

Characteristics of risk of micro—organisms No.1

① Pathogens are living creatures.

They live in a balanced environment. Opportunistic infections and reemerging infectious diseases will definitely appear.

② There are many kinds of micro-organisms. There is a possibility that new type of micro-organisms can appear naturally.

i.e. AIDS (acquired immune deficiency syndrome) virus and SARS (severe acute respiratory syndrome) virus

③ Pathogens grow (unlike chemical substances) and move in human bodies, and cause different symptoms.

④ Infection and development of the diseases significantly depend on health conditions of each person.

⑤ Human bodies have immune system.

This characteristic is advantageous for human beings.

Characteristics of risk of micro – organisms No.2

⑥ Pathogens are highly host-specific.

Pathogens can infect only certain animals and cells and develop infections.

⑦ Each exposure to pathogens is crucial for infections.

They are different from accumulated micro chemicals.

⑧ Since they are infectious, it is possible to spread with secondary and third infection.

People extremely feel scared and repulsive for being infected by something invisible.

⑨ Infected people don't immediately present the symptoms of diseases. There is an incubation period.

An incubation period makes it difficult to take effective measures due to the active movement of people.

Prevention of Waterborne Diseases No.1

- ① **Required safety level is becoming high.**
- ② **There are some pathogens which infect people by minimal dosages.**

There is a possibility to become infected and become ill by taking small dosages.

- ③ **It may be necessary to control micro-organisms which we were not previously concerned about. (opportunistic infection)**

- ④ **Consideration of vulnerable people is necessary.**

It is necessary to show consideration toward infants, elderly, and patients who are immunosuppressed.

- ⑤ **Infection which infects both human beings and animals has become more problems.**

i.e. Cryptosporidiosis

Prevention of Waterborne Diseases No.2

⑥ There has been a significant increase in the speed and number of people as well as goods due to the development of transportation, traveling and trading.

⑦ By-products created by disinfection have become a problem.

We have to choose the disinfection method that has minimal adverse effect.

⑧ Policy on biological terrorism has become necessary.

Even after the war in Iraq, we always have to keep in mind that biological terrorism can affect drinking water which is directly related to our health .

Examples of epidemic of waterborne diseases in developed countries

1974	Richmond, Florida, U.S.A.	6-15m depth shallow well, 1200 dysentery patients, disinfected by chlorine
1979	Bradford, Pennsylvania, U.S.A.	shallow well, 3500 diarrhea patients, unknown cause, disinfected by chlorine
1980	Bramham, U.K.	3000 diarrhea patients, unknown cause, filtered and disinfected by chlorine
1981	Eagle-Vail, Colorado, U.S.A.	80 diarrhea patients by rota virus, filtered and disinfected by chlorine
1986	Pittsfield, Massachusetts, U.S.A.	3800 Giardia patients, unfiltered and disinfected by chlorine
1986	British Colombia, Canada	3000 Giardia patients, unfiltered and disinfected by chlorine intake source: surface water and ground water
1993	Uggelose, Denmark	1400 patients like virus diarrhea, filtered but not disinfected by chlorine
1993	Milwaukee, Wisconsin, U.S.A.	400,000 Cryptosporidium patients, filtered and disinfected surface water
1993	Gideon, Missouri, U.S.A.	600 Salmonella patients, 15 hospitalized, 7 dead, not disinfected ground water
2001	North Battleford, Saskatchewan, Canada	1900 Cryptosporidium patients, filtered and disinfected surface water

Waterborne infectious diseases

	pathogens	incubation period	symptoms	infection type
bacteria	<i>Vibrio cholerae</i>	few hours~5days (normaly2~3days)	sudden watery diarrhea, nausea, dehydration, fever, stomach ache	type3 infection
	<i>Salmonella typhi</i> <i>S.paratyphi</i>	1~3weeks (normaly10~14days)	fever, head ache, back ache, feeling of weakness, loss of appetite, roseola, splenic tumor	type3 infection
	<i>Salmonella spp.</i>	few hours~3days (normaly12~36hours)	stomach ache, diarrhea, nausea , fever loss of appetite, sometimes blood poisoning	
	<i>Shigella spp.</i>	1~7days (normaly2~3days)	fever, stomach ache, diarrhea (mucous and bloody stool) 、 tenesmus	type3 infection
	<i>Enterotoxigenic Eschrichia Coli</i> <i>Enteroinvasive Eschrichia Coli</i> <i>Enteropathogenic Eschrichia Coli</i> <i>Entrohorrhagic Eschrichia Coli</i>	6hours~3days (normaly10~15hours)	watery diarrhea, stomach ache, symptoms like cholerae fever, stomach ache, mucous and bloody stool ,symptoms like dysentery stomach ache, diarrhea,, fever, nausea bloody diarrhea, nausea, stomach ache	type2*) infection

