8 Gastro-enterological infectious diseases

These diseases show an important medical phenomenon: gastroenteritis, or the reaction of stomach and gut tissue to micro organisms. Note that often there is diarrhoea, but this is not necessarily always the case and sometimes there is even constipation. Gastroenteritis can present as a classic inflammation, but also as a heavy reaction not including the classic inflammatory symptoms, with spasms and the loss of water and electrolytes.
Like many cells in the body, the cells that line the stomach and bowels have the ability to pump fluid actively, in and out against the concentrations**.** They can transmit electrolytes (Na^+, K^+, HCO_3^-, e.g.) over a membrane against a gradient**.** These pumps are biochemical wonders, just like chlorophyll in plants, which converts water and carbon dioxide into starch under the influence of light.

Micro organisms, especially bacteria, can very much disturb these ingenious gut functions. This is due directly to their antigenic make up, but also indirectly by producing toxins. We distinguish two types of toxins: *exo*toxins, which are actively discharged by living bacteria and *endo*toxins, which are only discharged from bacteria after their death (the later constitute a problem for the suppression of septicaemia = blood poisoning: the killing of the causal pathogens can kill the patient because he gets into a shock from the sudden release of toxins). In the case of the bacteria endangering intestine tissue we speak of *entero*toxins (which can be an exo- as well as an endotoxin).

The most dramatic example of the exotoxins is that of the cholera bacterium; the patient can easily loose twenty litres of fluids per day (rice water diarrhoea) and even after refilling he has a chance to die. Because he also loses a lot of electrolytes and bodily functions cannot go without these. That is why with Oral Rehydrationt Therapy with ORS fluids as well as salts are given.

Table: Several forms of gastro-enteritis, the causal organisms, incubation time, incidence in The Netherlands (partly as import cases), and case fatality rate

Disease	**Causal organism**	**Source**	**Incubation period**	**Year incidence**	**Case fatality rate**
typhoid	Salmonella typhi	water, food in devel. countr.		1-10	3-15 %
paratyphoid A	Salmonella paratyphi A	idem			0-1 %
paratyphoid B	Salmonella paratyphi B	idem			0-1 %
other salmonellosis	salmonella species	eggs, poultry, meat	18 hour-2 days	100.000	< 1 %
cholera	Vibrio cholerae (poss. var. El Tor)	water, raw fish in developing countries		0-10	0-3 %
shigellosis	Shigella dysenteriae/ sonnei/flexneri	shrimps, shell fish		10-100	0-3 %
listeriosis	Listeria monocytogenes	Soft cheese/ cottage cheese, pate, salads	5 days-5 weeks	10-100	20-30 %
clostridium-enteritis	Clostridium perfringens	stews, mince meat	12-24 uur	>1.000	low
botulism	Clostridium botulinum	Preserved food (salt, tins)	12-18 hours	0-1	50-100 %
campylobacter-enteritis	Campylobacter jejuni	poultry, raw milk, water	5-7 days	100.000	low
stafylococci-enteritis	Staphylococcus aureus	ice, cooked meat, pudding	Several hours	> 1.000	0,1 %
coli-enteritis	Escherichia coli (esp. type O:157)			10-100	5-10 %
rotavirus-infection	Rota viruses			X	low
Norwalk virus infection	Norwalk virus			X	low
gastritis	Helicobacter pylori	intimate contact with people	direct	100.000	< 1 % #

eventually via perforations by ulcers and gastric cancer hundreds of deaths per year.

To a lesser degree we also see dehydration by other diarrhoeal diseases. In developing countries especially it are these illnesses that threaten young children with death. Nearly one of the ten deaths in the world is a child between 0-4 years old in a developing country that dies from a diarrhoeal disease! Almost all of the pathogens are water borne. Several diarrhoeal/ gastroenteritis diseases will be discussed below: such as (stomach) typhoid, other salmonella illnesses, cholera, shigelloses, listeriosis, clostridium enteritis, botulism,

staphylococcus, Campylobacter gastroenteritis. Firstly we will give attention to the terms food infection and poisoning.

Many of the infections do not directly take place through faecal-oral contact, but through (drinking) water, milk or food. There are intermediates as well like flies, cockroaches or hands. In (drinking) water most of the pathogenic bacteria do not multiply; and viruses are not able to multiply at all outside cellular organisms.

