



Review on Emerging water Borne disease

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ABSTRACT:

Every year the cases of water borne infection through out the world are increasing. If we check the motto behind every Government the main aim will be evading the water borne infection and also to reduce toll death rate due to the water related infection. This mission has been started long back and still we are not able to meet the motto. This review focuses on the emerging pathogens its habitat and the case history which gives a clear view about how this can poses problem to the future generations.

Indexing terms/Keywords

Water related disease; infection; bacterial; emerging pathogen; water borne infections.

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INTRODUCTION

Water borne disease is a broad term, in which the microbes play a major role. The common terms in the history of water borne disease are E.coli, Vibrio, and Coliforms etc. Many bacterial diseases fall in the category of re-emerging disease due to the resistance to antibiotics (Louis H.Nel & Wanda Markotter). If we see our history there is lot of changes with new technologies and updated knowledge. Does this changes effect the pattern of microbiological contamination. May be YES. Most of them have a concept that water borne disease means through drinking water only, but there are many ways which can cause disease through water. As per World Development report in 1992 the Diarrheal diseases cases was estimated has 900,000,000 per year and approximately and toll death rate in case of children has reached to 2,000,000 deaths per year in children (World Development report 1992). In US between 1920 -1992 toll rates of 1,786 water borne outbreak with 472, 228 cases of illness and 1,091 deaths. (Harry Philippeaux et al). If we check the surveys the water borne disease is increasing day by day and the symptoms also varies from place to place. In earlier days E.coli also was reported as a rare case of infectious organism, but later E.coli became a general term of infection. There are many pathogens which includes marine bacteria, enteric bacteria, and protozoans etc which are resistant to most of the filtration and disinfection process.

The present review is about the emerging bacterial infection in which the source of infection is water. The water can be a direct or indirect source but in future this can pose serious issue.

Aeromonas hydrophila (flesh eating bacteria):

Aeromonas hydrophila is ubiquitous in water. They are heterotrophic gram negative aerobic, non sporing bacilli which are mainly found in the warmer climate. The optimal temperature for growth is 28°C with a wide range of temperature ranging from 4°C – 37°C. The habitat is mainly aquatic environment such as lakes ponds, rivers, fresh water & brackish water, although it has been isolated from fish tank, swimming pool and chlorinated water. This species are resistant to chlorine treatment, so that it can survive even after the chlorine treatment. Mode of transmission is generally through feco oral, or the contact with the contaminated water, food and it can also enter through open wounds. The symptoms starts developing after 48hr of infection with the formation of cellulitis which may later develop into skin necrosis fasciitis, fruncles and nodule formation in the skin. It can also be associated with the gastroenteritis, mild to moderate soft tissue infections. (Kenji Okumura et al 2011). A recent review says that Holy water is a potential source of cross-infection with various coliform bacteria, including *A. baumannii* and *Aeromonas hydrophila* (Rees JC et al 1996).

A. hydrophila occurrence has been ruled out in early 1980's to cause infection in fish and reptiles and later it also proved that the *Aeromonas hydrophila* is responsible for causing diarrhea in humans. (Samuel.A.Palumbo et al 1985). It has been isolated from polluted and non polluted water throughout the world.(Schubert,1975).It is also associated with corneal ulceration, endophthalmitis, osteomyelitis, septic arthritis, endocarditis, peritonitis, biliar obstruction and colecistitis, intra-abdominal abscesses, urinary infections, otitis media (Khardori and Fainstein, 1988). In US it reported that in summer the *Aeromonas* spp. is found in the faeces and in the tap water, and also the USA protection agency has listed the *Aeromonas Hydrophilia* in there contamination list has emerging pathogen in Drinking water (MM Aslani & MY Alikhani 2004).

Mycobacterium Chelonae

M. chelonae are gram positive acid fast bacilli which grow rapidly. It is considered as the commensals in the humans. (Brown TH 1985). They are free living ubiquitous bacteria which are found in soil and water (Sanders et al 1990). They are found in natural and processed water sources including sewage and in tap water. Environmental mycobacteria such as *M. chelonae* can resist temperatures of 45°C and some disinfectants such as 2% alkaline glutaraldehyde.(Alfred M. Emmerson 2001). The main causes of the outbreak has been reported by the exposure to non sterile water, inadequately disinfected or reusable instruments.(H-C. Wang et al., 1995). Hospital water supplies can readily become contaminated with environmental mycobacteria, e.g., *M. xenopi*, *M. abscesses*, *M. fortuitum*, and *M. chelonae*; if decontamination units do not have filters (0.2 µm) fitted to the water supply, rinse water may become contaminated.(Alfred M. Emmerson 2001)