感染症類型は「新しい時代の感染症対策について報告書」公衆衛生審議会伝染病予防部会基本問題検討小委員会、平成9年12月による。

*)腸管出血性大腸菌感染症は2号感染症として例示されている。

Waterborne infectious diseases 2

	pathogens	incubation period	symptoms	infection type
bacteria	<i>Vibrio paraheamolyticus</i>	3hours~3days (normally 12~24hours)	fever, stomach ache, nausea, diarrhea (mucous and bloody stool), head ache	
	<i>Yersinia enterocolitica</i> <i>Y.pseudotuberculosis</i>	3~10days (normally within 7 days)	diarrhea, stomach ache, fever, head ache, nausea, sore throat, arthritis, nodular erythema, rash, sometimes symptoms like blood poisoning	
	<i>Campylobacter jejuni</i> <i>C.coli</i>	1~10days (normally 3~5days)	diarrhea, fever, stomach ache, nausea, bloody stool like dysentery (infant)	
	<i>Clostridium perfringens</i>	6~24hours (normally 10~12hours)	stomach ache, diarrhea, nausea	
	<i>Legionella pneumophila</i>	2~10days	head ache, fever, pneumonia	type1 infection
	<i>Pseudomonas spp.</i>		diarrhea, mueosal infection, opportunistic infection	

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Waterborne infectious diseases 3

	pathogens	incubation period	symptoms	infection type
parasite	<i>Entamoeba histolytica</i>	few days~few months	fever, stomach ache, nausea, liver abscess, diarrhea (mucous and bloody stool)	type1 infection
	<i>Naegleria fowleri</i> <i>Acanthamoeba spp.</i>	3~14days	fever , stiffness in the neck 、 nausea, cerebral meningitis, keratitis, opportunistic infection	
	<i>Giardia lumblia</i>	3~6weeks	watery diarrhea, loss of appetite, nausea, slight fever	type1 infection
	<i>Cryptosporidium spp.</i>	4~5days	stomach ache, watery diarrhea	type1 infection

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Waterborne infectious diseases 4

	pathogens	incubation period	symptoms	infection type
viruses	polio virus	1~2 weeks	fever, spinal palsy	type3 infection
	coxsackie A virus	5~10 days	hand, foot and mouth disease, symptoms like cold, fever, pericarditis, myocarditis	
	Norwalk virus	2~3 days	gastroenteritis, diarrhea, nausea, stomach convulsion	
	rota virus	1~2 days	diarrhea, nausea, dehydration	
	adeno virus	5~10 days	conjunctivitis, gastroenteritis, pharyngitis, pneumonia	
	entero virus	2~6 weeks	fever, loss of appetite ,nausea, fatigue, jaundice	type3 infection

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Categories of pathogenic microorganism of waterborne diseases

Bacteria

Vibrio cholera
Salmonella typhi
Salmonella paratyphi
Salmonella
Shigella
etc.

Virus

Hepatitis A virus
Poliovirus
Rotavirus
Adenovirus
Norwalk virus
etc.

Protozoa

Cryptosporidium spp.
Giardia
Cyclospora
Entamoeba histolytica
Naegleria
etc.