Food infection and food poisoning

These two terms are often confused with each other. They however are two different things. Food poisoning occurs through living micro organisms in food, which multiply or not in the intestines and discharge or not discharge enterotoxins. Food poisoning occurs through toxins in food such as chemical by-products (like nitrite), but also metabolites or toxins from bacteria that already can be dead or gone. An example of food infection is enteritis by *Campylobacter jejuni*; an example of food poisoning is botulism (by the human) from the toxin of *C.botulinum*.

The Health Council suspects that half of the food infections and poisonings begin in the catering industry.

Typhoid (water and food borne)

An disease that also still was around a lot in the nineteenth century in The Netherlands and buried many thousands of people. The pathogen is called *Salmonella typhi*, a gram-negative bacterium exclusively living in human, but is able to survive for a little while in a watery environment. There are thousands of Salmonellae, but this one is the most feared. If there is only one justification in the nineteenth century to put so much money in the ground by the civil engineers, then it is the stomach typhoid.

After an incubation period of 2-3 weeks an already serious clinical picture occurs characterised by high fever (febris typhoidea) malaise, drowsiness, and not always diarrhoea (constipation also often happens). The fever can make the patient delirious; the Greek word ‘τυφος’ (túphos) means therefore ‘fuddled’. Further more characteristic is the relatively slow pulse (fever usually always increases the heart rhythm). The case fatality rate is without treatment approximately 15 percent; but is also with modern measures only still 3 percent. Much comes down to the resistance of the patient; many of inhabitants in our country did not have a fantastic condition in the nineteenth century when typhoid was still active. Momentarily the typical patient in The Netherlands is: someone that comes back from holiday healthy and then gets ill; it concerns many cases per year and the thing is that the doctors have to be aware (like they have to think of malaria as well). The holiday country is then still one of the many countries where typhoid is indigenous. Why?

Let us look how someone from Delft or Amsterdam got his typhoid in 1860. He took water from the canal for consumption; other water cost money (in the water, fire and ice shop) and he often did not like it that much. He took in a very interesting cocktail, coming from the intestines of many of the neighbours because the sewers of the houses discharged into the canals. Under which also typhoid bacteria, which need a very small *inoculum* to infect. In the past they spoke of Minimal Infectious Doses (MID); this term is not used anymore; because many factors determine now the risks of infection and the inoculum is only one of them. In any case: a relatively low number of typhoid bacteria are able to start off an infection. Cholera however needs a fair number of vibrio's to lead to an infection. But very possible was also an infection directly from a housemate who discharges the pathogen. For we are dealing with a faecal oral infection, that also can get to us in another way than through (drinking) water. For example through the hands, but also through flies (food) and through the soil. Up to the twentieth century a special route of infection was still possible in The Netherlands through milk. Farmers used to wash out their milk bottles thoroughly, because we are such a hygienic population. Unfortunately they did this nearly always in the ditch in which the sewers discharged. This is why the milk got contaminated. We see now the big importance of the development of the cooperative dairy factories around the turn of the twentieth century. Surprisingly enough some people prefer the raw milk; it has to be said that not only salmonella can live in there, but also tubercle bacteria. Milk directly from the farmer therefore always has to be cooked first. People who chronically are a carrier and scatterer of *S.typhi* are not allowed to work in the food industry, water mains companies, restaurants or kitchens. In practice this is hard to check. Much depends on the cooperation of the carrier himself and of the alternatives that are offered to him/her.

The environmental department of civil engineering can offer pre-eminently conciliation in the matter of typhoid. The separation of faeces from drinking water and food is essential to prevent scatterers becoming victims.

Paratyphoid A, B and C (water and food borne)

The incubation period of these disorders is shorter than for typhoid: 7-12 days. They more look like an acute stomach and intestine disorder and form a transition to 'other salmonella's'. The case fatality rate is also between typhoid and salmonella. The pathogens A and C more occur in the tropics while *S.paratyphi* B more occurs in moderate areas; in The Netherlands they barely occur.

