper management. Breaking this cycle is the function of an efficient water and sanitation system. In simplest terms, sanitation acts as a barrier between humans and disease causing agents. The barriers are generally physical, chemical or spatial. Therefore environmental factor plays important role in occurrence of water borne diseases. The following figure elaborates the different modes of transmission of microorganisms from excreta of infected persons to mouth of vulnerable people. In developed countries, due to proper sanitation measures faecal matters cannot contaminate drinking water and food and hence incidence of water related infectious diseases are very low as compared to poor countries (described latter). In developing countries, where sanitation facility is poor or not available, faecal matters contaminate water of tanks, lakes, and rivers. Open field defecation directly comes in to contact with near by water bodies or drain into rivers and contaminate water. Human faeces are the most dangerous pollutant – one gram of faeces contains 10 million viruses, 1 million bacteria, 1000 parasite cyst and 100 worm eggs.[lxxvii] Untreated sewerage (particularly from urban areas) drains into lakes and river and contaminate. The water from these sources is used for household consumption. In urban areas, the treatment plants are supposed to remove all pathogen to make water potable (see water quality latter). But due to inefficiency or non-existence of treatment plants in several occasions' potable water could not be supplied to households. Moreover, during supply though pipeline, clean potable water also get contaminated due to leakage of nearby sewer line. In rural areas, having no water treatment facility directly consume the polluted water. Therefore the net impact of poor sanitation and water supply is exposure of people to contaminated water and fall ill. Open field defecation also causes diseases transmitting through insects, particularly flies. Where open field defecation and accumulation solid waste coexist, outbreak of water related diseases are common. Accumulated solid waste acts as breeding ground of flies and these flies get physically contacted with faecal matters and transmit the pathogenic organisms in to food. Poor hygiene practice also facilitates disease transmission. Improper cleaning of hands after

defecation and direct physical contact with faecal contaminated soil in fields used for defecations result water borne diseases.

Complex faecal-oral transmission

The faecal-oral route of disease transmission



(a) To (b): Improper excreta disposal, leads to contamination of natural water resources in river, streams, ponds, lakes, and aquifers. Also contamination of water supply line with sewage system contaminates water.
(a) To (c): Improper excreta disposal leads flies and other insects to contact with faecal matters. Surface of insects harbours pathogenic microorganisms. Poor solid waste management enhances breeding of flies.
(a) To (d): hands get contact with microorganisms and remain on the surface due to improper hygiene practice or due to poor water supply.
(b) To (e): Untreated contaminated water transmits microorganisms to food, while washing raw vegetables, cooking and mixing. Irrigation with contaminated water makes vegetables and fruits potential source of microorganisms. Some microorganisms are resistant to high temperature (eggs of some parasites and intestinal worms), so uncooked or improperly cooked food contaminated with microorganisms may remain source of infection.
(c) To (e): When flies and other insects contaminated with micro organisms sit on food or get cooked with food become source of infection.
(d) To (e): unclean hands transmit microorganisms to food while handling.
(b) To (f): If untreated contaminated water is consumed.
(e) To (f): If raw or improperly cooked food contaminated with microorganisms are consumed.
(d) To (f): If food is eaten by using unclean hands

After entering into intestine pathogenic microorganisms multiply rapidly and produce toxins and restrict normal absorption of water from intestine to blood and cause stool watery liquid, i.e. diarrhoea (for example cholera, E Coli infection). Some toxins also cause vomiting and dysentery (blood with stool). People suffering from severe form of manifestation often die due to dehydration. Some variety of microorganisms penetrate intestine and comes into contact of various body organs, for instance liver, nervous system etc. Hepatitis virus affects liver and causes jaundice and liver failure, leading to death. Poliovirus affects nervous system causing paralysis of limbs. Parasites (worms) remain inside the intestine and thrive on sucking blood from intestinal walls or feeding on semi-digested food. The affected people become weak due to anaemia and malnutrition. Often sufferers die due to severe form of anaemia and heart failure and repeated infection due to depressed body immunity on account of chronic blood loss.

Natural calamity (flood, earthquake) spark out breaks of various types of water borne diseases. Disasters destroy the human settlements, sewage and water supply systems and put the displaced or marooned people more vulnerable to water borne diseases. Collapsed water and sanitation increase more exposure to pathogenic organisms. Absence of medical service increases the mortality, particularly the children, who are more vulnerable.

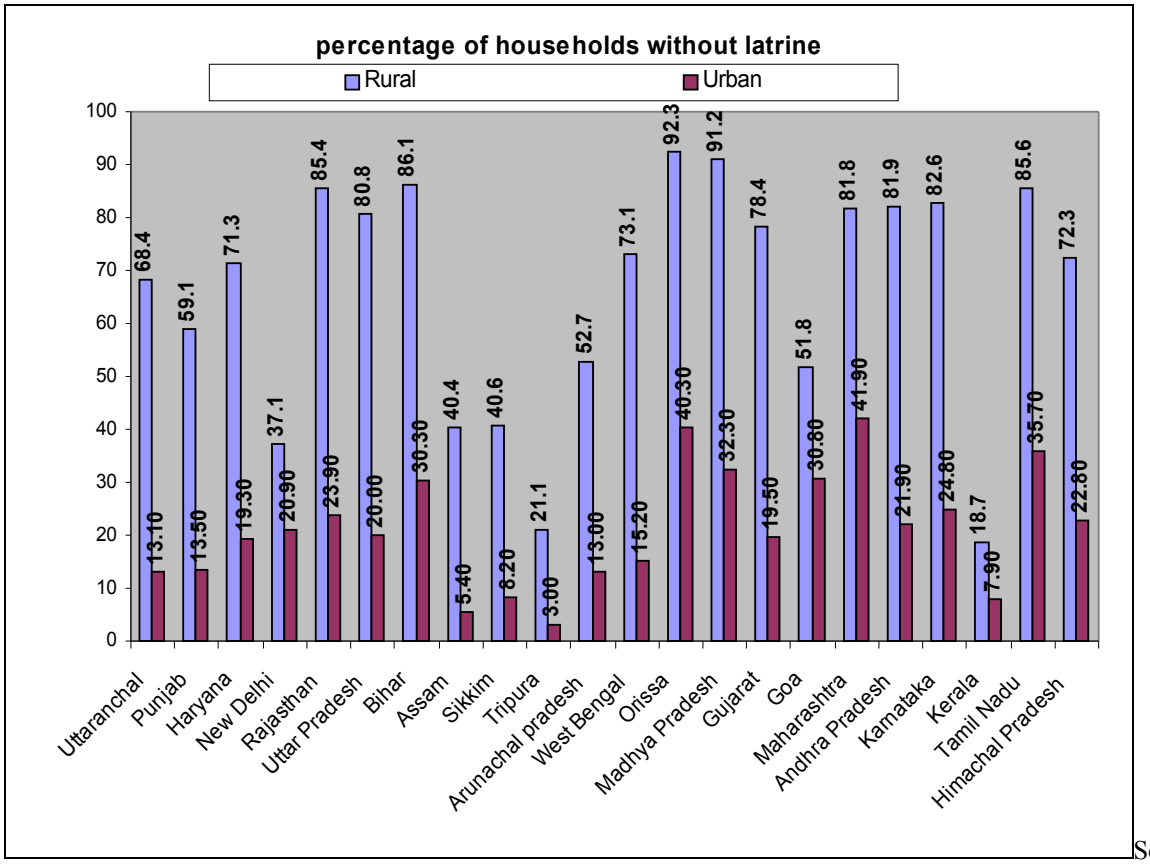
Box begins
Natural disaster and its role in diarrhoea
It is well-established fact that diarrhoeal diseases are a major cause of mortality and morbidities in emergencies (natural disaster) and studies have shown that they contribute to between 25 to 50 per cent of all deaths.[lxxviii] According to NICD, after physical trauma next immediate health problems after earthquake is water borne infectious diseases.[lxxix] Flooding forces huge populations into small areas - sanitation facilities there often cannot cope, and water supplies may become tainted. The prime threat is likely to come from cholera, which causes acute diarrhoea and vomiting. It is at its most deadly following natural disasters such as floods because treatment facilities are not available. Danger from E Coli is also likely to increase during flood.[lxxx]
An explosive epidemic of cholera in the district of Malda in the state of West Bengal, was induced by devastating floods resulting from overflowing of the two main rivers of the district, at the end of July 1998, affecting 15 blocks and 2 municipalities. Diarrhoeal outbreak occurred around the middle of August after receding of the floodwaters. Within two weeks of its onset, the outbreak spread throughout the district. An investigation was conducted to understand the epidemiological characteristics, identify the etiological agent, rationalise clinical management and suggest control measures. During the period between August and October 1998, 16,590 cases were reported with 276 deaths.[lxxxi] An epidemiological study was carried out by GP Chhotray from the Department of Microbiology and Pathology, Regional Medical Research Centre (ICMR), Bhubaneswar, Orissa, to find out the aetiological agent for diarrhoeal disorders in the super cyclone and consequent flood affected areas of Orissa, India. After analysis they detected Vibrio cholerae in stool samples. Drinking water scarcity

and poor sanitation were thought to be responsible for these diarrhoeal outbreaks. Timely reporting and implementation of appropriate control measures could contain a vital epidemic in this area.[lxxxii]
Box ends

Sanitation, sewage and waste disposal

The average human body excretes 50 litres of faeces/year. Faeces are full of pathogens and health-threatening material. Therefore, sanitation facility is important barrier to get human beings exposed to pathogenic organisms. But, 28% of Indian population had sanitation coverage (15% of rural and 61% of urban population).[lxxxiii] The *India Assessment Report 2002* on water and sanitation says that Kerala has the highest coverage, with 85 per cent of households having access to household toilet facilities.[lxxxiv] Larger, more populated and poorer states like Andhra Pradesh, Bihar, Madhya Pradesh and Orissa have lower access to toilet facilities as compared to smaller states.[lxxxv] In rural areas, sewerage systems and treatment facilities are practically non-existent. Rural India is always deprived of proper sanitation measure. Those who do not have access to toilet facilities go for open field defecation. Although water plays a direct or indirect part in their transmission by providing the micro-organisms or parasites which carry the actual illness with a habitat and transportation system, 'unsafe' sanitation practices and lack of environmental hygiene, rather than water itself, are at the root of the spread of these infection.

Census 2001 (figure below) shows the state wise rural and urban sanitary condition. Availability of latrine wise Rajasthan, Bihar, Orissa, Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka, and Tamil Nadu are the worst. More than 80% of rural households in these states do not have access to latrines. In this regard Haryana (6.1%) and Kerala (18.7%) are much ahead of rest of India. In Delhi, 37.1% of rural population do not have access to latrine. As far as access to latrine in rural area is concerned, Bihar, UP, Orissa, Madhya Pradesh, Rajasthan, Maharashtra, Karnataka and Tamil Nadu are the worst. More than 80% households do not have access to latrine. In this regard Kerala is the best (18.7%) followed by Tripura, Sikkim and Assam. As far as latrine facility in urban area is concerned, worst are Orissa, Maharashtra, Tamil Nadu, and Bihar. More than 35-40% households do not have facility. In this regard Tripura, Assam, Sikkim and Kerala are relatively better (3-8% do not have latrine facility). It is worth to note that the deprivation (i.e. non accessibility) is not equally distributed across the states and cities. Vulnerable population like poor and migrant population face all kinds of deprivation.