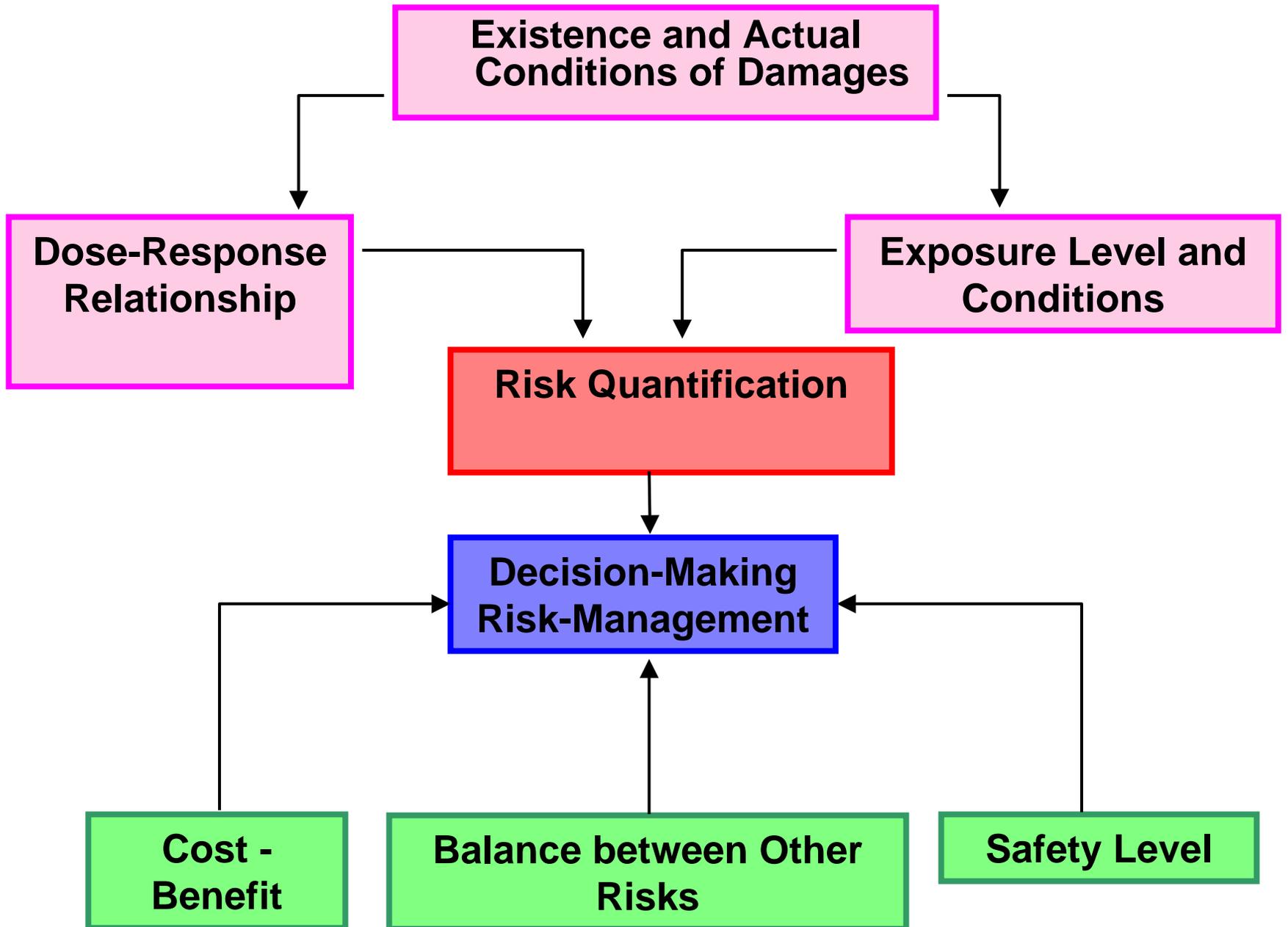
Helminth

Round worm (Ascaris)
Beef tapeworm
Dracunculoidea
Capillaria
Schistosome
etc.

