

Waterborne Pathogens: Why is Their Profile Changing
Prof. Syed A. Sattar
A Webber Training Teleclass

WATERBORNE PATHOGENS: WHY IS THEIR PROFILE CHANGING?

SYED A. SATTAR, PhD

- **PROF. EMERITUS OF MICROBIOLOGY, FACULTY OF MED., UNIV. OF OTTAWA, OTTAWA, ON, CANADA**
- **ADJUNCT RES. PROF., CIVIL & ENVIRON. ENGINEERING, CARLETON UNIV., OTTAWA, ON, CANADA**
- **CHIEF SCIENTIFIC OFFICER, CREM CO INC., MISSISSAUGA, ON, CANADA**



Hosted by Prof. Jean-Yves Maillard
Cardiff University, Wales



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ACKNOWLEDGEMENTS

- **MR. PAUL WEBBER**
- **PROF. JEAN-YVES MAILLARD**
- **MY STAFF & STUDENTS**

CONFLICT OF INTEREST?

- **NONE TO DECLARE!**

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OBJECTIVES

- **DISCUSS MAJOR CLASSES OF WATERBORNE PATHOGENS**
 - **IMPACT OF DEMOGRAPHY & CLIMATE ON PATHOGEN SPREAD BY WATER**
 - **FRESH WATER SHORTAGES & ITS IMPACT ON HYGIENE**
 - **WATER-BASED BIOFILMS AS SOURCES OF OPPORTUNISTIC PATHOGENS**
 - **EXAMPLES OF SUCCESSES IN PREVENTING WATERBORNE SPREAD**
 - **FUTURE PROSPECTS**
- **1970 ARBITRARILY CHOSEN AS THE STARTING POINT TO ILLUSTRATE THE CHANGES**
- **I HAVE EXPERIENCE IN WORKING WITH NEARLY ALL PATHOGENS TO BE DISCUSSED.**

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WHAT IS THE ISSUE?

- **WATER – THE ULTIMATE RECEPTACLE FOR TERRESTRIAL MICROBES**
- **A BEWILDERING VARIETY OF INDIGENOUS AQUATIC MICROBES**
- **A COMMON VEHICLE FOR MANY TYPES OF PATHOGENS**
- **CHANGING TECHNOLOGY PROVIDING NEW NICHEs FOR MICROBES**
- **SELECTIVE PRESSURES FOR MICROBIAL ADAPTATION**
- **‘MODERNIZATION’ MAKING US ‘SOFTER’ & MORE VULNERABLE**

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THE MICROBIAL WORLD IS INCREDIBLY VAST!

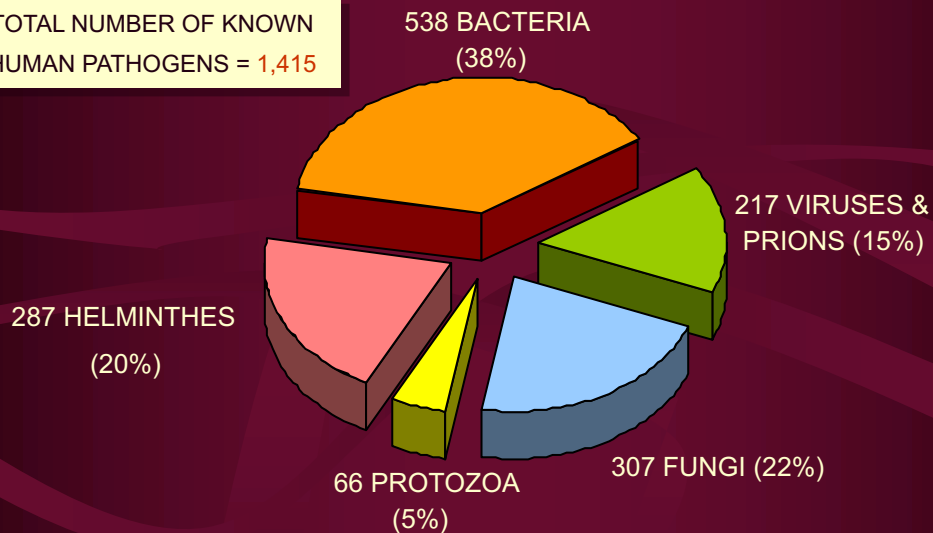
- **ESTIMATED NUMBER OF SPECIES:**
 - **BACTERIA - 5-10 MILLION; PROTOZOA - 65,000; FUNGI - 70,000-1,500,000**
 - **VIRUSES (MOSTLY BACTERIOPHAGES)**
- **EACH NEWBORN BECOMES A MICROBIAL 'GALAXY'**
- **MORE MICROBES THAN THE NUMBER OF STARS!**