Young people are crazy about Tattoos and are common in many countries. The infection behind the tattoo making is also common and it blames normally the needle or the unhygienic condition. But a rare case was seen in Newyork where the water is the base for the infection and the agent is *Mycobacterium chelonae* which is not life threatening but it causes painful pus filled blisters. The mode of infection here was the unsterilized or the tap water which is used to lighten the ink. Normally witch hazel or alcohol is being used to avoid the risk of bacterial infections but unfortunately this strain is resistant to most of the disinfectant. This may not be relevant in the Indian market but now days there are many youngsters in India who prefer tattoos and it's becoming most common, whatever precaution we take the ink can also be a source of infection. A report says the outbreak of *M.chelonae* infection followed by the liposuction was found and later the investigation proved that the portable water is the common cause of infection and the routes are due to the reuse of the liposuction tubing after washing with the tap water or the inadequate disinfection of infusion for handling for tumescent infusion solution (Hildy Meyers etal 2002)

Other Mycobacterial species are also responsible for the infection where the water acts has a major source of infection.

Mycobacterium marinum

Mycobacterium marinum is a gram positive bacteria acid fast bacteria which is widely distributed in aquatic environment especially in the stagnant water such as fish tank, swimming pool, and the incubation period ranges from 5 and 270 days.(Lucinda Elko et al 2003). The optimal growth temperature ranges from 28-32°C. They are photochromogen which are capable of producing pigment when cultured and exposed to light.(Mark N Schwendiman et al 2009). *M.marinum* was first isolated first in 1926 By Arosn from from salt water fish that died in Philadelphia aquarium, Later in 1951 it was



recognized to cause human infection by which was isolated from skin lesions in swimmer of contaminated swimming pool in Swedish town. In 1962 Swift and Cohen reported the first case of skin infection acquired from aquarium. (V. Caputo et al., 2010)

M. marium is capable of causing nonsystematic infections which is evident has granulomatous skin lesions. The route of infection is not clearly understood but it is most likely to cause infection through the cuts or wounds who gets exposed to the contaminated water. (Monica Hagedorn & Thierry Soldati 2009). In deeper infection it causes infection such as tenosynovitis, septic arthritis and very rarely osteomyelitis. (Peter Van Seymortier et al., 2004). The lesions are most common on the elbows, knees and feet of swimmers and on the hand and fingers of fish fanciers (V. Caputo et al., 2010). Cases were reported in case of the patients who had exposed their hands in the fish tank. The typical symptoms include the primary lesions typically blue red papule, nodule or plaque. In 2003 a 56 year male patient was ruled out with *M. marinum* infection with acute swelling and erythema on the proximal interphalangeal joint of the right middle finger. (Peter Van Seymortier et al., 2004) In 2008 it has been reported that this species was isolated from the patient who worked at fish Farm in Jiangsu Haiian, China. (Feng Y et.al 2011)

Salmonella Kottbus

Salmonella Kottbus a gram negative bacteria in which most of the cases reported was infants below one year of age. A report says in 1996 there was an outbreak of *S. kottbus* which has affected around 46 infants and the cause of infection was ruled out later has bottle water infected with *Salmonella kottbus*. The average age of cases reported was five months. (R Palmera - Suarez et.al 2007). Another species associated with the bottle water outbreak is *Salmonella bareilly* which was detected through CDC's (CDC 2002).

Chryseobacterium meningosepticum

Chryseobacterium meningosepticum formerly known as *Flavobacterium meningosepticum*, a gram negative, non motile bacteria ubiquitous in water and soil. They are most prevalent in hospital environment due to the ability of the organism to grow in non nutrient media. This organism can survive in the chlorine treated water, sink basin, taps (Hyu sun Yoon 2007). This pathogen mainly associated with meningitis in premature and new borne babies and rarely causes pneumonia, endocarditis and meningitis associated with adults. (Shou-Wu Lee et al., 2008).

In 1996 a report says that *Chryseobacterium meningosepticum* was isolated from tap water of the neonatal ICU. Eight cases of the *C. meningosepticum* have been reported from Aug 2002 – Dec 2003 at Mauritius at Jawaharlal Nehru Hospital. This bacteria are resistant to most of the antibiotics used against gram negative bacteria such as aminoglycosides, β -lactam agents, Chloramphenicol, carbapenems, but susceptible to agents used to treat gram positive bacteria like Rifampicin, Ciprofloxacin, Vancomycin, trimethoprim-sulfamethoxazole.