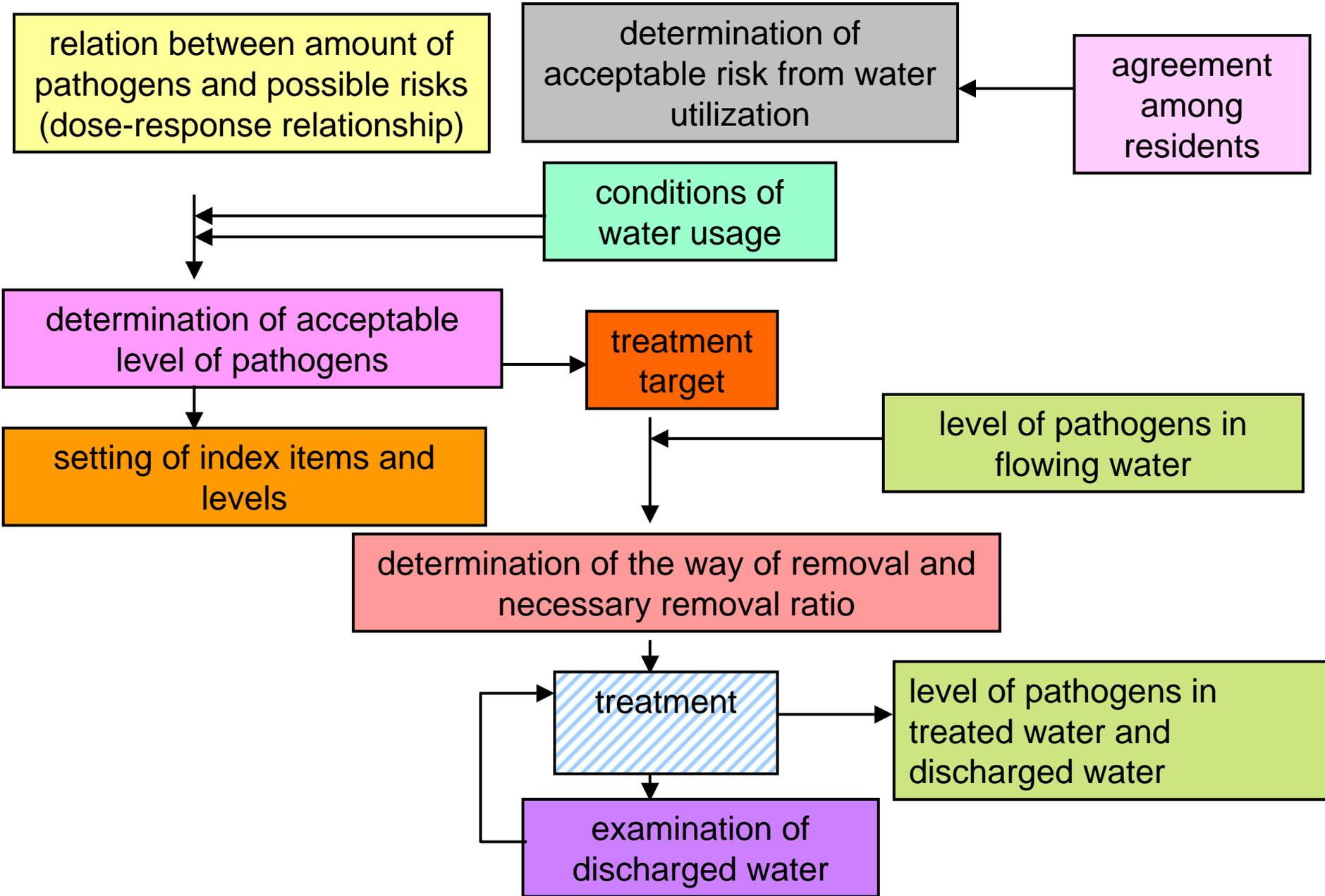
Human
Body

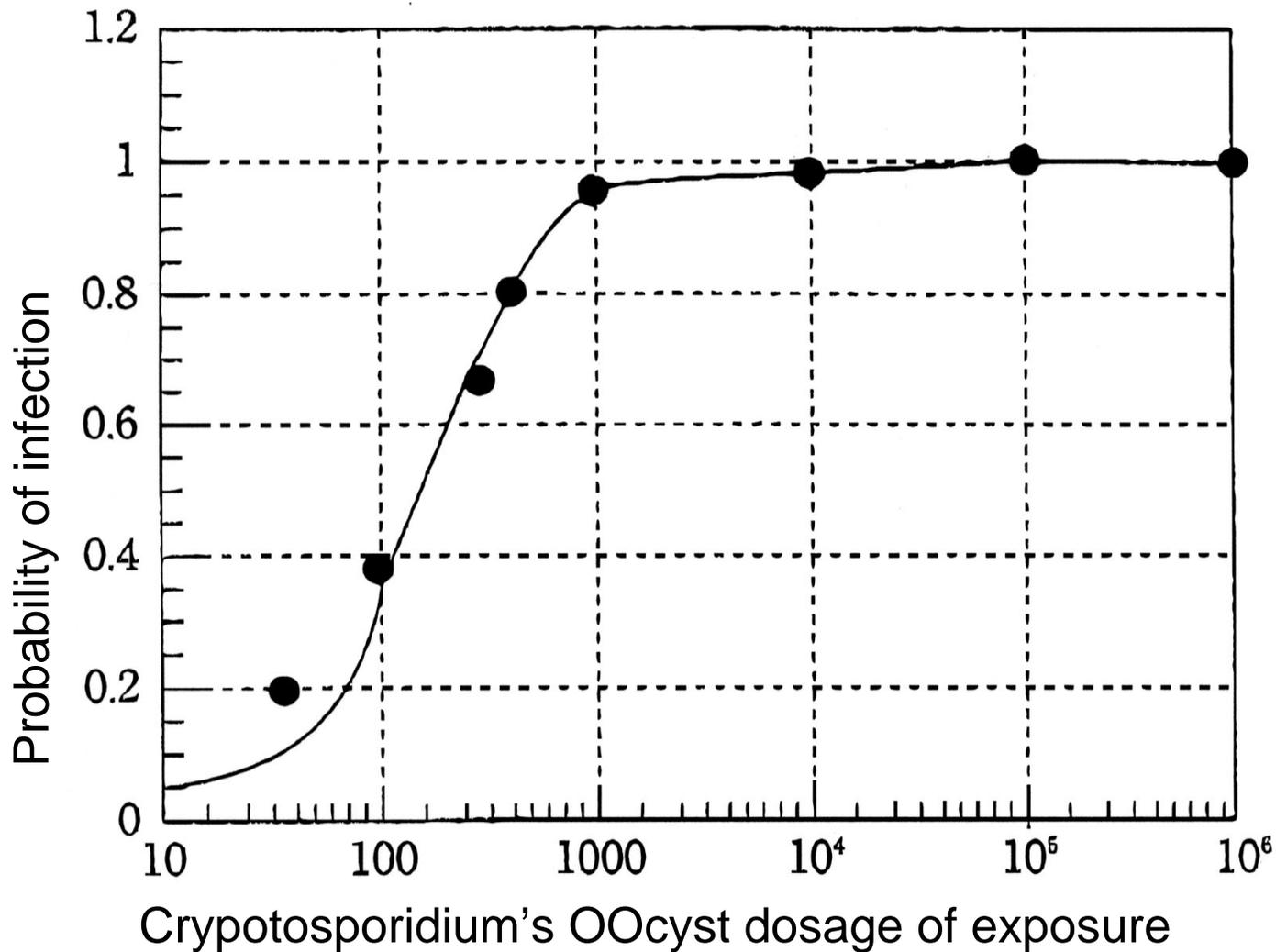
Risk of microorganisms · factors which influence assessment