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KNOWN HUMAN PATHOGENS (TAYLOR ET AL. 2001)

TOTAL NUMBER OF KNOWN
HUMAN PATHOGENS = 1,415



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COMMON TERMS DEFINED

- **PATHOGEN:** FRANK & OPPORTUNISTIC (PERIKAIROTS: ENVIRONMENT-BASED)
- **ZOONOTIC PATHOGENS:** ANIMAL PATHOGENS THAT CAN INFECT HUMANS AS WELL
- **PREMISE PLUMBING:** PART OF POTABLE WATER SUPPLY SYSTEM INSIDE A BUILDING
- **BIOFILM:** A SLIMY LAYER OF MICROBES ON SURFACES SUBMERGED IN LIQUIDS
- **MICROBIOME:** TOTALITY OF MICROBES IN THE BODY OR AT AN ENVIRONMENT SITE
- **MICROBIOTA:** COMBINES 'MICROFLORA' & 'MICROFAUNA'

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SPREAD OF PATHOGENS BY WATER



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RELATIONSHIPS BETWEEN WATER & PATHOGENS

- **WATER-BORNE:** INGESTION/INHALATION OF CONTAMINATED WATER (CHOLERA, TYPHOID FEVER, HEPATITIS A, LEGIONNAIRES' DISEASE)
- **WATER-WASHED (WATER HYGIENE):** DUE TO LACK OF SUFFICIENT WATER FOR PERSONAL HYGIENE (TYPHUS CARRIED BY LICE; TRACHOMA)
- **WATER-BASED:** CAUSED BY EXPOSURE TO PARASITES FOUND IN INTERMEDIATE HOSTS LIVING IN WATER (SCHISTOSOMIASIS)
- **WATER-RELATED:** DUE TO INSECT VECTORS WHICH BREED IN WATER (MALARIA)

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WHICH PATHOGENS TO FOCUS ON?

- **THE FOCUS HERE WILL BE ON:**
 - ENVIRONMENTAL MYCOBACTERIA
 - ENTERIC PROTOZOA (CRYPTOSPORIDA)
 - ENTERIC VIRUSES (NOROVIRUS)
 - VEGETATIVE BACTERIA (*LEGIONELLA PNEUMOPHILA*)

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ENVIRONMENTAL MYCOBACTERIA

- OTHER THAN THOSE CAUSING TUBERCULOSIS & LEPROSY
- MANY NEWLY DISCOVERED SPECIES; TYPICAL PERIKAIROTS
- IN BIOFILMS IN HOT & COLD WATER STORAGE SYSTEMS
- HIGHER RESISTANCE TO WATER DISINFECTING CHEMICALS
- SEVERE SKIN INFECTIONS FROM FOOTBATHS IN PEDICURE
- SHOWER HEADS & AEROSOLIZED MYCOBACTERIA