Source: Census of India 2001

While three quarter of countries population are deprived of latrine facilities poor treatment facility of sewage put whole population vulnerable to water borne diseases. Faecal material is simply deposited on open ground. From, there wastes are very often flushed into waterways, and whether it occurs naturally or by human intervention in the form of organized disposal or sewer pipelines, the polluting consequences are the same. According to the planning commission, 80 percent of pollution in rivers is from human sewage. Waste water from domestic sources (grey water) carry relatively less infective pathogens, but eventually get faecal contamination when it passes through open channel, which is frequently used for defecation by urban poor. The insufficient treatment facility of wastewater and sewage as well cause pollution of river, lakes, water bodies and ground water. The following table shows the report of CPCB on wastewater and sewage treatment in Indian urban areas. Sewage treatment is worst in Class I & II cities, where more than 160 million people live. Moreover, when the treatment plants break down the situation becomes worse. Wastewater treatment capacity is poor in all cities and worst in Class II cities and in smaller towns. (See table below) Wastewater has significant role in causing infectious water related diseases, as in Indian urban areas; domestic wastewater often gets mixed with human excreta. Therefore quality of wastewater treatment facility has public health importance in city and its surrounding areas.

Waste water and its management in urban area (1991)						
type	No	generation (mld)	collection	treatment capacity	untreated	per cent of treated
Million plus	23	9275	7471	2923	6352	31.5
Class I	299	16662	11938	4037	12625	24.2
Class II	345	1649	1090	61	1588	3.7
	667	27586	20499	7021	20565	25.5

Source: CPCB report 1997, 2000, quoted in Bhaskar Vira et al 2004, India's urban environment: current knowledge and future possibilities, in Tim Dyson et al (eds), Twenty-first Century India, OUP New Delhi, pp 300-301.

Sanitation is seen as something to be taken care of after the supposedly more basic need of providing clean drinking water and a basic water supply; low prestige is given to sanitation work. The statistics speak for themselves.[lxxxvi] The Government of India reports its figures based on geographical coverage and not on access to number of persons. By the coverage argument, 75 per cent of the rural and 85 per cent of the urban population have access to safe drinking water. By the same coverage measure, sanitation services are available to only 48 per cent urban and 3.15 per cent of the rural population.[lxxxvii] The actual numbers are actually much smaller and vary between rural and urban communities. As the Planning Commission pointed out in its Ninth Plan appraisal, "…while the provision of drinking water to urban areas in the country has improved over the years, the provision of sewerage and drainage facilities has not received adequate attention. Ideally the water supply and liquid waste management facilities should be integrated. The absence of this integrated approach has resulted in the degradation of the environment, with serious health impact."

Where public latrine facilities are available, very few have access to make use of them. This is because the latrines are not properly maintained or cleaned and are often shared by dozens of families, creating ideal situations for pathogens to thrive, and for epidemics. In addition, the lack of sufficient and clean water in these toilets discourages their use. In addition to this is the general apathy towards waste disposal, especially human sewage. There is greater political concern for providing drinking water, than to invest in sanitation. Waterborne diseases therefore have a continuous opportunity to re-invade drinking water systems, and defeat gains made from piped water distribution.

Box starts
Modern toilet – Compounding more wastage of water
Flushing excreta is not ecologically viable, says Uno Winblad, coordinator of a Rs 2.5-crore international research and development project "Sanres" (Sanitation and Recycle) which is funded by the Swedish International Development Cooperation Agency and aimed at developing alternative, eco-logical concepts of sanitation for urban areas. Winblad explains that on an average, a person in America and Europe produces 400 to 500 litres of urine and about 50 litres of faeces each year. Further, 15,000 litres of pure water is used to flush this away, thereby raising the quantity of polluted water to more

than 15,000 litres per person. To this is added an average of 15,000 to 30,000 litres of bath water and wash water per person. Winblad says that instead of handling 50 litres of faeces, we end up polluting a large volume of water. In developing countries, 90 per cent of all sewerage is simply discharged into the environment without any treatment, he says, adding that this leads to pollution of ground water, surface water and soil. In India, 70 per cent of the surface water is polluted. We need to go back to the drawing board to reinvent a green toilet. If necessary, to go back to our past and find technological innovations those are sustainable and equitable. So that every Indian can have access to sanitation and still have clean water to drink. The alternatives to the flush toilets are emerging. These are beginnings of the new approach of sanitation - sewer less and less water intensive. Instead of focusing on the sewerage and treatment plants, flush toilets themselves can be modified to the amount of water they use. Low flush toilets that use just one litre per flush have been designed. Quite a large amount of water can be saved and recognising this, many cities, like Los Angeles, USA, are giving rebates to people willing to change their toilets to low water systems, and in some cases, provide them free. Meanwhile authorities have to learn to treat water as a scarce resource. Only if they do so, will they be able to come up with the desired results.

Indians had evolved certain systems to manage and treat waste in a more ecologically friendly manner. This traditional system of waste management — dry human waste composted and reused on the land —is being revived under a new name in the west today. The problem is that, in India, traditional waste management had dehumanised and degraded the individual handling this task. The problem also is that traditional technology — rudimentary at most times — could be unclean and unsafe. But should we throw the baby out with the bathwater? Clearly, the principles of traditional sanitation — if not its practices — were sound and sustainable. These were built on the extremely modern concepts of recycling and reuse. Is it so impossible to re-engineer the traditional composting toilet for this modern industrial world? But this would require scientists to think outside the caste system, in which the lives, and minds of most Indians and its political leadership, are mired.

Neighbours pay the price

Sewage released into a river-fed lake in Bangalore found its way to Tamil Nadu where it led to an outbreak of freshwater cholera

Nobody is safe. Cholera can travel great distances before it finds its victims. If the polluter pays principle was to be strictly applied in the country the residents of Bangalore would have to pay for the cost of treatment of cholera patients in another state, namely Tamil Nadu. In August 2003, cholera had assumed alarming proportions in Dharmapuri and Krishnagiri districts. While there were 979 reported cases, the disease is said to have claimed 45 lives.

The pathogens, which caused the disease, came from Bellandur Lake, located in Bangalore. The lake serves as an irrigation reservoir, a drinking water source and a fishing tank. But it has also become a dumping destination for sewage and effluents. Its condition deteriorated to such an extent that the Bellandur gram panchayat was forced to file a public interest litigation (PIL) petition in the Karnataka High Court in 1999. In the PIL, it contended that the Bangalore Water Supply and Sewerage Board (BWSSB) must stop pumping sewage water directly into the lake. The court ordered the BWSSB to network all sewerage lines and ensure that water was treated at least up to the secondary stage before being discharged into the lake. While a 163-million-litre-per-day (MLD)-capacity sewage treatment plant (STP) is located right next to the lake, it does not take care of more that 60 MLD of waste, laments H Jaganath, former chairperson, Bellandur gram panchayat. The lake is connected to the Chinnar river, a tributary of Ponnaiyar river in Karnataka. While traveling downstream towards Tamil Nadu the Chinnar becomes heavily contaminated with sewage, which provides an ideal breeding ground for the cholera pathogen. It is therefore not surprising that the local people residing in the villages along the river in Tamil Nadu suffer from cholera after drinking the water. A classic example of how rich Bangalore can actually pass on the burden of its waste to the poor villagers of Dharmapuri and Krishnagiri districts.

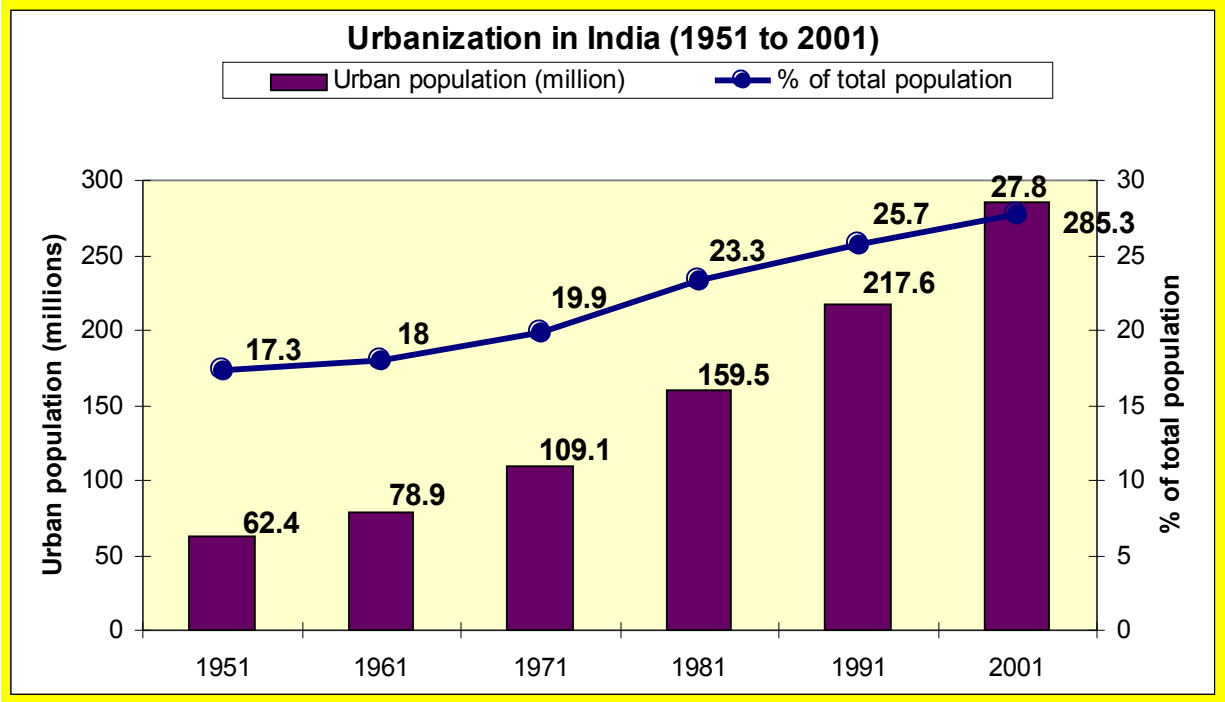
Amid this phase of uncertainty, the two state governments continue to pass the buck to each other rather than adopting a coordinated approach to deal with the problem. For its part, the Central Pollution Control Board (CPCB) doesn't want to get involved in the row. D C Sharma, south zonal officer, CPCB, says: "The complaint must be handled by the BWSSB and Bangalore Lake Development Authority." Both Vidhyashankar and Tamil Nadu Pollution Control Board member secretary K Shanjivi refused to comment on the issue. The situation bodes ill for the residents of Takkati. Till the two governments get their act together, the villagers' only source of water will also be a source of disease for them.