- microorganisms density of in raw water
- detection rate and precision
- activity and survival condition of detected microorganisms
- removal by processing and disinfection
⇒ microorganisms level in water
- tap water intake



Targeting for Treatment and Their Water Quality

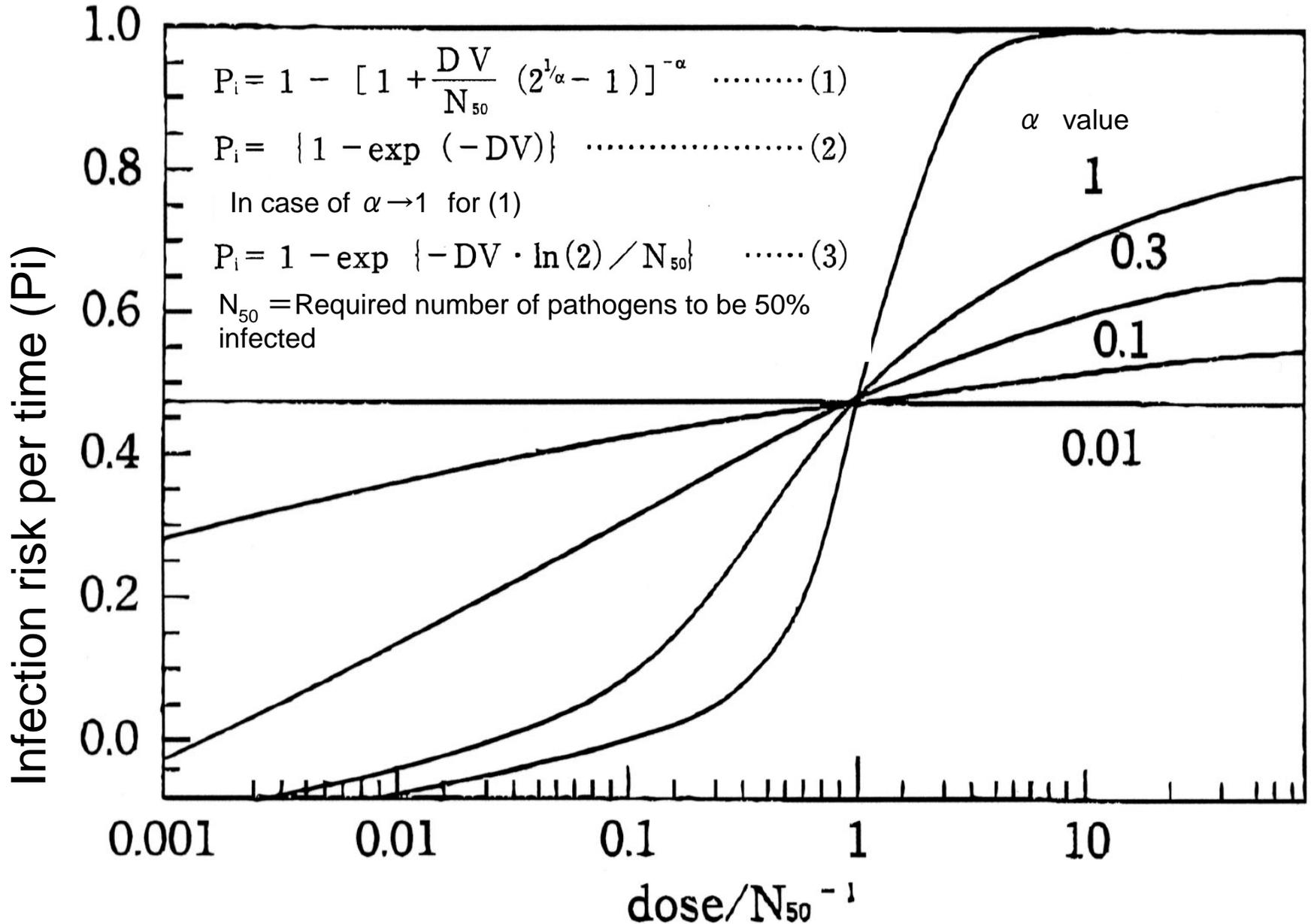




**Dose-response relationship of
cryptosporidium**

Source: DuPont H.L. et. Al., (1995) "The infectivity of *cryptosporidium parvum* in Healthy Volunteers, The Journal of New England Journal of Medicine, Volume 332:855-859