ENVIRONMENTAL MYCOBACTERIA



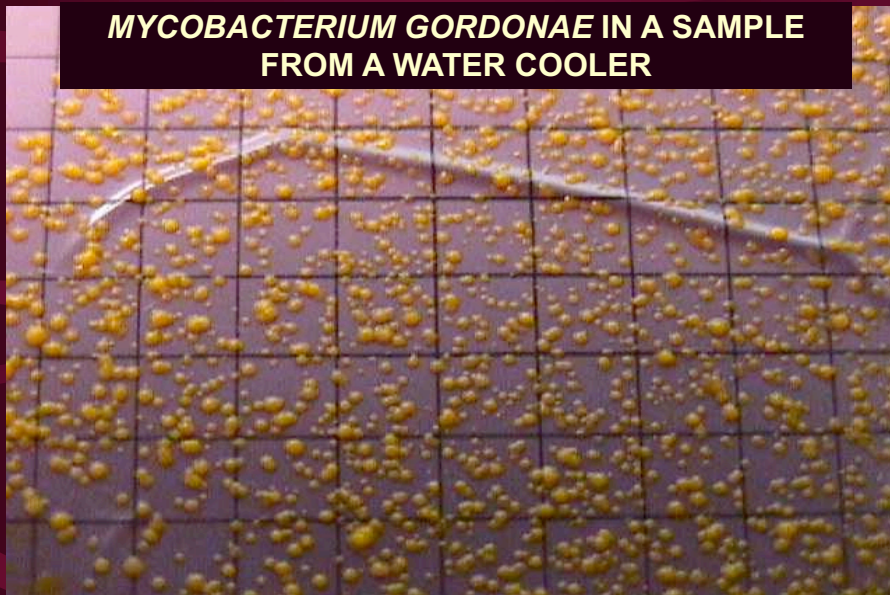
SKIN LESIONS FROM MYCOBACTERIA IN A FOOTBATH (NEJM 2002)



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MYCOBACTERIUM GORDONAE IN A SAMPLE FROM A WATER COOLER



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ENTERIC PROTOZOA

- **CRYPTOSPORIDIUM, TOXOPLASMA & GIARDIA (ZOOSES)**
- **STABLE & RESISTANT TO DISINFECTANTS (E.G., CHLORINE)**
- **SPREAD VIA POTABLE & RECREATIONAL WATERS**
- **TOXOPLASMOSIS & LONG-TERM SEQUELAE?**

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WATERBORNE SPREAD OF CRYPTOSPORIDIUM

- **AMONG THE MAJOR EMERGING PATHOGENS**
- **SEVERAL LARGE WATERBORNE OUTBREAKS ALREADY RECORDED**
 - **LARGEST CRYPTO OUTBREAK IN MILWAUKEE, WI (MACKENZIE ET AL., 1993)**
- **PARTICULARLY SERIOUS FOR THE IMMUNOCOMPROMISED & ELDERLY**
- **OOCYSTS HIGHLY RESISTANT TO CHEMICALS COMMONLY USED FOR DISINFECTION OF WATER; UV IRRADIATION MAY HELP**
- **OOCYSTS ALSO SURVIVE IN WATER FOR AT LEAST SEVERAL DAYS**

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WATERBORNE OUTBREAK OF TOXOPLASMOSIS
(BOWIE ET AL., 1997)

- **LARGEST SUCH OUTBREAK RECORDED IN VICTORIA, BRITISH COLUMBIA, IN 1995**
- **SURFACE WATER WAS UNFILTERED BUT CHLORAMINATED**
- **AT LEAST 110 CASES, INCLUDING 12 NEWBORNS, WERE DETECTED**
- **THE EXACT SOURCE OF THE PATHOGEN REMAINS UNKNOWN, BUT WILD CATS & FIELD MICE ARE SUSPECTED**

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ENTERIC VIRUSES

- **MANY TYPES CAN BE WATERBORNE**
- **IMPORTANCE ON RISE WITH BETTER CONTROL OF BACTERIA**
- **CURRENT INDICATORS OF FECAL POLLUTION INADEQUATE**
- **NO CHEMOTHERAPY & LIMITED VACCINES**
- **NOROVIRUS (NV) & HEPATITIS E VIRUS**

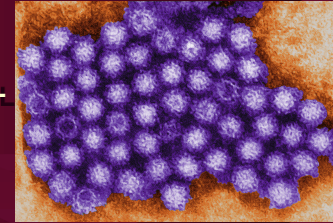
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NOROVIRUS (NV)

- **FOUND IN EARLY 1970s; ~27 NM IN DIAM.; HIGHLY PROLIFIC!**
- **GLOBALLY, MOST COMMON CAUSE OF ACUTE NON-BACTERIAL GASTROENTERITIS; INCUBATION PERIOD ~12 HOURS!**
- **>200,000 FATALITIES/YEAR FROM DEHYDRATION**
 - **NO CLEAR TARGET AGE OR SEASONALITY; REINFECTIONS**
 - **HIGHER RESISTANCE TO DISINFECTANTS THAN ENTERIC BACTERIA**
 - **VIRUS IN FECES & IN VOMITUS**
 - **NO VACCINES OR SPECIFIC DRUGS AVAILABLE**
 - **NV REMINISCENT OF INFLUENZAVIRUSES IN GENETIC CHANGES**