Chromobacterium violaceum:

Chromobacterium violaceum is a saprophytic bacterium which was first discovered in 1905 by Wooley in water buffalo. Later in 1927 it was seen in humans also (Sneath PHA et al 1953). In humans *C. violaceum* results in systemic and severe disease ranging from cellulitis and skin abscess, which can later develop has sepsis and multiorgan abscess in lung, liver spleen. They are gram negative, non sporing bacteria measuring approximately about 0.5 μ m long and 2-3 μ m wide, which are the habitat of soil and water. There exhibit both pigmented and non pigmented strain where the infection caused by non pigmented strain are very rare. (J. Lee, et al 1999). A study carried out between 1971 – 2005 says that the mortality rate is between 60%-80% (A G Orsetti, et al 2013). Infections occurs mainly via traumatic injury or by drinking contaminated water, and cellulitis or an abscess may or may not form at the site (Martinez R et al 2000, A G Orsetti, et al 2013).

Chromobacterium violaceum in which the source of infection is due to recreational activity, or it can also occur after the exposure of wounds to the stagnant water or soil. (Roberts SA et al 1997, Ender PT et al 1997) They are widely distributed in the nature and are sensitive to temperature. The infection pattern is again different by eating away the body tissue. The case history was interesting where an old man at the age of 42yrs fell down from bike into a drainage canal and had injuries on head and *C. violaceum* was isolated from the wound, the symptoms developed was fulminating septicemia, with necrotizing metastatic lesions and multiple abscesses in the liver, lung, spleen, skin, lymph nodes, and brain, resulting in fatal multiorgan failure (Gunther Slesak et al 2009). *C. Violaceum* is usually susceptible to chloramphenicol, tetracycline, gentamicin, co-trimoxazole, ciprofloxacin and imipenem, and resistant to penicillins, cephalosporins and aztreonam (Ti TY et al 1993, Midani S et al 1998, Atapattu DN et al 2001). A first case of *C. violaceum* from coastal Karnataka has been reported in a 2yr old girl (Mamatha Ballal et al 2000). These organism may be the rarest but in mere future we can find this in our drinking water because in many places our drinking water is getting mixed with the drainage water. As per the reports the infection by *C. violaceum* is rare but the mortality is very high and this is most predominantly seen in south eastern countries.

Erysipelothrix rhusiopathiae

Erysipelothrix rhusiopathiae thin, gram positive bacilli, non sporulating bacterium which was isolated by Koch in 1878, (Koch, R. 1880, Annette. C. Rebolit And W. Edmund Farrar, 1989) which causes erysipeloid. It is a zoonotic infection in humans caused mainly with meat and fish handlers. (Dean Campbell and Mark Cowan 2013) The habitat is aquatic and it can survive for long period in the fish slime. (R. L. Woodet al 1975) In case of humans the infection is very rare and it is found especially with fisher man. The mode of infection can be exposure of the infectious agent through the wound or by punctures where the incubation period ranges from 1-7 days with mild cutaneous infection termed has erysipeloid. In the



severe cases it is associated with purpuric rash which is blue or purple with well raised border. (Dean Campbell and Mark Cowan 2013).

A report by Ramona Simionescu et al in 2003 reports that lady was manifested with narcotizing fasciitis where the source was reported has pet gold fish.

Halomonas venusta

Halomonas venusta, gram negative halophilic proteobacteria, non fermentative bacteria found in marine environment. *H.venusta* was first discovered by Baumann et al 1973(Alexander von Graevenitz et al 2000). This is also seen harboring in the fish and the fish acts as a mediator for spreading infection. The case history says a healthy women at the time of recreational activity was bitten by the fish which is infected with *H. venusta*. Later the symptoms developed to a painful cellulitis with watery discharge (Alexander von Graevenitz et al 2000).

Burkholderia pseudomallei

Burkholderia pseudomallei causes Melioidosis with complex pathogenesis, the causative organism was first described by Whitmore in 1912 when he first isolated *B. pseudomallei* from an opiate addict in Rangoon. This is a gram negative bacilli resistant to many antibiotics such as Gentamicin and Colistin. An interesting thing about these bacteria is it can be seen as gram positive bacteria under environmental stress. *B. pseudomallei* is an environmental saprophyte isolated from wet soils, agricultural soils, streams, pools, stagnant water and, in particular, paddy fields throughout the endemic areas. (Air Vice-Marshal Bruce H Short 2002). This is normally found in rainy season and the most susceptible people are with the occupation such as farmers, construction people travelers and the through recreational activity. The clinical symptoms may vary from person to person and severity also varies. The patients may suffer from rapidly fatal septicemic illness without pneumonia to focal abscess. Other clinical manifestation includes acute form, spreading fulminant sepsis. The most common symptoms are bacteriemia, pneumonitis, pulmonary, splenic, hepatic and cutaneous abscesses. One of the biggest drawback of this infection is the sudden death or death within two days of infection.