Source: DTE…

Urbanization

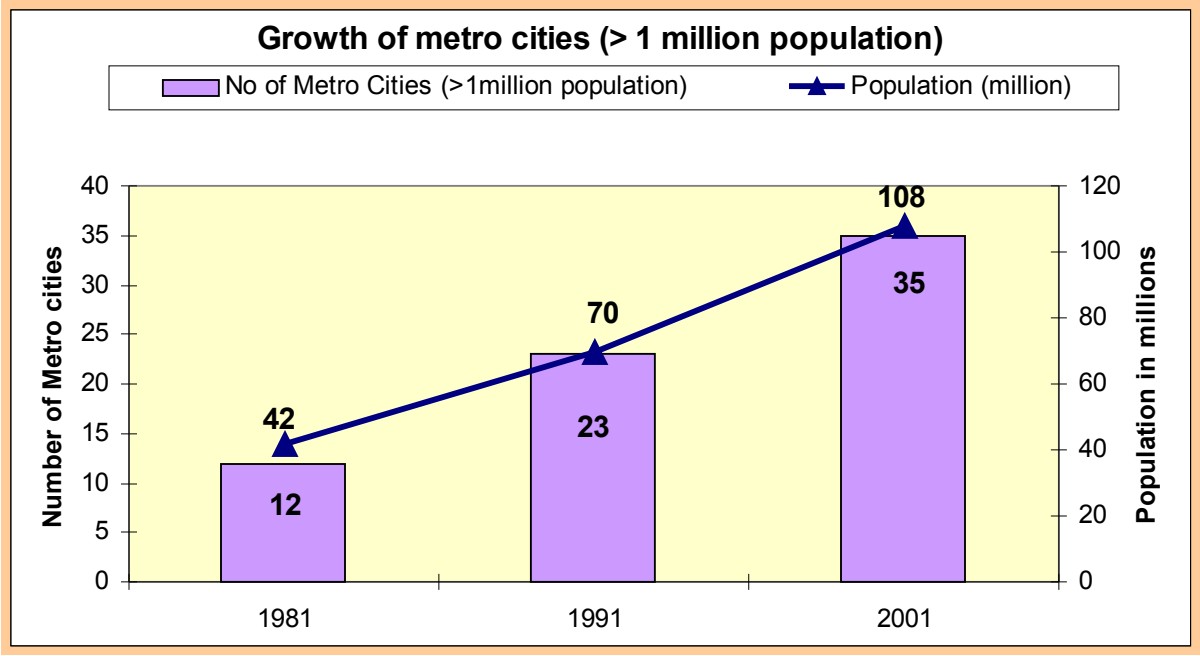
India, being a developing nation, is faced with two problems. On one side a lack of infrastructure and on the other an ever-increasing urban population. The urban population in India has jumped from 25.8 million in 1901 to 285 million in 2001. This has thrown up two self-perpetuating problems: shortage of water and sewage overload. According to KC Pant, Deputy Chairman, Planning Commission said "it is estimated that by 2025, more than 50% of the country's population will live in cities and towns and thus the likely demand for infrastructure facilities is expected to rise sharply posing a challenge to urban planners and policy makers."[lxxxviii] The figure shows growth of urban population from 1951 to 2001 along with corresponding proportion of urban population. In 50 years, (1951 to 2001) total population increased from 62.4 million to 285.3 million (i.e. adding up 4.5 million per year on an average). Proportion of urban population rose from 17.3% in 1951 to 27.8% in 2001. In 1991, there were 13,376 villages with population of 5000 or

more. Were the 113 million inhabitants of these villages to have been treated as urban then the level of urbanization would have risen from 25.7 to 39.2 per cent.[lxxxix]



Source: Census of India 1951, 61, 71,81 and 91 and Registrar General, India 2001, quoted in Tim Dyson et al 2004, Migration and urbanization retrospect and prospect, in Tim Dyson et al (eds), Twenty-first Century India, OUP New Delhi, p 116.

Following figure shows that from 1981 to 2001, in just 20 years the total number of million plus population city increased from 12 to 35 (i.e. 3 times). Correspondingly population of million plus cities rose from 42 million to 108 million (i.e. 2.6 times).



Source: Planning Commission 2002, Water supply and sanitation – India assessment 2002, Govt of India, New Delhi, p 16.

Public services could not keep pace with rapid urbanization. Water supply, sanitation measure, management of sewage and solid wastes could cover a fraction of total urban population. There are clear inequity and disparity between the rich and the poor as far public services are concerned. Slum dwellers always received least attention from the civic authorities. The rapid growth of urban population took place due to huge migration of population (mostly from rural areas and small towns to big towns) and inclusion of newer rural areas in to nearest urban settings, apart from natural growth of urban population. The following table show that the there is growing number of migration from rural to urban and from urban to urban. Usually migration from urban to urban took place from small town to big town. All migrations are mostly to search for jobs, as rural job opportunity is shrinking consistently for last several decades. These newcomers take shelter in slums, which has very minimum facilities in terms of water and sanitation.

Migration (million)		
Year	Rural to urban	Urban to urban
1971	23.2	16.5
1981	33.6	23.9
1991	39.8	26.5
1999-00	45.6	30.9

Urban Slum: A tale of two cities

There are no reliable records on population living slums. Although the environmental condition of slums is deplorable, there is variation of among the slums depending upon its stratification by local authorities. Various slums are notified and getting relatively better services. On the other hand, unauthorised / non-notified slums are deprived of all basic amenities. The urban slum population of India is severely under reported as per official estimates. Moreover, urban water and access /coverage are often calculated by measuring the total water available in an urban area and dividing this by total population. This provides an unsatisfactory assessment of coverage, as there is inequity in distribution of water in Indian cities. While wealthier parts of town receive huge quantity of water, poorer areas go dry, yet the average supply per capita looks good. Poor quality, regular shortages in supply (which in turn leads to contamination), weak infrastructure and high leakages (as high as 25-50%) are also major problems confronting the provision of urban drinking water. The following box on basic facts of slum shows vulnerability of urban population.

Urban Slums: Basic facts

Total number of slums - 51688
Notified slums – 26166 (50.6%)
Non-notified slums – 25522 (49.4%)
40.2 million people from 8 million households are living in 51688 slums (22.6% of total urban population of 607 cities/towns reporting slums)
5.5 million (13.7%) slum dwellers are in the age group of 0-6 years
26% of population of million plus cities are living in slums
33.4% of all slums do not have latrine facilities
29.3% of all slums do not have drainage facilities, 51.6% of all slums have open drainage
77.7% of all slums have tap water facilities (mostly public), rest depends on hand pumps, well, river and other sources
24.4% of all slums are located along the cities major drains, open sewer, river banks and river beds
44.9% of all slums get water logged in monsoon
40% of all slums do not have garbage collection system, in 15.8% garbage is collected by municipalities once in two weeks or beyond
52.4% of all slums houses are either mud, thatched made or combination with brick and vulnerable to any kind of natural calamities
83.1% of all slums have no underground sewerage system
4.7% of all slums' nearest Govt. hospital and health centres are located in 5 kilometres or beyond (despite being located in the urban areas)
Just 70% of the money allotted (1996-2004) in National Slum Development Programme was utilized
Per slum per year average expenditure under National Slum Development Programme (1996 to 2004) was Rs 39025 (USD 870), which is not sufficient to improve the living condition of slums
85% of all slums during the period of 1997 to 2002 had either no improvement or deterioration of sewerage system
71% of all slums during the period of 1997 to 2002 had either no improvement or deterioration of garbage disposal
62% of all slums during the period of 1997 to 2002 had either no improvement or deterioration of drainage facilities
56% of all slums during the period of 1997 to 2002 had either no improvement or deterioration of latrine facilities

The following table shows that among the slum population, people living in non-notified areas are more vulnerable. Moreover, deterioration of the condition is more observed in non-notified areas.

Comparison between non-notified and notified slums		
	Non-notified	**Notified**
No garbage disposal	46.3	16.4
No improvement of condition	86.6	65.1
No underground sewerage	96.5	70

Covered drainage facility	0.7	25.3
Open drainage	43.4	59.6
No drainage facility	55.9	15.1
No latrine facility	50	16.6
Public latrine facility	31.5	41.9
Available latrine facility showed no improvement or deterioration in 1997-2002	83.4	29.3
Available drainage facility showed no improvement or deterioration in 1997-2002	87.2	53.4
Available garbage facility showed no improvement or deterioration in 1997-2002	84.3	58.7
Available sewerage facility showed no improvement or deterioration in 1997-2002	94.2	76.2
Available water supply facility showed no improvement or deterioration in 1997-2002	68	52.1
Availability of government health facility beyond 2 km	30.8	28.3
Garbage collection once in two weeks or beyond	18.5	13.8
Tap as sources of drinking water	71.3	83.9
Hand pump as sources of drinking water	21.7	9.8
Mud or thatched house or combination with brick	69.7	36.3
Water logging	53.9	36.1

Municipal solid wastes also contribute in waterborne diseases. The accumulated solid wastes are favourite breeding grounds of flies and other insects. These insects are responsible for direct transmission of pathogenic organisms from defecation sites to food and water. Due to lack of segregation at source, hazardous solid wastes are mixed with non-hazardous solid waste and convert whole solid wastes in to hazardous. For example, infected hospital wastes, are extremely harmful to the municipal workers, who are involved in handling the wastes, but with out enough protection. The poor children, who are involved in rag picking, are exposed to hazardous solid wastes. Hospital wastes contains cottons, discarded equipments, and other substances, which contain multiple varieties of pathogenic organism causing direct exposure to human bodies. Several, studies show that hospital based pathogenic microorganisms are multi drug resistant and infection due to hospital-based microbes may cause more fatal infections. Often, municipal solid wastes contain faecal matters due to putting used diapers with household solid wastes. Pathogens of solid wastes may enter groundwater and contaminate. Although there is no national level data on municipal solid waste generation, collection, and disposals some estimates were made. Estimation based on various studies says, before 1980, annual growth rate of per capita solid waste generation was 1 per cent and after 1990, annual growth rate of per capita solid waste generation was 1.33 per cent. Change of lifestyle, consumption pattern and introduction of technology in packaging have increased the use of non-biodegradable products and hence proportionate increase of solid waste. the following table shows the change of total amount and rate of production of solid waste during India's independence and 50 years latter. Due to increase population, quantum of total solid wastes generation raised from 6 million

tonnes in 1947 to 48 million tonnes (8 times) in 1997. The areas of landfills increased from 1200 hectares to 20200 hectares.

50 years of solid waste generation		
	1947	1997
Urban pop (million)	56.9	247
Per day per capita waste generation (gm)	295	490
Total waste generation (million tonnes)	6	48
Area under landfills (1000 hectares)	0.12	20.2

The population in Mumbai grew from 8.2 million in 1981 to 12.3 million in 1991 (49% of increase). During the same period the MSW generated from 3200 to 5355 tonnes per day (67% growth). Growth of MSW out paced the population growth can be ascribed to changing life style, food habits and changing living standards.[xc] According to the CPCB, the total MSW generated by the 23 million plus cities (as per 1991) was 30,058 tonnes per day. Total solid waste generated by all 299 class I cities (100000 and above) estimated 48134 tonnes per day.345 class II cities (50000-99999) was estimated 3748 tonnes per day. The average per capita generation of solid waste was 0.449 kg per day for the millions plus cities, 0.376 kg per persons per day for all Class I cities and 0.152 kg per person per day for class II towns. [xci]

The management of solid waste in urban areas are in very poor condition. While on an average, 59.7% of the generated solid wastes are collected; only 5.7% of the collected wastes are properly treated (either recycling, composting etc). 93.4% are dumped either in sanitary landfill or in open ground outside the cities. In most of the cities there is no existence of sanitary landfill and therefore the solid wastes are simply dumped. Situation of class II cities and smaller towns are worse.

Status of municipal solid wastes in towns / cities (1991)		
Collection efficiency	Treatment of collected solid waste	Dumping of collected solid waste
59.7	5.7	93.4

In India, only eight out of 3,119 towns and cities have complete main sewerage with sewage treatment services, and only 20 per cent of towns and cities have partial service coverage.[xcii] The coverage in Kolkata is a mere 40 per cent, in Mumbai it is 80 per cent and Chennai scores the highest with 94 per cent sewerage coverage achieved. This translates into majority of the urban houses not having access to sewerage. Access to sewerage ranges from a measly nine per cent of households in Patna, to about 69 per cent in Mumbai.[xciii] Many cities expanded beyond municipalities, but the new urban agglomerates remain under rural administrations, which do not have capacity to handle

the sewage. Management of sewage is worse in smaller towns. Most of the smaller towns do not have any sewage treatment plant. The sewage is either directly dumped into river or lakes or in open field. In Delhi, many city's toilets are not connected to the sewerage system, which results in the pollution of groundwater, and also makes wastewater treatment plants difficult to run as they need minimum levels of sludge to operate.

Sewage and management in urban area		
type	No of cities having partial sewage treatment facilities	% of cities having partial sewage treatment
Million plus	19	82.6
Class I	76	25.4
Class II	17	4.9
	112	16.8

1.14. The problem of delivery

Public health services: collapsed edifice

Government policy on water and sanitation

Fiscal drain

In the five and a half decades following Independence, the government, has literally poured down the drain Rs 73,476 crore, in an attempt to provide water supply and sewage disposal to the citizens of this country. This expenditure was made in the period ranging from 1951 to 2000 from the First Plan till the Ninth Plan and three annual plans. However, it has made no difference to the incidence of waterborne disease in the country (except cholera). While acute gastroenteritis has no significant change over past one decade, incidence of enteric fever increased significantly.