Poison-beta Model and Exponential Model of Dose-response Relationship



Minimum infective dose

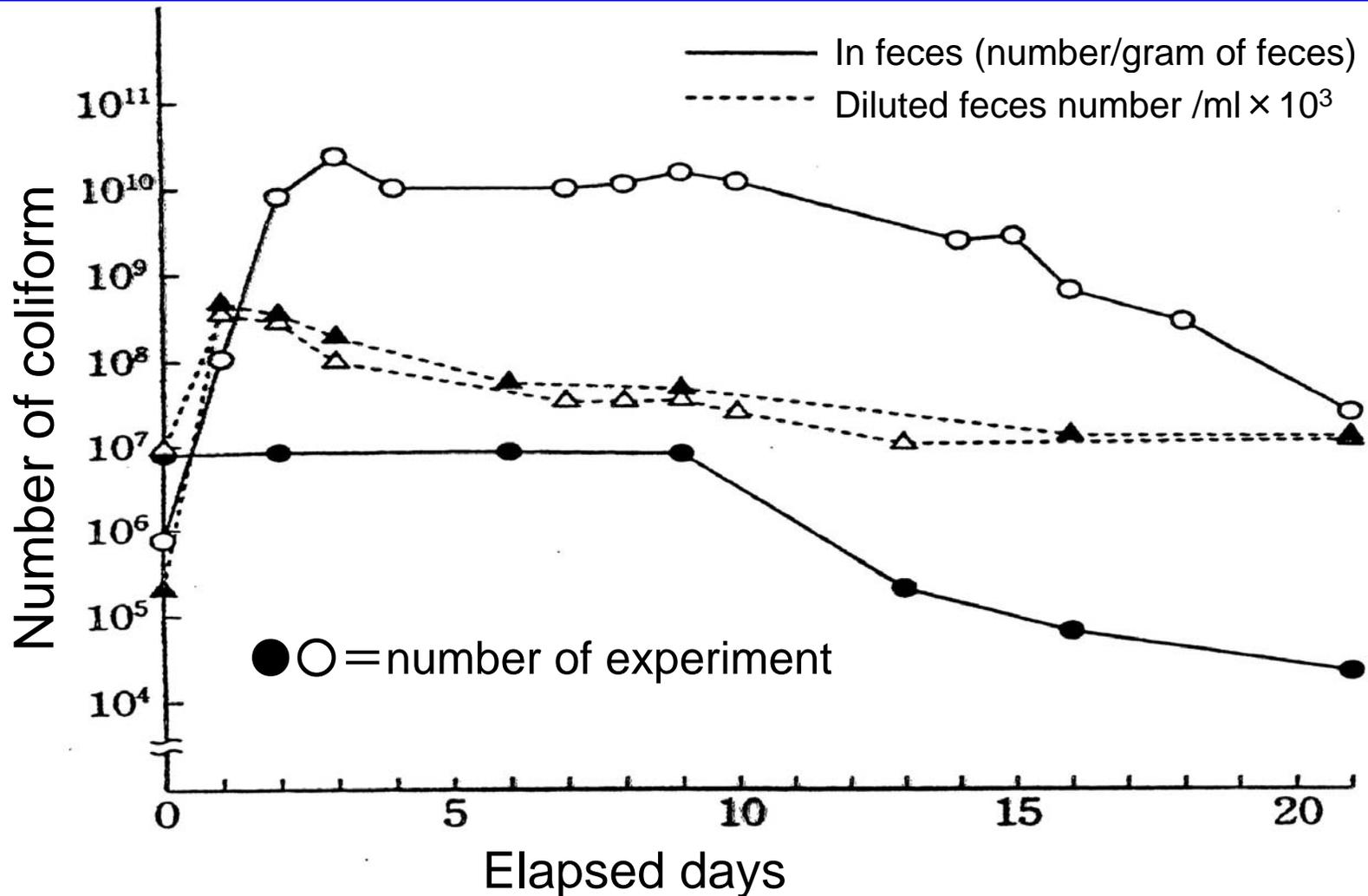
microorganisms	minimum infective dose
<i>Salmonella</i> spp.	10 ⁴ ~10 ⁷ CFU
<i>Salmonella typhi</i>	<10 ⁵ CFU
<i>Shigella</i> spp.	10 ¹ ~10 ² CFU
E.coli O157	10 ¹ ~10 ² CFU
Vibrio cholera	10 ³ CFU
Legionella pneumophila	>10CFU
Giardia.(G.lambliia)	10 ¹ ~10 ² cyst
Cryptosporidium spp(C.parvum)	10 ¹ oosyst
Entamoeba histolytica	10 ¹ cyst
roundworm (<i>Ascaris</i>)	1~10 ¹ egg
dracontiasis	1~10 ¹ egg
hepatitis A virus	1~10 ¹ PFU
rotavirus	1~10 ¹ PFU

CFU: colony forming units

PFU: plaque forming units

Variation per day of number of coliform count in feces and diluted feces

(Dispersed 0.05g faces in 1liter of dilute solution for microbiological examination)



National Primary Drinking Water Standards by EPA (U.S.A)

Items	Maximum allowance concentration or TT* (mg/L)
<i>Cryptosporidium</i>	TT (99% removal / inactivation)
<i>Giardia</i>	TT (99.9%removal / inactivation)
<i>Heterotrophic Bacteria</i>	TT (no more than 500 bacterial colonies per milliliter)
<i>Legionella</i>	TT (no limit, but EPA believes that if Giardia and viruses are removed/inactivated, <i>Legionella will also be controlled</i>)
Total Coliforms (including fecal coliform & E.coli)	5%
turbidity	TT (turbidity may never exceed 1 NTU, and must not exceed 0.3 NTU in 95% of daily samples in any month.)
Viruses (enteric)	TT (99.99%removal/inactivation)