The first case of human melioidosis in Australia was described in a young diabetic adult from Townsville in 1950 who died of septicemic melioidosis (Remington RA 1962). Six melioidosis cases were identified from the 2004 tsunami survivors. (Wirongrong Chierakul et al 2005) in Southern Thailand. The case history says in Singapore in early 1990's there was sudden death in the construction sites where later ruled out has Melioidosis infection. The average mortality rate from melioidosis over the study period was 42.6%. The minimum estimated population mortality rate from melioidosis in 2006 was 8.63 per 100,000 people (95% CI = 7.33–10.11), the third most common cause of death from infectious diseases in northeast Thailand after human immunodeficiency virus (HIV) or acquired immunodeficiency syndrome (AIDS) and tuberculosis (Direk Limmathurotsakul., et al 2010). In Taiwan a report says that there was a steady increase in the melioidosis cases between 1982 -2000 (Hsueh P et al 2001)

Vibrio vulnificus

Vibrio vulnificus is a gram negative motile curved shape bacteria. They are found in warm coastal regions, especially in the summer season when water become warmer. The bacteria can enter through wound or ingestion after an exposure to contaminated water. The clinical manifestation was redness and swelling of the wound followed by the sepsis. The symptoms include the fever, chills, diarrhea, nausea, vomiting, septic shock, and characteristic skin lesions, which include lower extremity cellulitis with ecchymosis and bullae, Because the organism can cross the intestinal mucosa rapidly, development of bullous skin lesions of the lower extremities, which are thought to be an early manifestation of sepsis, can occur within the first 24 h after onset of illness. (Klontz KC., et al.1988) Although wound infection have been diagnosed in the healthy individual, the infection is mainly seen with the person whose immunity is impaired such as kidney disease, Diabetes, cancer etc. (Nicholas A. Daniels 2011). Iron is a predisposing factor for *V. vulnificus* where it used iron stores for bacterial growth, where the infection if found in the liver patients whose iron levels are elevated. (Haq SM, Dayal HH.,2005).

The first case of *V. vulnificus* was reported in 1970 with leg wound infection after exposure to New England Coastal water (Roland FP, 1970). They mainly causes wound infection, septicemia and diarrhea. The case history from US says that many cases have been reported due to the *Vibrio* Infection. According to Center for disease control and prevention 58 cases of *Vibrio vulnificus* has been reported in US between 1997 to 1998. A report by Chiang SR in 2003 says that in Taiwan there is a dramatic increase in the *V. vulnificus* infection with a history of dying within 48hrs of infection. From 1994-1996 the review report from Gulf Coast surveillance says that 45% of the infection is found to be wound and 43% of primary septicemia and 5% of gastrointestinal tract infection (Shapiro RL 1998).

Edwardsiella tarda

E.tarda was first described by Ewing et al in 1965, which is a gram negative anaerobic rods which measure ranging from 1 µm in diameter and 2–3 µm in length. They are the habitat of fresh water. It has been cultured directly from lakes, rivers, well and sewage water (Ellen M. Slaven et al 2001). Very rarely cases have been reported in Thailand and Taiwan. Cases has been reported with the marine exposures where it was identified mainly in warmer weather, from the month of May to October, which gives an evidence that increase proliferation can happen in warmer water or both (Ellen M. Slaven et al 2001).

A case report by Vartian CV in 1990 says that a 15 year old boy was infected with *E.tarda* while he was walking with bare foot in a fresh water lake and injured by submerged branch and he was found with progressive swelling and pain. A case



was reported with Septicemia and Necrotizing Fasciitis for an old 62yrs Japanese male, who had diarrhea, swelling and erythema over the knee which developed into necrotic lesions. General symptoms are gastro enteritis which developed into ulceration and bleeding. *E.tarda* has reported to colonize the vagina where it is potential source of neonatal sepsis through exposure at birth. In 2002 it was reported that a pregnant women who had spent time in lake, later the infection was found in the new born baby (Mowbray EE et al 2002). Before 2003 the *E.tarda* infection was very rare with a reported case of 2 but later rate increased to 300 in which water was the main source of infection with a prevalence in Singapore, Vietnam and Cuba. V Manchanda 2006 reported a case of liver abscess which was caused by *E.tarda* and the source of infection was ruled out to be the exposure to pond water.