The Union government has set ambitious targets for itself. India aims to reach 100% coverage of water supply by 2004,consolidation by 2007 and augmentation by 2015. Special emphasis to be given to 'not covered' and partially covered' habitations. Consolidation is essentially coverage of newly emerged habitations and those, which have slipped back to 'partially covered' or 'not covered'. In order to fulfil the 'dream' India will need to reach an additional 232 million people by 2004, further 19 million by 2007, another 33 million by 2015 (i.e. total 284 million). If the Millennium Development Goal (2001-2015) (MDG) to be achieved (i.e. halving uncovered population by 2015), the figure will be approximately 142 million. By 2007, nearly 35 per cent of rural India would have sanitation (as against the current coverage of 15 per cent). For urban population it aspires to provide sanitation services to 75 per cent of the population from the existing 61 per cent. By 2007, cities would get 100 per cent coverage in terms of drinking water, as against the current 95 per cent. These are ambitious goals, which need substantial investments.[xciv] To achieve the MDG, the Tenth (2001-2007) and proposed

Eleventh Year Plans (2007-2013), would need Rs 287 billion in rural sanitation and Rs 67,000 billion in urban water supply and sanitation (i.e. total Rs 67,287 billion investment till 2015). But the 10th 5-year (2002-2007) plan outlay shows that only Rs 4,420.6 billion (6% of total required amount) have been sanctioned for water and sanitation.

The MDG target

	Coverage (% and millions of people served / to be served in 2015)			No of people to reach each year
	1990	2000	2015 MDG	
Rural Water	41% 260 mn	94%?	70.5% 583 mn	13 mn
Rural sanitation	6% 38 mn	15%	53% 438 mn	21 mn
Urban water	55% 155 mn	95%?	77.5% 309 mn	6 mn
Urban sanitation	44% 94 mn	61%?	72% 287 mn	8 mn

Even if MDG target is met, huge number of people will remain unserved. (table below)
Estimated population will remain unserved even if MDG goal is met

	Still unserved (million)	Served (million)
Rural water	244	583
Rural sanitation	388	438
Urban water	90	309
Urban sanitation	112	287

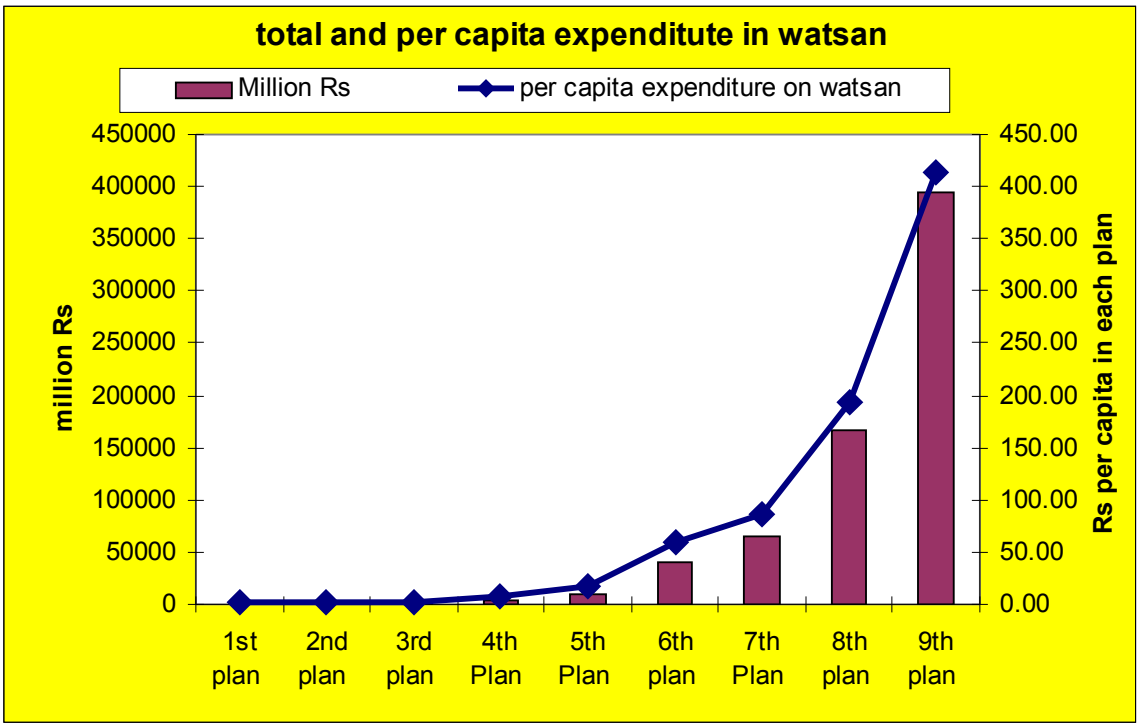
The following table shows investment in water and sanitation in all five years plan (from 1st to 9th). The amount mention adjusted with 2002 valuation of rupees. Investments in the water and sanitation sector were Rs 49 crore during the First Five Year Plan in 1951. They shot up to almost Rs 40,000 crore by the Ninth Plan, in 1997-2000. In 10th five year plan more than 44 thousand crore has been planned to spend on water and sanitation.

Investment in Water and Sanitation (with % of total plan Outlay)

5 year plan	Rs (crore)	%
1st (1951-56)	49	1.46
2nd	72	1.07
3rd	106	1.23
4th	437	2.75
5th	1031	2.62
6th	4047	4.15
7th	6522	3.62
8th	16711	3.85

9th	39538	4.60
10th	44206	

The following figure shows that from 1st to 9th five-year plan, total and per capita investment on water and sanitation increased considerably. But still it is far below the requirement. 9th five year plan shows that per capita per plan investment is around Rs 400 or Rs 80 per capita per year, which is a very meagre in amount.



Economic cost of water borne diseases – *how worth is investing in water and sanitation?*

The Central Bureau of Health Intelligence, a body set up under the Directorate of Health Services and assigned the task to collect all health related data, reports that towards the end of this period, between 1989 and 2001, there were more than 9 million cases of diarrhoea alone every year. This means, that almost one out of 100 persons suffered from a serious episode of diarrhoea each year during the period.[xcv] Waterborne diseases have imposed a severe economic burden on the Indian state. Exact figure on economic burden of water borne diseases at national level is difficult. Particularly when the morbidity report is grossly underestimated. Several studies show that it account for huge burden on nation's economy. The economic burden mostly contributed by medical cost, loss of wage during illness period and loss of national productivity due to illness related absenteeism. Medical costs include medicine, doctors' fee, and hospital charge. In government hospitals and free charitable hospitals the burden is less on common people. Where as, in private hospitals, the patients spend the entire expenditure. More over the

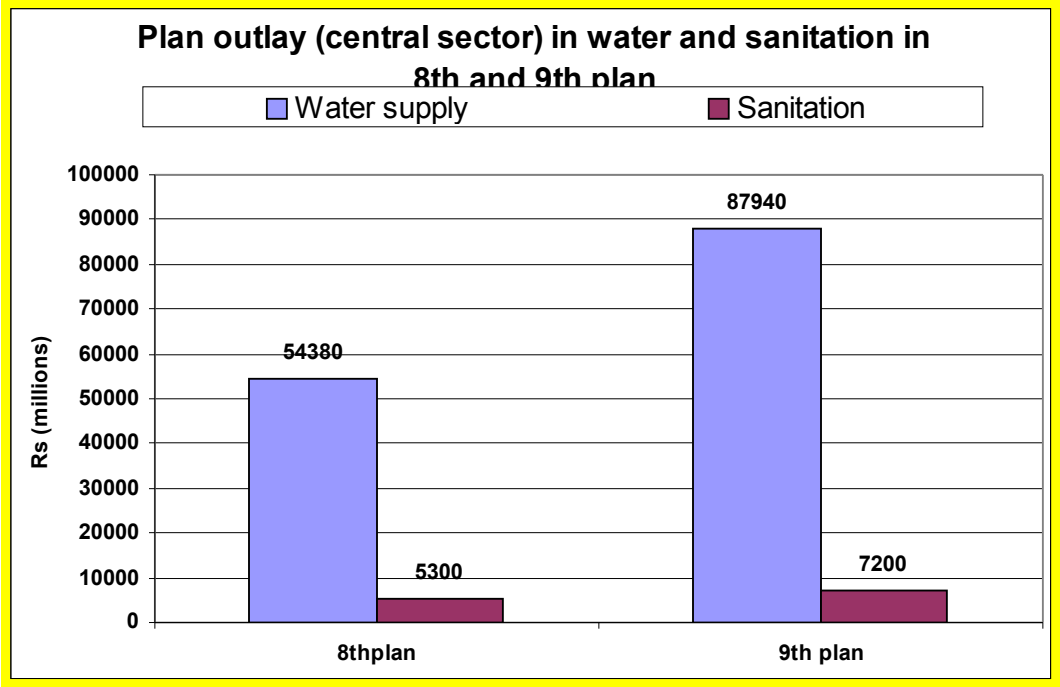
incidental expenses such as transport costs are not often included on economic burden. But experience shows that due to poor infrastructure in peripheral health systems, majority of the populations travel from village to towns or small towns to cities to seek better treatment. This leads to huge economic burden on the families of patients. To arrive at this conclusion researchers have tried to use a model to estimate the economic burden of waterborne diseases in India. However, this is a subject that still requires more study and detailed research. Archana Patel, a paediatrician from the clinical epidemiology unit of the Indira Gandhi Medical College, Nagpur, Maharashtra and her colleagues estimated in 2003, that every episode of diarrhoea costs on an average between Rs 481.25 and Rs 520.60. They did this by assuming that diarrhoea would force a worker to stay away from work for a period of five to eight days. Again assuming that a rural skilled worker would earn the above amount in these many days, she correlated the cost of the episode to loss of wages. According to Patel and colleagues, the cost of treatment comes down if a patient visits a government hospital. A government hospital normally bears 65 per cent or Rs 309, of the expenses. However, if the patient were to visit a private hospital, the cost of treatment is entirely borne by the individual and their family.[xcvi]

According to certain estimates the nation spent Rs 2,745 crore in these ten years to treat cases of diarrhoea alone. Evidence that the benefits of this system have failed to trickle down to the common person - found in a study carried out in 2000, by Gordon Hughes, Kseniya Lvovsky and Meghan Dunleavy. These environmental health policy advisers with the World Bank found that dirty water still accounts for 2.06 million deaths yearly among children in India. Ninety per cent of these children were from poor rural households possibly with out access to basic sanitation and clean water.[xcvii] Another estimation by United Nations Children's Fund (UNICEF) states that the country loses Rs 3,600 crore in terms of medical costs, person days and loss of health.[xcviii]

Providing clean water and proper sanitation facilities may seem expensive, but the costs of not providing them are much higher. In Karachi, Pakistan, for example, a study found that poor people, living in areas without any sanitation or hygiene education, spent six times more on medical care, than people who lived in areas with access to sanitation and who had a basic knowledge of household hygiene. In India, rural people spend at least 100 rupees each year for the treatment of water/sanitation-related diseases. According to the Government of India, this adds up to Rs 6,700 crore annually, which is just Rs 52 crore less than the annual budget of the Union health ministry and more than the allocation for education. Estimation of private expenditure to take preventive steps are also no far behind the economic burden of water borne diseases. According to an estimate made by Mumbai-based water economist Marie Helene Zerah in 2000, in Delhi an average household spends Rs. 105 to boil water or Rs. 113 to filter water for consumption per person, every year[xcix]. Given the fact that the Union Territory of Delhi alone has 25,54149 households this amounts to an astronomical figure.[c]

Water and sanitation programme: tunnel vision

There is dismal picture with regard to central sector plan outlay in water and sanitation. In the first 5-year (1951-56) plans allocation for the water supply and sanitation sector was less than 1.5% of total outlay. In the eighth 5-year plan (1992-97), during the international decade for water supply and sanitation, the allocation was increased to 3.85%. Majority of the funds went for piped water supply. Sanitation receives less than 2% of the total outlay for the Water Supply and Sanitation Sector Plan.[ci] Sanitation has been given least priority in 8th and 9th 5-year plan (below). Since independence drinking water was always a priority but emphasis was laid upon sewage and sanitation only in the late 1970s. Since defecation and sewage disposal is something personal, grassroots agencies and national policy did not want to address it proactively.