Other Salmonella (water and food borne)

The members of the thousands of numbers of the genus Salmonella feel at home in various animal species, *S. typhi* and *S. paratyphi* in the human and other various animal species. As we know the meat inspection is mainly the search after salmonella and the determination of their inoculum. Little is acceptable, but too many can make the human ill through meat that is

not cooked properly. However this does not mean that salmonella's in meat always come from an animal: human carriers are also dangerous (see *S.typhi*). Eggs are the most infamous for the presence of salmonella (*S.enteritidis*), but also meat of poultry and pigs come into our kitchen contaminated. The ever-returning misery with the dessert 'bavaroise' is annoying and dangerous, because of the usage of raw eggs. A long incubation and proliferation are given to the salmonella that subsequently come on the table in millions; directly eaten raw (a normal occurrence by Japanese breakfast) the egg was not considered as dangerous. Well known is the story of the Europe top in Maastricht, in mid eighties; salmonella struck the highest Europeans, who had enjoyed a "rich" (contaminated) buffet.

Cholera (water and food borne)

Cholera is already described 800 years ago before our era in India. The disease spread out more than ones through the Ganges delta over big parts of the world. In our country it was not easy for the disease, in spite of the ship travels to the East. On the long trips the route of infection had to be uninterrupted to introduce the disease. It is suspected that the pathogen only just came with the faster ships of the eighteenth century from the East, without however leading to epidemics; the bacteria for one came with the ballast water. In the ninety century the disease spread out in six big pandemics over the world. In 1832 it arrived in The Netherlands; ten thousands of people got ill of the approximated 2.5 million (morbidity) and almost 5,000 patients died (mortality).

How slowly the insights of the cause of these water borne illnesses took off, we see for example from these written words of a doctor from Rotterdam at the beginning of the first epidemic (in heavy contrast with the words of John Snow)

The disease has an incubation period of 10 hours and characterizes itself with heavy watery diarrhoea and vomiting. The loss of many litres of fluid (up to 24 litres per day) and electrolytes can lead to a quick death. Alongside drinking water, milk as well as shell animals and other food are described as a possible source. In the last South American epidemic, around 1990 (the first one with the variant El Tor) the cause of the epidemic was often raw fish with lemon juice (quive). This *Vibrio Cholerae* El Tor was for the first time isolated in the quarantine station El Tor in the Sinaï. Pilgrims (Hajjis) took the pathogen to Indonesia. In 1958 the pathogen spread out from Celebes and was the cause of the big pandemic of the sixties (the seventh pandemic). Momentarily there is an increasing incidence in South East Asia; The concerning cholera bacteria has an antigen O: 157, that makes the *E.coli* also very dangerous.

*Table: Number of registered **deaths** (mortality) by cholera asiatica during epidemics in The Netherlands from the beginning of the 19th till the start of the 20th centuries. The morbidity was several times higher.*

Year	Number	Year	Number
1832	4,872	1867	1,591
1833	4,671	1873	277
1848-1849	**22,078**	1874	48
1853	2,891	1892	293
1854	2,038	1893	263
1855	2,980	1894	228
1859	3,748	1901-1904	2
1866	**19,691**	1909	18

Because cholera comes in waves it has something to do with the immunity of the population. The immunity is high after an epidemic and decreases again until again enough susceptible individuals.

In The Netherlands cholera meant a social impulse: the home nursing services erected to care for these patients and also the plea for the construction of drink water services won.

Shigellosis (water and food borne)

In the beginning of the eighties / was startled by an epidemic of shigellosis by humans who had eaten shrimps around Christmas time. In a elderly people home in Utrecht several inhabitants died. The shrimps came from Bengal (Bangladesh) and were contaminated by peeling. This led to the development of the shrimps peel machine and since then there has been no epidemic. This short story shows a few things: although only one person is infected through food many thousands can get infected; especially we find lethal cases of gastroenteritis among people with reduced resistance and elderly people. The incubation time is several days, which makes it more difficult to determine the cause of the intestine disorder.

Shigellosis of bacillary dysentery (distinguished from amoeba dysentery) is caused by a gram negative bacterium, Shigella. There are three groups: *Sh.dysenteriae*, *Sh.Flexneri*, *Sh.Sonnei*. After an incubation period of several days stomach cramps, diarrhoea and fever that can sometimes increase greatly begins. A diverse number of antibiotics can do something against it. For reasons that are not clear the season top is in the autumn.