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HEPATITIS E VIRUS

- **A RELATIVELY NEWLY RECOGNIZED WATERBORNE PATHOGEN**
- **NOW CLASSIFIED AS A CALICIVIRUS**
- **CAUSES OUTBREAKS INVOLVING THOUSANDS**
- **FORMERLY CALLED ENTERIC NONA-NON-B HEPATITIS VIRUS**
- **PARTICULARLY DANGEROUS FOR PREGNANT WOMEN**
- **CERTAIN CASES MAY BE ZONOTIC IN ORIGIN**
- **DIFFICULT TO CULTURE; NOT MUCH KNOWN ABOUT ITS SURVIVAL & DISINFECTION**

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LEGIONELLA PNEUMOPHILA & OTHER SPECIES

- DISCOVERED ONLY IN 1976 BY DR. JOE McDADE (CDC)
- INHALATION & A POTENTIALLY FATAL PNEUMONIA
- HABITAT IS WATER-BASED BIOFILMS (PREMISE PLUMBING)
- A PERIKAIROT (CLOSE LINKS WITH FREE-LIVING PROTOZOA)
- RARE SECONDARY CASES!
- WATER DISINFECTION A MAJOR CHALLENGE!
- WE FOUND THEM IN GROUNDWATERS (2000)

PICTURE OF LEGIONELLA



WITH DR. JOE McDADE (2005)

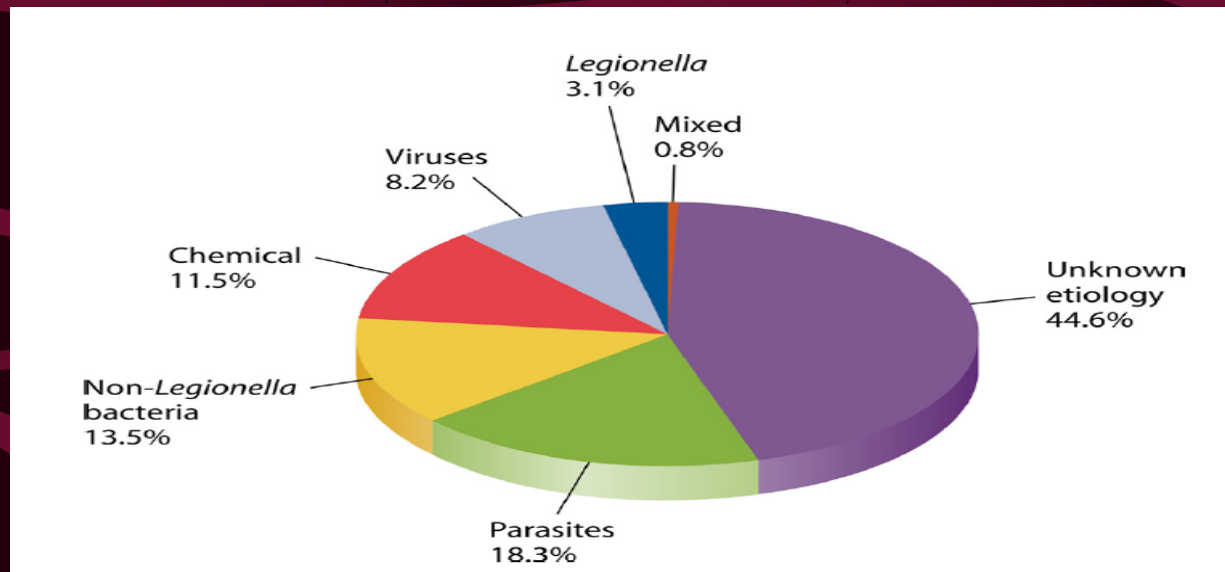


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DRINKING WATERBORNE OUTBREAKS IN THE U.S. (1971-2006)

(CRAUN ET AL, CLIN. MICROBIOL. REV. 2010)