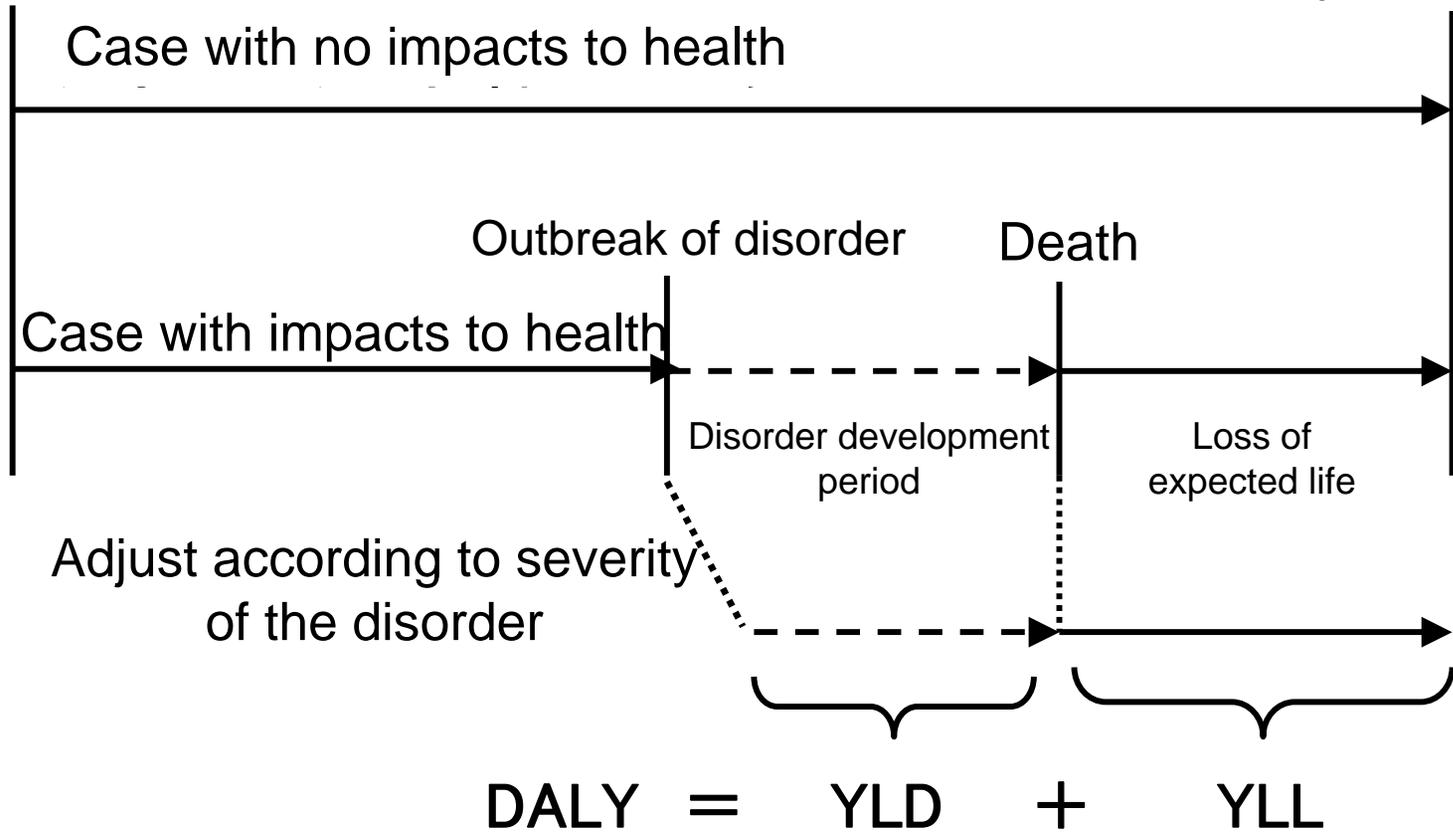
NOTE: TT (Treatment Technique) – A required process intended to reduce the level of a contaminant in drinking water. For microorganisms, EPA requires systems using surface water or ground water under the direct influence of surface water so that we have to achieve goals in brackets.