Sphingomonas paucimobilis

Sphingomonas paucimobilis was first discovered to cause human infection in 1977 and was named as *Pseudomonas paucimobilis*. (Mehmet Özdemir et al 2011). They are non fermenting gram negative bacteria which is responsible for the nosocomial infections. They are normally found in aquatic environment such as drinking water system, mineral water, water equipment used in hospitals, river water, waste water, distilled water, dialysis fluid can be a water borne clinical pathogens which is for hospital infection especially in immuno compromised patients. (Calubiran et al., 1990; Morrison & Shulman, 1986; Reina et al., 1991, I-Ching Kuo et al 2009) The major drawback is this bacteria is capable of forming bio film in water pipe line connections. They are associated with clinical symptoms such as bacteremia, pneumonia, catheter related infections, meningitis, peritonitis, osteomyelitis, septic arthritis, postoperative endophthalmitis, lung emphysema, splenic abscesses, urinary tract infections, and biliary tract infections.

Between October 2008 – November 2008 15 cases of neonatal infection has been reported due to *S.paucimobilis* and major source of infection is distilled water which is used for humidifying of incubators and mechanical ventilator. (Mehmet Mutlu., 2010).

Francisella tularensis

F. tularensis are non motile gram negative coccobacilli, nonmotile, and appears as small approximately 0.2–0.5 µm by 0.7–1.0 µm (Ellis J et al., 2002). A Spanish outbreak of 19 cases was reported due to the contact of river caught cray fish. (Anda P et al 2001). The same report says there was about 1091 cases of Tularemia cases between 2005 – 2008 in Turkey. Saban Gurcan reported 8 cases of Tularemia in children who had a history of swimming in a pool filled with water from local stream and contact with stream water. A survey of small tularemia outbreak in a village of Karamursel county of Kocaeli province was done in between January 2005 – March 2005 where 17 patients were diagnosed with tularemia where the age group was between 27-80yrs in that 59% was female and symptoms varied from person to person with weakness, swelling on the neck (94%), sore throat (88%). The reason for outbreak was later ruled out to be natural spring water. (Meric M, 2008). Later in Nov 2009 – December 2009 investigation was done in the same village for water borne outbreak of tularemia, 14 cases were identified with 11 cases of Oropharyngeal tularemia, 3 cases of glandular form and 1 case in pneumonic form. Where the source was ruled out to be natural spring water. (Ulu Kilic A 2011). In March 1982 49 cases of oropharyngeal tularemia in Italy due to water system. (Greco D et al 1987).

Stenotrophomonas maltophilia

Stenotrophomonas maltophilia are aerobic gram negative bacteria measure approximately 0.7–1.8 × 0.4–0.7 micrometers. *S. Maltophilia* is an environmental bacterium found in aqueous habitat, including plant rhizospheres, animals, food and water sources. (Joanna S. Brooke 2012) *S. maltophilia* is found among the heterotrophic plate count in the natural potable water. (Rusin PA et al 1997). The most common sites of contamination were sink drains, faucets, and other items frequently in contact with water. (Denton M et al 1998). An outbreak due to *s. maltophilia* was reported at NICU where infant was infected and the source was ruled out to be the tap water was used to wash the preterm infants (Verweij PE 1998). A paint company in the state of Paraná in Brazil had several batches of water-based acrylic paints contaminated with microorganisms, which was identified as *Stenotrophomonas maltophilia* (Fernanda Rochoel La Rosa et al 2008).

Plesiomonas shigelloides:

Plesiomonas shigelloides anaerobic gram negative with size ranging from 0.3-1.0 µm in width, 0.6-6.0 µm in length. The organism was first isolated by Ferguson and Henderson in 1947. They can survive at wide range of pH and temperature such as pH ranging from 4-8 and temperature ranging from 8-44°C. The mode of transmission is mainly through the faeco oral, consumption of infected sea food, contaminated water. A survey was done by Teruyoshi Arai et al in 1980 to isolate *Plesiomonas shigelloides* which showed 3 (0.0078%) of 38454 healthy Tokyoites, 37 (3.8%) of 967 dogs, 40 (10.3%) of 389 cats, 25 (10.2%) of 246 fresh water fish, 64 (12.8%) of 497 river water samples, and 2 of 19 (10.5%) sludge samples.

Discussion:

Water can be a source of infection, it can be a direct exposure or indirect. This can be avoided by proper care. In many cases the hospital acquired infection is through the negligence which takes hundreds of life. In the current report most of the cases has been reported very rarely, but in the mere future these names will be replaced by new microbes by making them the general infections.



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