Source: Planning Commission 2002, Water supply and sanitation – India assessment 2002, Govt of India, New Delhi, p 53.

Moreover, water supply programme gives immediate tangible benefit in terms of convenience in household activities. Therefore it becomes as one of the popular agendas of politicians to gain political mileage. So, there has been always lack of political will to address the sanitation issue. This is the major failure from government part to understand the people's need and priorities for sanitation. Indeed, lack of public awareness on sanitation could not generate pressure on local administration and national policy level as well. Govt. of India launched the Central Rural Sanitation Programme to improve the sanitation in rural areas in 1986. (See box below)

Box starts

Rural sanitation programme

Govt. of India first launched the nationwide programme for sanitation, the Central Rural Sanitation Programme (CRSP) in 1986 under the ministry of rural development. The objective was to provide one million sanitary latrines to rural households, along with an additional 250,000 sanitary latrines to community centres such as health sub-centres, schools, *panchayat ghars* and *anganwadis*. The CRSP, which hinged on substantial subsidy as a means for creating demands for household toilets was found to be strategically weak. The idea of rural sanitation programme was that the toilets would be provided free to low-income households, particularly those belonging to scheduled castes and tribes and inspired to build their own. Although the NGO's suggested that local masons could be trained to undertake toilet construction, the government did not take up the idea.[cii] Of the sanitary pour flush toilets constructed in the decade of late eighties and nineties as a part of CRSP, less than 50 percent were found to be used. Since the budget was only enough for one or two latrines to be built in each village, they were constructed in the most influential households. Where they were constructed in the compounds of poorer villagers, they were usually used for storage of grain or other valuables. Few villagers other than well-off landowning families would think of using such a structure for defecation. State budgets were used to employ contractors but beneficiaries had not been properly consulted that what they actually needed.[ciii] In 1999, the Restructured Central Rural Sanitation Programme (RCRSP) came into being. The RCRSP advocated increased involvement of communities and offered a range of low cost sanitation options, along with emphasis on education and training. To accelerate the programme, the total sanitation campaign (TSC) launched in 1999 as the part of RCRSP. The program shifted from high subsidy to low subsidy regime, advocating a greater household involvement and demand responsiveness, and providing for the promotion of a range of toilet options to promote increased affordability. Since its inception, RCRSP has been launched in 67 districts of the country till 2002. Of the 138.2 million households in India, (2001) nearly 3.5 million rural households constructed household toilets with support from TSC. Of these 2 million have been constructed in 2002-2003, reaching five percent of poor rural households. 1700 women's complexes, 41000 school toilets have been built. Total plan outlay of TSC is Rs 33780 million including Central Govt. share Rs. 20190 million, State share of Rs 7380 million, community share of Rs 6210 million. Up to 2003 (since 1999) Govt. already spent Rs 2915 million.

The main objectives of the TSC are

- Improve quality of life in rural areas
- Accelerate sanitation coverage
- Increase awareness programme
- Covering school and anganwadis in rural areas
- Encourage cost effective and appropriate technology development and application
- Endeavour to reduce water and sanitation related diseases

To improve information, education and communication TSC has provision of Rs 12.5 million per district. It is expected that the public awareness programme will change the sanitation practice and behaviour. The central subsidy from central and state Govt. reduced from Rs 2000 per households to Rs 500 for below poverty line and zero subsidies for above. TSC identified that targeting school will sustain the programme as change of mind in the formative years would last long and also could improve the general health of the vast number of students. It incorporates sanitation and personal hygiene as mandatory topics in school education under the TSC. According to 10th five-year plan, out of 573000 primary and secondary schools with out sanitation facilities, 220000 schools and 353000 schools to be taken care by department of elementary school and department of drinking water supply resources respectively.

TSC showed some impressive success in several states, for instances East Medinipur district in West Bengal, Khammam in Andhra Pradesh, Ramanathapuram in Tamil Nadu and South Tripura in Tripura. Nandigram II block of Medinipur district was the first block in the country in India, to have 100 percent sanitation coverage. There was strong commitment from government agencies, panchayat, NGOs and communities and the program became successful. The experience shows that lack of water has been a natural deterrent in acceptance and hence dry improved pit toilets and ecological toilets were found to be more accepted than flush toilets. Easy access to good quality materials and skills and integration of public awareness increased the acceptance of toilets. Experience from Tamil Nadu and Tripura show that involvement of self-help group ac powerful local institution to promote the idea of sanitation among the community. Focusing women is key to success of the program as they are the care givers to children and sick. If they change to more healthy sanitation practice – household members and community at large get immensely benefited.

Despite the novel efforts of TSC, there is no tangible change in sanitation in the country as a whole. In spite of incorporating the community participation through the RCRSP, the coverage of households having sanitation facilities in the covered areas remain abysmally low at 49.32 per cent only.[civ] The success factors are not always available in all places. More over, corruption, lack of coordination and poor community participation led to the programme failure in many places. Moreover, total sanitation coverage (100% toilet coverage) does not ensure zero open field defecation, as farmers could not come to home from fields in the middle of their activities.

Box ends

In 1972-1973, the Central government launched the Accelerated Rural Water Supply Programme (ARWSP) to help the states increase coverage of drinking water. The programme was given a boost in 1986 with the launch of the Technology Mission of Drinking Water and Related Water Management, also called the National Drinking Water Mission (NDWM). This programme was later renamed as the Rajiv Gandhi National Drinking Water Mission (RGNDWM). The Ministry of Rural Development (MoRD) runs

the RGNDWM. RGNDWM provides funds and technical assistances to the states for rural water supply and sanitation (RWSS).

In 2002, MoRD came up with a scheme- Swajaldhara, a participatory driven approach, which emphasized that the rural people should feel the ownership and, therefore, contribute at least 10 per cent of the capital expenditure of the Scheme upfront; and the communities and their Gram Panchayat must shoulder the Operation and Maintenance (O&M) responsibility of the Schemes. To be made operational in 883 villages covering eight states, the Centre has allocated a budget of Rs 87 crore for it. The project proposals involve mini pipe water supply, bore well, water harvesting and rejuvenation of water bodies. Ultimately the programme is to be extended to all the districts of the country with an outlay of Rs 2,060 crore. However, this money would still fall short if all 1.4 million habitations in the country were to be supplied with hand pumps and piped water schemes. According to concerned authority, around Rs 5,000 crore would be needed for the same.[cv]

Though more than Rs 10,000 crore has been spent in the last five years for the ARWSP, with Rs 1,700 crore allocated for 2004, only 30 per cent of the villages targeted for this fiscal year have been covered. Even with so many policies favouring them, the situation in rural India has only worsened. This is because at the end, what the villages really get are broken or leaking pipes, hand pumps that do not function, drying up of water sources or polluted water from the source. So what remains in the end, is the increasing number of 'problem villages', which though may have been connected to water supply, really don't get any water.[cvi] [cvii]

Bureaucracy and corruption

Poor maintenance, under utilization of funds, inferior quality materials, erratic water supply

In one hand government data showing rising investment in water supply and sanitation and on the other there is either rise or no improvement in morbidity. The big question is where the money gone? As per information available, there are over 3.5 million hand pumps and over 0.1 million-piped water supply schemes in India, installed under the rural water supply programme. The estimated costs for operation and maintenance of these current prices would be around Rs 20 billion per year. At present the available funds for operation and maintenance are around 2.3 billion. Hence a very large gap exists.[cviii] Of the Rs 5.7 billion has been released to states (in 2000), approximately Rs 1.2 billion (24%) has been utilized so far by the states till 2002. likewise, of the Rs 3.5 billion released under total sanitation campaign, about Rs 0.8 billion (23%) has been utilized so far.[cix] In 1996-97 the program evaluation organization, an independent organization under planning commission studies 87 villages in 16 states. They found routine maintenance takes place in 27.6%. Yearly repair takes place only in 43% of breakdowns. Some states have not been able to release the allocated funds for central assistance under accelerated Rural Water Supply Programme in eighth plan and ninth plan. The biggest loser has been Bihar, which has lost Rs 4000 million of central assistance.[cx] Urban water supply,

transmission and distribution networks are largely of very poor quality, in addition to being out dated and badly maintained, resulting high operating cost. Physical losses are typically high, ranging from 25 to over 50%. Since most Indian cities have intermittent water supplies, this increases the incidence of waterborne diseases. When water lines are empty a vacuum is generated inside them and the pipes may suck in liquids from the surrounding environment. This could include sewage spilling out from nearby sewer lines. Real prevention measures could have been based on teaching people how to deal with sewage, understand the concept of hygiene and put into use practices, which could put an end to the cycle of infection. Unsatisfactory service standard, poor tariff, poor resource, poor maintenance is a vicious cycle.[cxi]

There is hardly any reporting of outbreaks and epidemics This is due to inadequate surveillance and reporting systems and limited collaboration between health authorities and the water and sanitation sector.[cxii] Therefore it has become possible for politicians to play with figures and sanction schemes according to their whims and fancies.

To put any preventive measure in place it is important to put someone in charge of it. The health ministry should have a say in the strategies being outlined to prevent waterborne disease. Perhaps the very idea of preventing microorganisms from reaching the kitchens of potential victims never occurred to our planners and thinkers. Similarly the health ministry has no say in the disposal of waste. Waterborne diseases are a result of not managing water resources or waste disposal properly. Framing of appropriate policies and regulations is one of the ways to bring down the incidences of these diseases. While policies do exist, there is a lack of coordination and accountability between the different agencies involved. Even the Planning Commission in its assessment report on water and sanitation in India – 2002, acknowledges this.[cxiii]

Drug resistance: a crisis in curative policy

The unnecessary prescription of antibiotics seen in industrialized nations has also been documented in many developing countries, particularly in cases of acute infantile diarrhoea. Clinical misuse of antibiotics may be more common among private practitioners than among public health personnel—private practitioners charge higher fees, the demand for antibiotics seen in private patients is higher, and more drugs are available in private clinics than in public hospitals. In India, traditional healers often dispense antibiotics. A high proportion of patients in some developing countries including India, are treated by untrained practitioners simultaneously with oral and injectable antibiotics administered with contaminated needles and syringes for misdiagnosed non-infectious diseases. Use of antibiotics with out prescription is very common practice. Chemists sell drugs to customers with out prescription, which is punishable under law. But due to lack of monitoring and accountability of chemists, it has become major part of retail business. Common cultural beliefs about antibiotics include the notions that there is a pill for every symptom; antibiotics can heal many illnesses, including dyspepsia and headaches; and injections are more powerful than pills. The

misuse of antibiotics frequently becomes integrated into the local culture (e.g., antibiotics are used to prevent diarrhoea after eating suspected contaminated foods. Finally, because many drugs are expensive, indigent patients purchase incomplete regimens whenever possible and discontinue treatment when symptoms disappear but before the pathogen is eliminated.[cxiv]

The pathogens are growing stronger too. The sewage disposal system, which provides them with an opportunity to breed, is also providing them with an opportunity to mutate, change and become stronger and more vicious. As a result the only weak line of defence against them, antibiotics prescribed by the medical community - is failing to check them. A pathogen gets two opportunities to evolve. When it comes into contact with an antibiotic within the gastrointestinal tract of the patient, or when the individual excretes the antibiotic into the sewer system.