Indication of microorganism removal characteristic by unit process

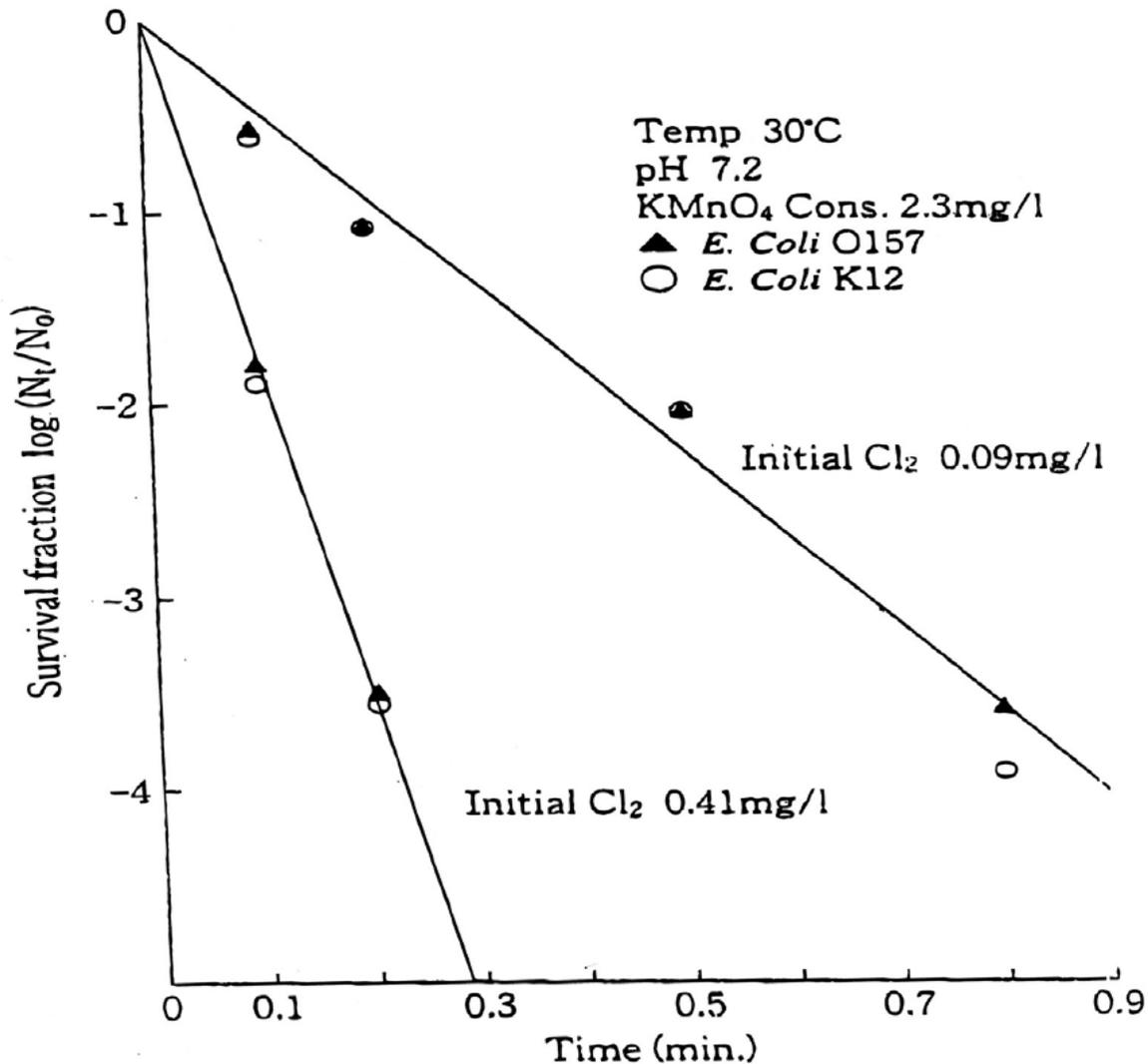
Targeted components	Removal unit process	Removal characteristic		
<Infusible components>	Coagulating sedimentation, Rapid filtration	1-3 log	(90-99.9% removal)	
	Pathogenic bacteria	Slow filtration	(99-99.99% removal)	
General bacteria	Oxidizing disinfectants	Ozone	.002 (pH6-7)	
Coliform bacteria		Chlorine dioxide	0.4-0.75 (pH8-9)	
		Chloramines	95-180 (pH8-9)	
		UV	–	
		Chlorine	0.05-0.34 (pH6-7)	
Pathogenic protozoa <i>Cryptosporidium</i> <i>Giardia</i>	Slow filtration	1.0-4.0 log	(90-99.99% removal)	
	Coagulating sedimentation	0.5-1.0 log	(70-90% removal)	
	Rapid filtration	1-2 log	(90-99% removal)	
	Membrane filtration (MF, UF)	5-7 log	(99.999-99.99999% removal)	
	Granule activated carbon	1-2 log	(90-99% removal)	
	Oxidizing disinfectants	Ozone	CT value to be required for 99% removal inactivation (mg. min/L)	5-10 (0.95)
		Chlorine dioxide		160 (15)
		Chloramines	Water temperature 10°C	14400 (30)
		UV	Cryptosporidium; out of brackets	–
		Chlorine	Giardia; in brackets	14400 (80)

0 years of age

life expectancy



Basic Concept of DALYs



Inactivation of *E. coli* O157 by chlorine at the turbidity of 5mg/l

Priority for the technicians are

public safety

health

welfare

U.S. National society of professional engineers ; article 1 of
Rules of Practice in the Code of Ethics for Engineers