The transmission goes through a faecal-oral route (shrimps peelers), but it also can be transmitted through insects (flies) and through drinking water. In countries of South Asia this disease is only one of many that cause gastroenteritis and diarrhoea. A few deaths by shigellosis in an elderly home would not reach the paper (besides the fact that elderly homes barely exist in comparison to orphan homes, of which many do exist; explanation?).

Botulism by the human (food borne; food poisoning through toxin)

Clostridium is a genus which gives us the dangerous *C.tetani*, but also other members are harmful to mankind. Not only *C.difficile*, that causes hospital infections, but especially the *C.botulinum*. The term botulism makes every true civil engineer think of our border lakes and the death of water birds and fish in the Summer.

However in this case we mean the production of an extremely potent toxin by *C.botulism*, which is found in long kept food and causes food poisoning.

Campylobacter enteritis (food borne)

According to the Health Council the number one of the bacterial food infections, which pushed away salmonella to the second place. The campylobacter through poultry means to us the same as salmonella means to us through eggs, chickens and pigs. The story behind many serious cases of gastro-enteritis in The Netherlands, sometimes leading to hospitalisation or even death, is overly known, but cannot be repeated enough.

Due to our hygienic upbringing our Pavlov reaction towards the chicken is: “Good heating up”. This is correct, but then the tool (board, knife, e.g.) is further used for ingredients of our salad and other not boiled spices, after using it for cleaning and preparation of the chicken. The campylobacter, that was prevalent in large numbers in and on the chicken gets a big chance like this. Many people also leave a well-boiled turkey or chicken on a contaminated dish or board, what of course is not correct as well.

The top season is in the summer related to barbeques and other things like that. The place which the bacteria affect is more or less indicated by the name: *Campyolobacter jejuni*; the jejunum is a part of the thin intestine. The story of the resulting gastro-enteritis is the same as the previous one. Antibiotic therapy is also in this case indicated. The following thing about prevention apart from personal hygiene can be said:

For years it has been proved that the bio industry (with the emphasis on the second word) with its batteries e.g. forms an increasing source of health threatening factors: grow hormones, increasing resistance against antibiotics, pig manure, ammonia discharge, salmonella, campylobacter infections, etc. Real improvements (for people and animals) are not probable in the short run, because

a. We prefer paying a little less for the shopping and
b. Thanks to the gigantic agrarian export the country is doing fine for the moment.

Staphylococcus (food borne; food poisoning by toxins)

The classic story of food poisoning of groups in our country is nowadays the staff outing with picnic. When everyone gets home gastroenteritis with vomiting and diarrhoea breaks out at several addresses in the beginning of the evening or around midnight. The next day the total

number becomes clear: no one appears at work. The cause is the enterotoxin of the staphylococcus, an exotoxin. A season top is of course in the summer.

The gram positive Staphylococcus thank their name from the fact that under a microscope they are little round balls in the shape of a bunch of grapes (σταφυλος, staphylos). They are normally present in big numbers on the skin, usually as *Staphylococcus epidermidis*, or sometimes as *Staphylococcus aureus* which infamous for its wound infections and its boil. Their toxin we also know from another disease known from the eighties: the toxic shock syndrome. When tampons are not removed in time staphylococcus from the own skin, can grow in them and their toxin is taken in by blood. This leads to fever symptoms. The last few years little is heard of this phenomenon, this mainly because of a change in composition of tampons.

***E.Coli* enteritis (food borne)**

Many colon bacteria exist and many are useful in human perspective. They transmit things in our intestine and from which they form useful compounds. They are one of our indicator organisms and they taught us a lot about micro organisms (most studied bacterium). Some types however are pathogenic. In the last few years one variant causes an disease mainly occurring in America that is called the hamburger disease. Epidemics follow the logic of one particular hamburger chain (others every time; they are many). Patients get after an incubation period of several hours bloody diarrhoea and high fever. The case fatality rate is high. It is the variant O157 (pronounce “oo” 157) of *Escherichia coli* coming from stock for slaughtering who are responsible for this. The antigen (Shiga toxin) is however also the newly gained property of the *Vibrio cholerae*, that momentarily strikes South East Asia. This is annoying, but also gives perspectives in the control of cholera, against which the vaccine is still not good. Even from a mean variant of *E. colon* a better cholera vaccine can follow and therefore still is useful to us. In our country mainly the University of Groningen does the research of antigens.