Antibiotics are like the infantry. Their job is to seek out and destroy pathogens. To accomplish this task they have to be present in sufficient amount and for a sufficient length of time. In case this army of antibiotics is withdrawn before it has fulfilled its task, it leaves behind lurking pathogens that strike again. These survivors have been exposed to the antibiotic and may have learned how to cope with the assault. This information is stored in their genes and passed on to their progeny. The pathogen mutates and becomes stronger. This happens when the patient has not taken the full course of the antibiotic.

In the second case, when antibiotics are released into sewage, through a patient's urine or excreta, they impart low doses of immunity to diverse potential pathogens before they infect human beings. Antibiotic resistance is a global public health crisis. But unlike the irrational or improper drug use in developing countries, in the West the use of antibiotics in farm animals is to blame for resistance in pathogens. A report by Keep Antibiotics Working, the Campaign to End Antibiotic Overuse, based at Tufts University, Boston says that resistant bacterial infections increase health care costs by at least US $ 4 billion per year in USA.

Indian researchers first noticed this trend of resistance in the mid 1980s. Several reports of diseases failing to react to conventional antibiotics shocked the medical community that relied heavily on these pills. A study conducted between June 1988 and May 1991 by researchers in Mumbai showed that 80 per cent *Shigellae* was resistant to conventional drugs. The two species studied - *S. flexneri* the dominant type, alternated the epidemic with another related species, *S. dysenteries*. After comparing this data with the results of another study carried out during the period 1983-87 the researchers concluded that it was increasingly getting difficult to treat patients with conventional antibiotics[cxv]. Another study carried out in the King Edward Memorial Hospital, Parel, Mumbai in 1990 found that nearly 70 per cent of all typhoid cases were resistant to prescribed antibiotics.[cxvi] Since then, many other studies have shown that typhoid has gained resistance.

By the end of the 20th Century, the situation had become even more alarming. Doctors had routinely prescribed three different drug formulations to deal with cholera, namely fluoroquinolone, ciprofloxacin and norfloxacin. Suddenly they found studies that revealed that these medicines had lost their efficacy. Pallavi Garg from the National Institute of Cholera and Enteric Diseases (NICED), Kolkata in 2001, began looking into the phenomenon of antibiotic resistance in cholera. She found that the cholera bacterium had developed resistance to these three first line antibiotics in the hospitals of Kolkata. Her research showed that by 1995, the cholera bacterium has progressively become resistant to the action of two main antibiotics. By 1999-2000, these two antibiotics had completely lost their effectiveness. Only one drug (tetracycline) could be used with certainty in case of an infection.[cxvii] However the researchers concluded that it was only a matter of time before this became impotent too. "Other enteric organisms have already acquired resistance to tetracycline and it is only a matter of time that the cholera bacterium will acquire resistance", says S K Ghosh, Chief Medical Officer of Nadia Civil Hospital, in West Bengal where several persons died following an outbreak of cholera in 1996. According to Sujit Bhattacharya, director, NICED, Kolkata, "The list of anti-microbial agents still effective against cholera is shrinking. The emergence of resistance to specific antibiotics almost parallels the sequence in which the drugs were introduced in the marketplace."[cxviii]

Drug resistance: epidemiological implication

Drug resistance has serious implication in duration of disease spread. If microorganisms remain alive due to failure of antibiotics to kill – the patients become source of infection

A guinea for the thought

Improvement in water supply and awareness brings down the rate of worm infestations. The guinea worm eradication programme proves this

Perhaps the only silver lining of government programme in water borne disease is eradication of guinea worm. The last case was found in Jodhpur district in Rajasthan in 1996. In 2000, India was globally declared as free of guinea worm disease.

Before eradication guinea worm was public health problems in Rajasthan and central part of India. It was mostly found where step wells were the major sources of water for domestic consumption. The parasites adult parasites inhabits the subcutaneous tissues mainly legs. The female worms penetrate to outer layer of skins and form blister. When blister comes into contact with water, the blister soon raptures and releases larvae into water. Cyclopes – small fresh water crustaceans, pick up the larvae, which is the intermediate host. When human being drinks the cyclopes containing water acquires infection. The disease was not life threatening but used to cause lot of discomfort, pain and walking problems to the sufferers.

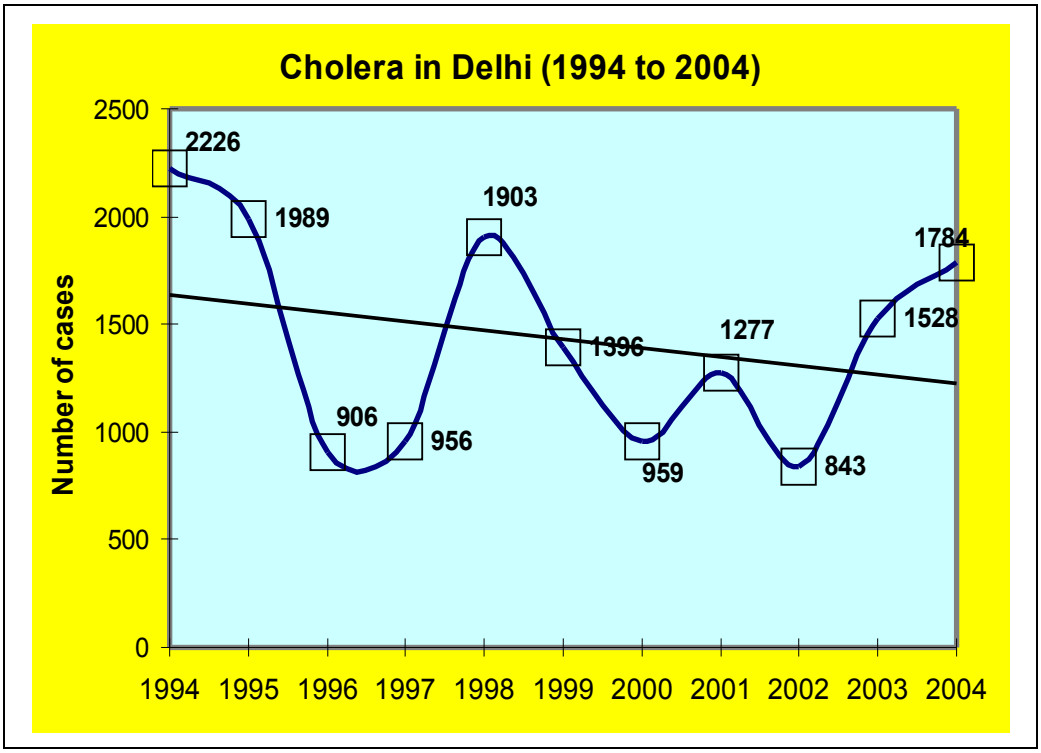
The major eradication programme included provision of safe drinking water through pipe water supply and hand pumps, control of cyclopes, surveillance and treatment of cases. Control of cyclopes mostly included public awareness programme advising the community to use double thickness cloth to filter contaminated water to remove cyclopes and boiling of water before use. Gradual shifting of well and surface water to ground water stopped transmission of guinea worm as larvae could not survive water more than 2-3 days.
Source-PARK

1.15. Delhi: a case study

Delhi is well known for bouts epidemic of number of water borne diseases. Every year report of cholera, gastro enteritis, hepatitis and typhoid in capital's daily is routine phenomena. Majority of the sufferers are from slums and unauthorised colonies, not provided with proper water and sanitation. But flip side is, Govt of Delhi claims spending of huge amount of money on water and sanitation, waste water treatment, solid waste management and health service as well. But where is the gap? Why Delhi shows dismal picture of water borne diseases?

Health outcome
Disease profile

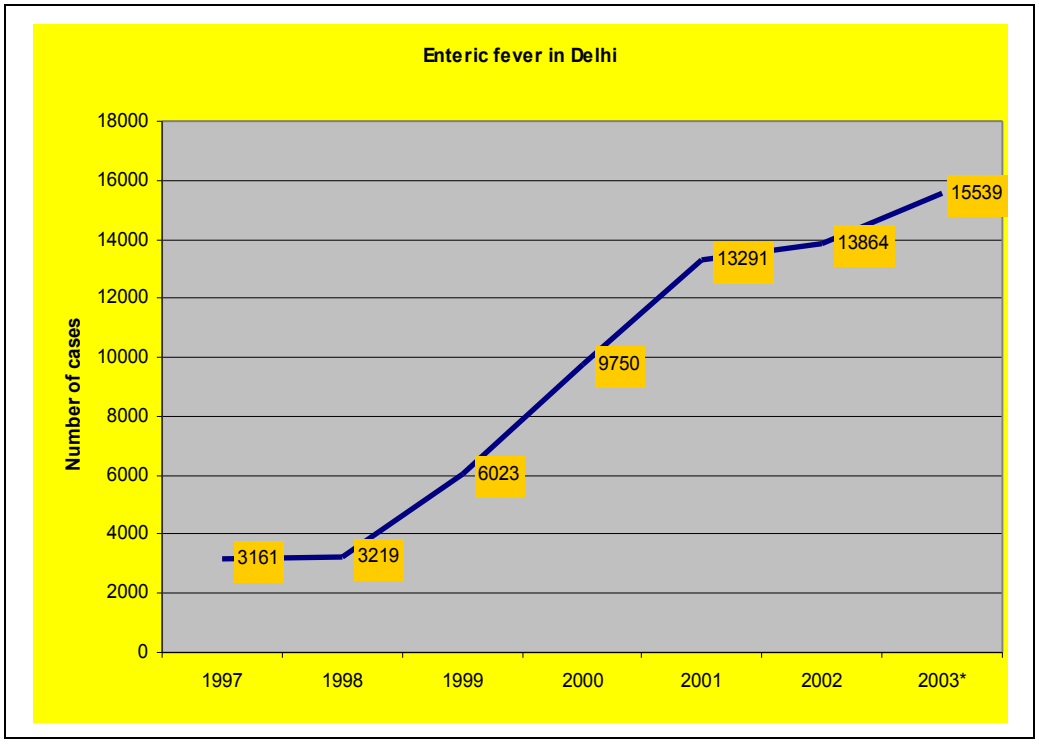
Cholera, acute gastro enteritis, enteric fever, viral hepatitis are the major water borne diseases in Delhi. The following figures show trend in cholera incidence pattern. For instance last 10 years figure shows that there is up and down swings, but general trend is down ward but still in total number it is high as compared to many Indian states. Despite repeated claim of authorities showing improvement in water and sanitary condition in the city, results contradict.



According to concerned doctors of MCD, the dips in 1996, 2000 and 2002 are probably due to poor reporting and natural transmission of cholera bacteria in the environment. Dr TM Singh, epidemiology division of MCD, said that changing strain of bacteria could be another cause of rising number of cases. Often new strain (sero type) becomes more virulent and causes disease among more number of people. For instance in April 2004, new *'inaba'* strain was found in many places of Delhi and caused epidemic. On the other hand there is steady rise of enteric fever and acute gastro enteritis. It is worth to note that all diseases are under reported as vast numbers of cases are seen by private practioners, who never report or notify to local health authorities. On the other hand there is also no concerted effort to collect reports of routine incidence of disease. Local authorities becomes active when there is any out break followed by public outrage and media attention. But regular cases always get missing. But according to Dr TM Singh, missing of cholera cases are less as compared to other water borne diseases due to better reporting system. Cholera is notifiable disease for long and doctors are familiar with reporting of cholera to higher authority. Any suspected cholera case should be reported to Infectious Disease (ID) hospital in North Delhi. But reporting of other water borne diseases grossly suffer from under reporting. In addition to that, majority of the sufferers are from slums and unauthorised colonies who seek treatment initially from quacks, are spreading all over the under developed areas in the metropolis. These quacks never report any single case to higher authorities and by and large of them are not aware of reporting. More over, their illegal practice is also major reason to remain silent. They complete their responsibility by prescribing antibiotics. So the existing reports are entirely based on cases admitted or examined in hospitals and reports of sporadic epidemics during high

transmission period and collapse of local sewer system. In fact, all Delhi based data are essentially from 22-index government hospital spreading across the city. These are essentially government run hospitals. MCD doctors admitted that these reports are "*tip of the iceberg"*. Dr R Sharma, microbiologist of ID hospital, said rise of water borne disease in recent years attribute to rapid '*development'* activities in Delhi. Most of the sporadic epidemic occurred in and around developmental projects. Flyovers and road widening projects, under ground cable installation caused damage of water supply line and sewer system. Contamination of water supply pipeline with sewer line caused out break of cholera and other water borne diseases. Delhi Jal Board, sole agency for water supply in the city could not restore water supply on time. The problem became more acute in summer during high demand period. Dr R Sharma, of ID hospital, who has been associated with cholera for two decades, said that nature of cholera infection changed over couple of years. Now in winter cholera cases are also reported. Probably due to better diagnostic technique being used in the ID hospital, or global warming and possibly due to changing of virulence of the pathogenic organism.