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THE CHANGING FOREGROUND

CHOLERA
VIRAL DIARRHEAS
TOXOPLASMA
DYSENTARY
CRYPTOSPORIDIUM

TYPHOID
ENVIRON. MICROBACTERIA
HEPATITIS A
HEPATITIS E

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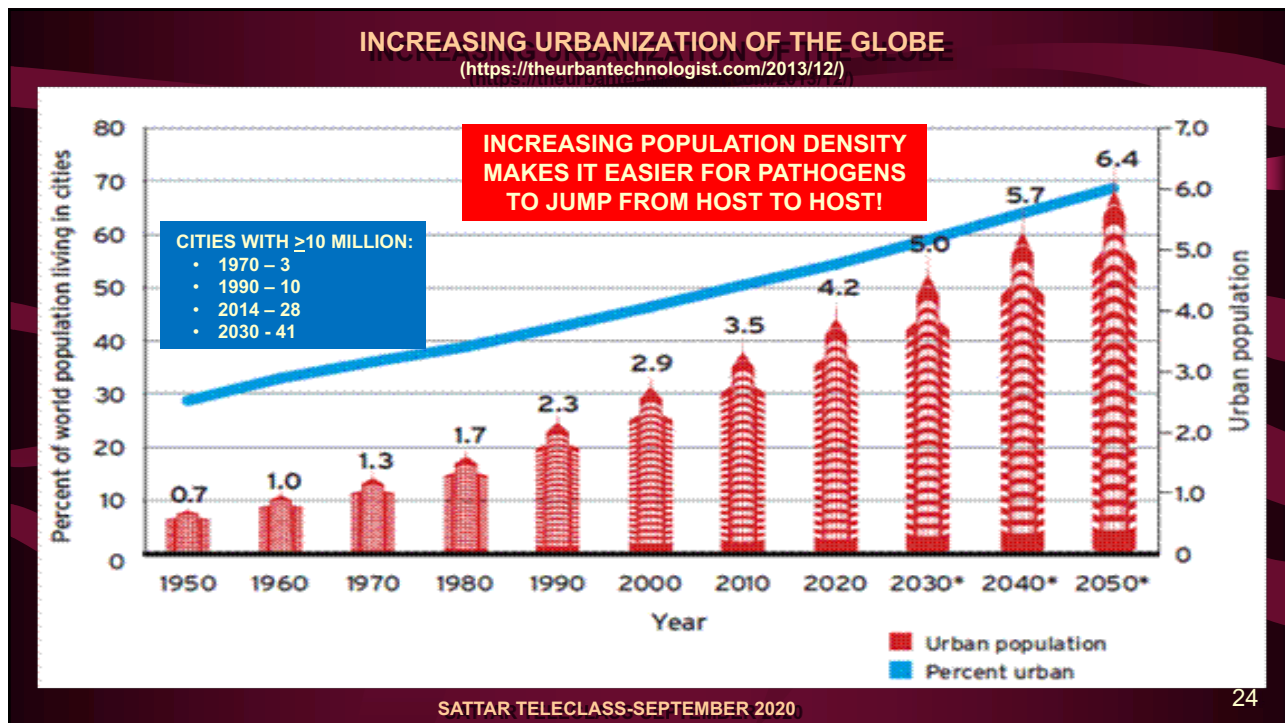
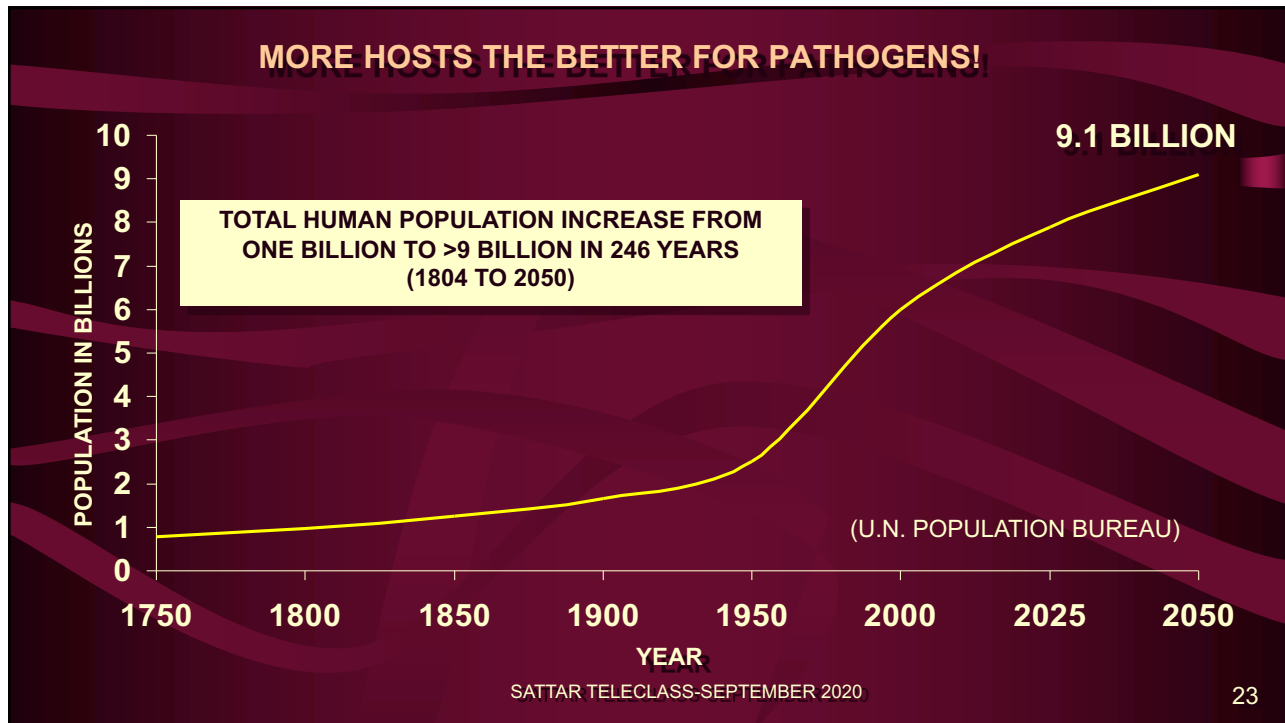
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**WHY IS THE PROFILE OF WATERBORNE
PATHOGENS CHANGING?**