Helicobacter pylori

“A screw shaped bacterium of the area between stomach and intestine”. Since the last fifteen years this bacterium is seen in association with stomach lining infection (gastritis). Although it is theoretically possible that a micro organism settles in an already damaged mucous membrane, it is more and more indicated that it yet causes the damage itself. Gastritis can lead to a stomach ulcer and this again can lead to perforations or to a malignant deterioration (cancer of the stomach). Note: in developing countries (where old age cancers are relatively rare) this is the most common cause of death by cancer.

The bacterium is probably transmitted by kissing or cuddling. The risk of infection increases through the years. Mostly older adults seem to get the bacterium. A minority will suffer from it.

It is one of the most occurring bacterial infections of the world. At the moment a therapy is developed that exists of a cure of several antibiotics. A big chance is however that the bacterium after expulsion will show up and cause gastritis again.

Rotavirus infection (food borne)

The rotaviruses are the most important causers of gastro-enteritis and diarrhoea by young children (see also ORS below). They also cause a quarter of the traveller's diarrhoea. In our areas the incidence leads to around the winter months. The disease lasts about 2-6 days. ORS is the remedy. They are busy working on the vaccines.

Norwalk virus infection (faecal-oral)

This group of viruses mainly causes gastro-enteritis and diarrhoea by older children and adults; as much as one third of the non-bacterial cases. The incidence is spread out evenly over a year. The incubation period is from three quarters of a day to three days. The disease after the outbreak lasts one or two days. Sometimes support from ORS is needed.

Enterovirus infection (faecal-oral/ food borne)

Enteroviruses belong to the picorna viruses (pico-RNA-viruses). The group includes for example polioviruses (see there) and echoviruses. They are in regard to gastro-enteritis of lesser importance compared with the two previous groups of viruses.

Oral Rehydration Therapy (ORT) with Oral Rehydration Solution (ORS)

Approximately 10 percent of the 52 million registered deaths per year on our planet is a child under five in a developing country that dies from the consequences of an acute gastro-enteritis with dehydration and loss of electrolytes. In the light of the current medical science most of the death cases are avoidable. The extremely simple and effective rehydration is described below, which is probably the most important medical intervention of this century and can yearly save the life of millions of children as well as adults. However it is repeated again that the engineer can beat the doctor by the best prevention of gastro-enteritis. Enough clean water without getting (faecal) contaminated before the points of discharge.

The figures of America show that acute diarrhoea with dehydration and salt loss is not only a problem of developing countries. Here we find as much as 200,000 hospitalisations per year of children under five with this disorder. There are "only" 400 death cases (very little in comparison to developing countries). The most important causer is the rotavirus (a quarter of the cases).

The treatment of acute diarrhoea involves two phases:

a. The rehydration phase, in which water and electrolytes are given as oral rehydration solution to compensate for the losses suffered.

b. The maintenance phase, that compensates previous losses as well as comprehends a diet.

Surprisingly enough the rehydration therapy already exists in the thirties of the eighteen-century. Back then articles were published in London and Paris that dealt with the pathology and remedy of cholera. They mention the intravenous adding of salt solution: “firstly get the blood back to its natural, specific gravity and secondly complement the deficit of salts”. The bad condition of patients, who were treated with the therapy, the poor handling of the maintenance phase, and especially the infection by the non-sterile technique, was the real cause of the disappointing results.

Development in our century of an adequate therapy was based on chemical analysis of the defecation by diarrhoea. An indication of the complementation of the deficits was gained. The WHO decided in 1975 to recommend only one sort of ORS for the whole world, although theoretically different kinds of “solutions” can be possible for several types of diarrhoea. The composition of the ORS expressed in mille moles per litre (mmol/l) is:

acid	spectre		alkaline	spectre
Na^+	90		Cl^-	80
K^+	20		Base*	30
		Glucose 111 (= 2%)		

* partly bicarbonate (HCO3-)

This formula is a compromise between the solution for cholera and other diarrhoeal diseases, mainly the nitrate proportion. Commercial solutions also exist, which slightly differ from the WHO formula. Clean water for the ORS solution is of course used for the oral administering (=through the mouth). Intravenous administering is only allowed with sterile fluid and sterile equipment through a disinfected place of the skin to a vein!