The following figure shows that enteric fever in Delhi from 1997 to 2003 are increasing in trend. According to MCD officials, eating of raw vegetable s as salad can be important source of typhoid bacteria. Water of river Yamuna which the dumping ground of Delhi's sewage used in irrigation of vegetables grown in trans Yamuna and down stream. Common vegetables, grown in these regions are consumed raw and contain all kinds of pathogens including salmonella typhi. More over, in several hotels and restaurants proper hygiene is not practised.



Vulnerable group

It is again the poor who suffer. Majority of cholera out breaks occurred in slums and resettlement colonies where poor live and government deny providing drinking water. Even in the authorised colonies lived by poor; the quality and the supply of water always remained lower than requirement. More over, repair of damaged sewer or water pipeline is more prompt in the localities where middle and upper middle class live. 2004 cholera report of MCD shows that major cholera epidemics took place in the following regions - Tughlakabad village, Pilanji Kotlamubarakpur, Gobindpuri, Sangamvihar, Mukandpur, Lalbagh, Dhirpur, Sant Nagar, Burari village, Azadpur, Nathupura, Baljeet Nagar, Nehru Nagar, Wazirpur JJ colony, Paharganj, Nabikarim, and Dakshinpuri JJ camp. According to Dr TM Singh of MCD, all these areas are either unauthorized colonies or resettlement colonies where basic amenities like water and sanitation are virtually non-existent. In summer, prolonged water scarcity makes their life absolutely miserable.

But the fact also is that over 40-50 per cent of Delhi's people live "illegally", in unauthorised colonies and slums. These population lives in about 1304 unauthorised colonies, 1080 JJ clusters, 44 resettlement colonies and 209 rural villages.[cxix] All are mostly unconnected to the sewerage system. In 2001, government said it would complete sewerage of 490 regularised but unauthorised colonies by March 31, 2003 and the rest by March 31, 2004. However, by 2004, it had only managed to complete the internal sewerage of 482 of these colonies; now it would aim to lay sewerage systems in the remaining 496 such settlements by December 2005. The problem is even larger, when one understands that vast numbers of people live in colonies, which are classified as unregularised and unauthorised, where the government has no plans to even introduce sewage systems. There several bouts of out break of various forms water borne diseases occurred in the slums and resettlement colonies, around the river Yamuna. Delhi's sewer drains into the river and the people living around get exposed to all kinds pathogens trough direct exposure or contamination of ground water. Ironically, when poor bears brunt of disease outbreak on account of discriminatory policy of government, are also blamed for the pollution. The Yamuna Action Plan, meant for cleaning of river Yamuna aims to remove poor people living along the river, so that the river can be cleaned. In 2001, the state chief secretary told the court that out of the 600,000 slum dwellers in the city, roughly 60,000 lived along the river. These poor people contributed to the pollution, the government believed. So, over the past 10 years, every successive government has, in the name of river cleaning, worked hard to remove slums of poor people. Nobody has ever asked what is the evidence that these poor people living on the banks of the polluted river are its villain and not its victims.

Reasons

There several issues to be responsible for water borne diseases in Delhi. They are linked with broad based issues related to water and/or management of huge amount of waste generated daily.

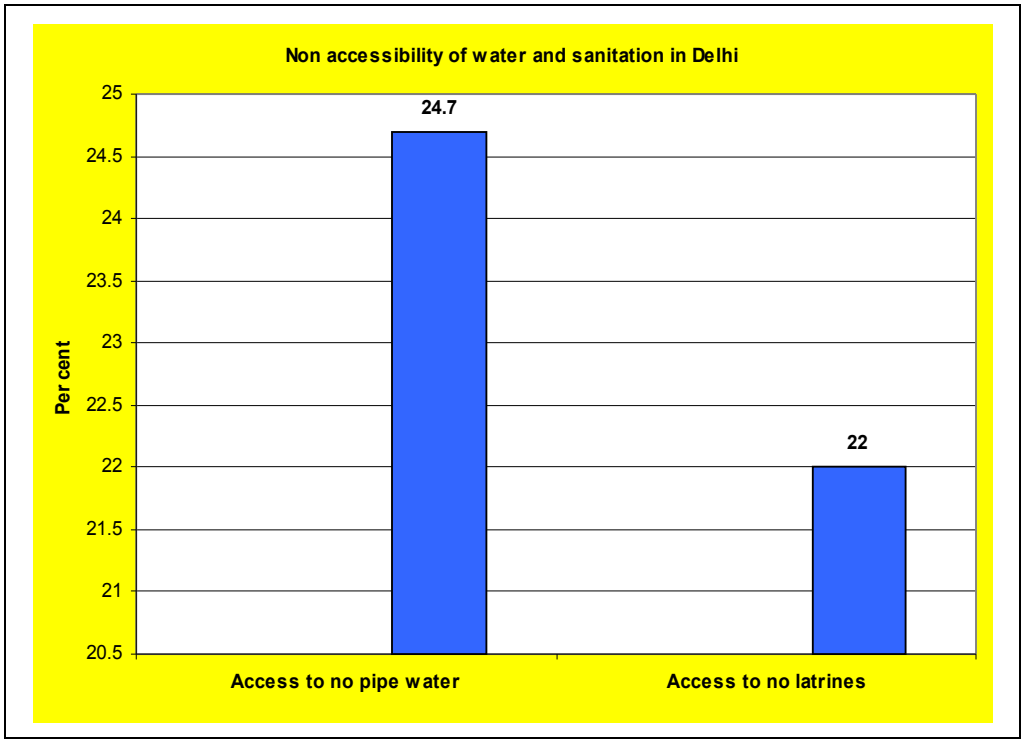
Water related issues

Water quantity: there is always sketchy picture with regard to water supply to households. City planners really do not know how much water the city uses. At present, the city's water demand is about 3,600 MLD, it has a capacity to treat 2,880 MLD raw water and it officially supplies 3,040 MLD of water. This includes 410 MLD of officially drawn groundwater, which then adds to the waste stream. But the water supplied does not reach people. The djb admits that only 1,730 MLD water reaches its consumers. It can be assumed then that people have to depend on groundwater aquifers — tube wells — for their supplies. But how much groundwater is extracted in Delhi is a mystery. Given the water-waste connection, the mystery deepens as the city hunts for how much sewage it generates. There is always regional disparity regarding water supply in Delhi. In Mehrauli the per capita consumption is lowest (29 litres per day). On the other hand in cantonment and NDMC areas these are 509 and 462 litres per capita per day respectively. 3% of Delhi population get 11% of water of DJB. 70% of population of Delhi village get less than 5% of supplied water. So rich and powerful are responsible Delhi's pollution by producing equal amount of per capita wastewater. Delhi losses around 142 million gallons per day during transportation of water. Huge amount of water is also lost in households.[cxx] The map below shows the region wise water supply in Delhi. Quality of water supply in Cantonment areas and NDMC areas are better as elites and most of the influential city planners live in these places. Maintenance of water supply and sewerage are better in these regions. Narela, Najafgarh, receive 31 and 74 lpcd respectively. Civil lines, Rohini, West Delhi, South Delhi, City region, Karolbagh, Paharganj, Shahdara receive water with in the range of 130 to 337 lpcd. But there is always regional disparity with in the regions. JJ colony and unauthorized colonies are always at the end point of receiving line.

The regional disparity is clearly reflected as disease out come. In 2004 there were total 1 and 17 cholera cases in cantonment and NDMC areas respectively, rest of the Delhi contributed 1766 cases.

Water quality: Major raw water sources of Delhi are from river Yamuna, Bhakra storage, upper Ganga canal and ground water. These water sources are treated in nine water treatment plants before supplying to households. Quality of treatment plant is very important issue as major water sources are highly polluted with pathogenic organisms. Moreover, ensuring to maintain quality till reaching individual household is challenging task. Often, piped water gets contaminated with adjacent sewer lines due to leakage and damage caused by any construction work. According to MCD doctors, household illegally using booster pumps to extract more amount supplied water invites trouble to them and the locality. If supplied pipe line is not properly sealed, suction during non-supply period causes negative pressure, which drags water from surrounding soils contaminated by damaged sewer line. This results accumulation of contaminated water inside the pipe. During the supply fresh water, the contaminated water gets mixed and causes number of diseases to the people who drink without further treatment at home; for instance boiling, filtering etc. Several families, who could afford resort to own bore well in order to avoid dependency on erratic water supply of DJB. But studies show that more than 50 % of ground water in Delhi is contaminated with coliform. [cxxi]

Sanitation: Sanitary condition of Delhi is in extremely bad shape, particularly in resettlement colonies. Open field defecation is the only option for more than 22% of cities over 14 million population. The figure shows that over 24 and 20% population does not have access to piped water an sanitation.



Under Yamuna Action Plan (YAP) extended phase, Rs 150 crore or 90% of the allocation was channelled into Delhi, to set up 1146 toilet complexes in 1100 slum clusters and 46 resettlement colonies to tackle the problem of sewage disposal. An analysis by the national river conservation directorate shows 60 percent of these complexes remain unused, they have no water, or are too expensive for people to use or simply improperly sited or ill maintained. Women face more problems due to growing population and lack of privacy.

Waste management issues

Delhi's 17 sewage treatment plants have a treatment capacity of 2,330 MLD. The problem is that nobody quite knows how much sewage the city generates. If the sewage generation estimate of the cpcb is used — 3,853 MLD — then the city can treat 60 per cent of its waste. If the estimate of the Delhi Jal Board (djb), 2,934 MLD, is accepted, then 80 per cent of the wastewater generated can be treated. The fact also is that nobody plans for sewage when they plan for water. For instance, the city government plans to supply another 630 MLD of water as soon as Uttar Pradesh releases water from the Tehri dam to the city's Sonia Vihar water treatment plant. In other words, 3,510 MLD water treatment capacity will now be available to the city, and each citizen will get 250 litres per capita daily (lpcd). The waste this water will create is still unaccounted for. The problem also is that a large portion of the city's existing sewer lines — about 5,600 km long, which include 130 km of trunk sewers — are either silted or settled. Government says that only 15 per cent of the trunk sewers are in order. So, for the past many years of

river cleaning, the government has set deadlines to clean the trunk sewers to Delhi, to transport the sewage to stps. A simple plan, it would seem.

Qualities of sewer treatment plants are also questionable. Pollution regulators only work on the basis of three parameters — BOD, COD (chemical oxygen demand) and TSS (total suspended solids). These are clearly inadequate. The key issue is that the waste is full of pathogens deadly to our health. Only in some plants — those built using Yamuna Action Plan money, and so affiliated to National River Conservation Directorate (NRCD) — is the NRCD-set coliform standard (1000 most probable number/100 ml) applied. But in these plants, the disinfection units, which use ultraviolet radiation to kill coliform, are invariably out of order. Other plants, where CPCB standards apply, do not have a coliform standard, for no such design requirement is applicable to them. In other words, these expensive plants can be built, and still pollute. For instance, in the Okhla sewage plant, even as the BOD has been brought down to 20 mg/l the best coliform levels are as high as 2.4 crore mpn/100 ml. It is no wonder that the river is high in coliform when it leaves Delhi.