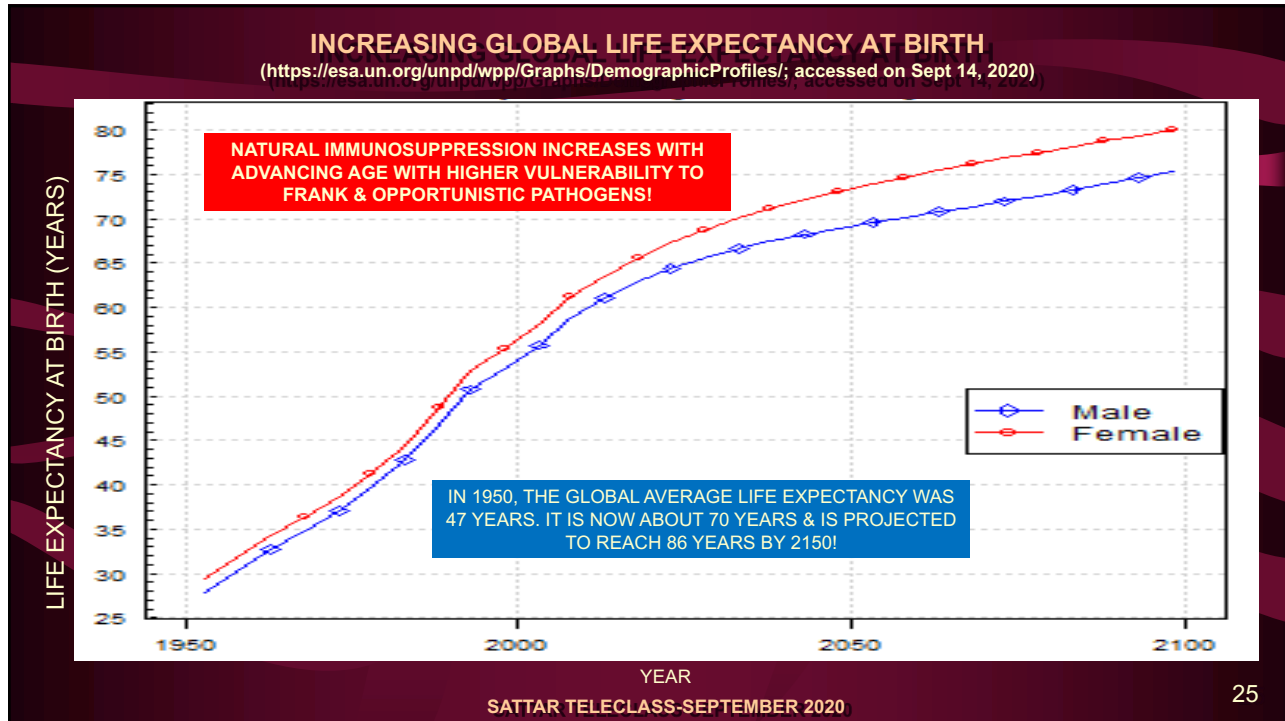
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FRESH WATER SHORTAGES
 (GUJRAT, INDIA; TIME MAGAZINE, DEC. 2003)