Delhi is a classic example of how wrong urban policy could lead to hub of multiple water borne diseases. Disparity across the city put majority of the poor population in vulnerable position. Unfortunate part of Delhi is, that its not the lack of money but poor planning and lack of political will resulted suffering of millions of people.

1.16. The way ahead

Ensuring to provide every Indian potable water, sanitation coverage is indeed a major challenge. The task ahead is mind-boggling. Assuming that every Indian has a chance to consume 40 litres of water daily for their requirements, and assuming that we do not reuse this water at any stage, something that normally does not happen, it would require 56 billion litres of water everyday. To keep up this process for a year we would need to purify and cure and supply almost 20,440 billion litres of water. It would be mindless to attempt doing this in a centralized manner. A close look at the benefits of sewers and piped water, reveal that they are a highly subsidised luxury the rich avail. The poor pay the price for these systems with ill health, mainly because in a manner of speaking they live downstream. Pill popping and other medical interventions are something only the rich can afford. These remain out of reach of most poor people. The paradox of waterborne diseases is that dehydration; the most common manifestation can only be treated with clean water. This is a dilemma for victims are forced to consume the bad water that caused the disease. Add to this the persistence of dirty water to the vulnerable - malnourishment, poor physical growth, mental development and anaemia.

Clearly the government has not succeeded in controlling outbreaks and epidemics in cities and villages alike. By focussing only on providing drinking water and ignoring sewage, the waterborne diseases have a large window of opportunity to strike repeatedly. Unless this is gap is completely sealed, diseases will continue to occur. But government

agencies continue to build flush toilets and keep chasing the impossible dream of sewerage. The questions vis-à-vis sewage and drinking water is not about either and or. Both have to be implemented simultaneously and at furious pace.

Meaningful strategy

There should be multipoint strategy to control water borne disease. At micro level improvement of quality and quantity of water supply, sanitation measure and hygiene practice significantly reduce mortality and morbidity due to water borne disease. Esrey SA analysed total 144 studies conducted worldwide on impact of aforementioned intervention program on occurrence of diarrhoea and published in WHO bulletin in 1991.[cxxii] The results were very impressive and can be applied to India's policy (figure below). The analysis shows, safe excreta disposal and improve hygiene separately reduced diarrhoea occurrence around 35 percent. Improve water quantity reduced diarrhoea incidence by 22 percent. Improve water quality reduced water borne disease by 15 percent. If all measures are taken together, reduction of water borne disease will be by around hundred per cent. In fact due to adoption of the same measures the developed nations could control all major water borne diseases. Some interventions are interlinked. For example, water quantity is associated with hygiene practice.

Box

Hygiene: cost effective and sustainable

Water supply systems and sanitation facilities are directly linked to behavioural practices in the communities. Some pollutants get into the human system because of such practices, as not covering food, eating unwashed food, not washing hands and drinking untreated water. For instance, a common transmission route of the bacillary dysentery, amoebic dysentery and diarrhoeal diseases is from man's faeces by flies to food or water. Thus, hygiene practices play a role in harmonising provision of clean potable water supply and sanitation systems.[cxxiii] Val Curtis, associated with the London School of Hygiene and Tropical Medicine, says, "Hand washing with soap after contact with faecal material is not a common event." Good hygiene practices and adequate disposal of excreta can prevent almost all gastrointestinal infections.[cxxiv] Several worldwide studies show that good hygiene practice at household levels is the sustainable and cost effective method of control of water borne diseases.

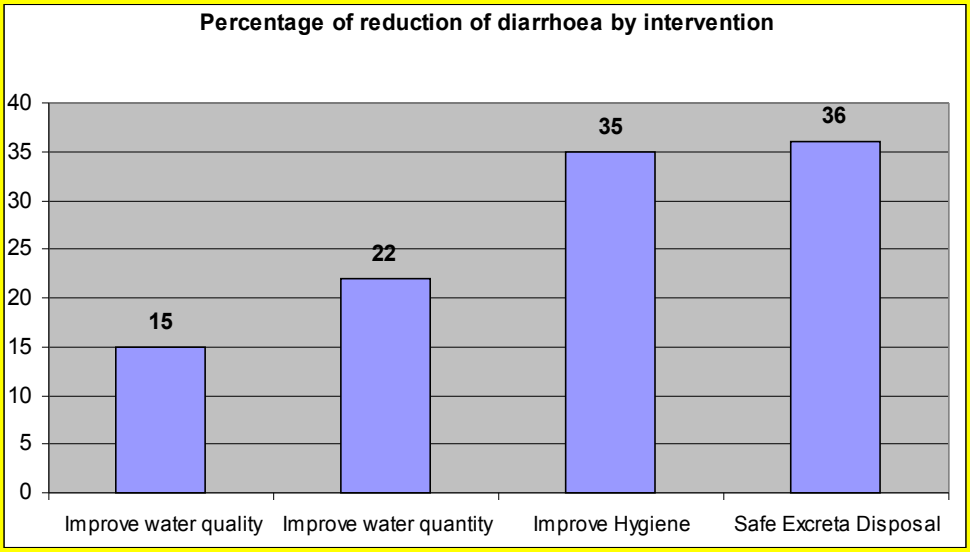
Box ends

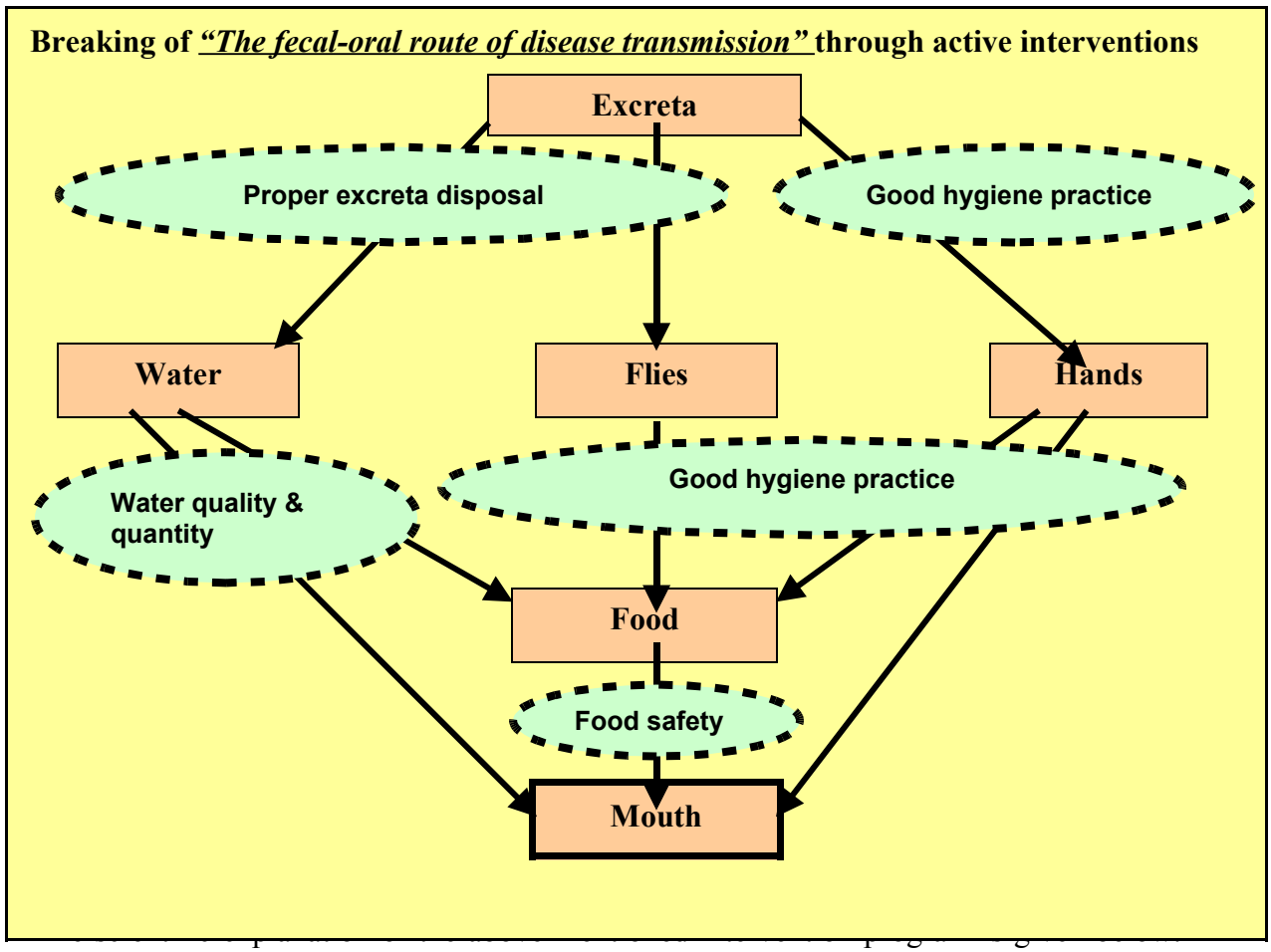
Box starts

Old practice saves lives

Water contamination, at source and during household storage, is a major cause of enterically transmitted infections in developing countries. study by Thomas Brick of Christian Medical College, Vellore assessed contamination of the municipal water in Vellore, a south Indian town, which obtains its water intermittently from a surface lake and by pumping subsurface water from a dry river bed, and monitored microbial contamination during household storage. All samples of the 'treated' municipal water were contaminated when freshly pumped, and on household storage, 25/37 (67%) showed increased contamination during storage periods from 1 to 9 days. Household storage in brass, but not in containers of other materials significantly decreased contamination of water. This was confirmed in the laboratory by testing water seeded with 10^3 to 10^5 *Escherichia coli* per 100 ml stored in containers of different materials. Despite the requirements for provision of safe drinking water in municipal areas, in practice the water supplied in Vellore is contaminated and current household storage practices increase the level of contamination in at least two-thirds of households. The researcher suggested that implementation of locally appropriate point-of-use disinfection and safe household storage practices in developing countries is an urgent need to ensure a safe, reliable year-round supply in areas where clean water is not available.[cxxv]

Box ends





The figure shows to maintain the primary objective of providing health food and water, sanitation measure, hygiene practice, quality and quantity of water supply and food safety are essential. These measures block transmission of pathogenic organisms in various phases – from source to environment to food and drinking water and ultimately to mouth.

While we are talking about micro level strategy to reduce water borne disease, macro level strategy at policy level is equally important. There should be national level strategy to provide improved quality and appropriate quantity of potable water to every household. On the other safe excreta disposal should be given equal priority. The above study already shows the importance of safe excreta disposal and hygiene practice.

While there is a need to check the mindless application of unsustainable technologies, there is also no need to import expensive technological fixes right away. New strategies could be indigenous, low cost, on site and they will succeed if they treat water as a scarce resource. Ecological sanitation like reed bed technologies shows that there are new approaches, and that these are based on traditional understanding of the human-

environment relationship. These are not really new technologies, just a new way of looking at things.

Unfortunately sanitation engineers have no interest in changing the technology paradigm. They know flush toilets subvert the sustainable use of freshwater, because every gram of faeces contaminates 1,500 litres. However, sewage mixing in drinking water is not their problem in any case. When it comes to providing clean and safe drinking water, the government has come up with cleverly framed standards that change the very definition of safe water. There is very little the municipalities need to do therefore to ensure sustainable supply of water, leave alone maintaining quality. As a desperate measure, families and individuals continuously invest in expensive, end of the pipe, domestic appliances that assure them of clean water. But there is a limit to how much they can clean the water. With raw water quality deteriorating every day, appliances too will fail to meet their tall claims. But most important need is a change in mindset of society and government. The flush and forget attitude is wasteful and will not work in the future. The sooner we understand this, the better.

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