INCREASING DEMAND
 (CAPE TOWN, SOUTH AFRICA; JULY 20018)

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MICROBIAL MUTATIONS & ADAPTATIONS

- **DRUG RESISTANCE (POST-ANTIBIOTIC ERA!)**
- **COMBINED IMPACT OF CHEMICALS & PATHOGENS ('CHEMBIOACTION')!**
- **PREMISE PLUMBING**
- **SINKS AS SOURCES OF PATHOGENS**
- **MULTI-ETIOLOGIC INFECTIONS**

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IS THERE ANY GOOD NEWS?

- **POLIOMYELITIS AT THE VERGE OF ERADICATION!!**
- **~350,000 CASES IN 1988 AT START OF GLOBAL VACCINATION**
- **FIRST WATERBORNE DISEASE TO BE ERADICATED!**
- **GUINEA WORM DISEASE (DRACUNCULIASIS); FIRST WATER-BASED DISEASE TO BE ERADICATED; NO VACCINES OR DRUGS!**
- **IN 1986, 3.5 10⁶ CASES IN 20 COUNTRIES; NOW REACHING ZERO!**
- **INGESTION OF WORM-INFECTED WATER FLEAS (CYCLOPS)**
- **COMMUNITY EDUCATION & COARSE WATER FILTRATION**
- **JIMMY CARTER'S CENTER PLAYING A KEY ROLE**



SABIN VACCINATION (WHO)



<http://www.traveljournals.net/pictures/147271.html>

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CHALLENGES?

- **CLIMATE CHANGE & INCREASING WATER POLLUTION**
- **POPULATION INCREASE, MOVEMENTS & CHANGING DEMOGRAPHICS**
- **INCREASING POLLUTION & FRESH WATER SHORTAGES**
- **MICROBIAL ADAPTATIONS & CONTINUING EMERGENCE**
- **DRUG RESISTANCE; LIMITED VACCINES**

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OPPORTUNITIES?

- **REINVENTION OF THE TOILET**
- **BETTER & MORE SUSTAINABLE WATER TREATMENT**
- **WATER PROTECTION DURING DISTRIBUTION & DELIVERY**
 - **TAP WATER MAY NOT BE THE SAME AS POTABLE WATER!**
- **WATER RECYCLING & CONSERVATION**
- **BETTER & MORE WIDE-SPREAD IMMUNIZATION**
- **POPULATION CONTROL AN URGENT NEED!**

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"If there is magic on this planet, it is contained in water."

- Loren Eiseley


THANK YOU!

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www.webbertraining.com/schedulep1.php	
October 15, 2020	<p><i>(FREE Teleclass)</i> THE VALUE OF CERTIFICATION - "WHAT'S IN IT FOR ME?" Speaker: Sandra Callery, Certification Board of Infection Control</p>
October 20, 2020	<p><i>(European Teleclass)</i> CAN WE HALVE GRAM-NEGATIVE BLOODSTREAM INFECTIONS? A DEBATE Speaker: Prof. Jon Otter, Imperial College Healthcare NHS Trust, and Martin Kiernan, University of West London</p>
October 20, 2020	<p><i>(FREE ... WHO Teleclass - Americas)</i> CLEAN HOSPITALS: THE NEXT FRONTIER IN INFECTION PREVENTION Speaker: Prof. Didier Pittet, World Health Organization, Prof. Pierre Parneix, CPIAS Nouvelle Aquitaine, France</p> <p>Sponsored by the WHO Infection Prevention & Control Global Unit</p> 

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