THE AIRBORNE SPREAD OF INFECTIOUS AGENTS: SURVIVAL AND DECONTAMINATION OF HUMAN PATHOGENS IN INDOOR AIR

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OBJECTIVES

- 'AEROBIOLOGY' & POTENTIAL OF PATHOGEN SPREAD BY AIR
- CHALLENGES OF STUDYING PATHOGENS IN AIR
- OBSTACLES IN LINKING AIR TO ACQUISITION OF INFECTIONS
- SET-UP TO STUDY AIRBORNE SURVIVAL & REMOVAL/INACTIVATION
- TESTING OF AIR DECONTAMINATION DEVICES
- FUTURE DIRECTIONS

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AEROBIOLOGY & INDOOR AIR QUALITY

- 'AEROBIOLOGY' – STUDY OF LIVING ORGANISMS & THEIR PARTS IN AIR
  - INCLUDES MICROBIAL QUALITY OF INDOOR AIR
- INDOOR AIR IS AN ENVIRONMENTAL EQUALIZER!
- EXPOSURE TO 'INDOOR AIR' WITH CAVE-DWELLING ~200,000 YEARS AGO
- DOMESTICATED ANIMALS (CATTLE, DOGS & PIGS) FACILITATED RISE OF ZOONOSES INCLUDING AIRBORNE ONES (E.G., MEASLES)
- WE SPEND MORE TIME INDOORS & BREATHE ~11,000 L OF AIR/DAY
- WE ALL LEAVE OUR OWN PERSONAL MICROBIAL 'FOOT-PRINT' INDOORS
- BUT, LACK OF STANDARDIZED WAYS TO STUDY MICROBIAL AIR QUALITY
- ALSO, DEARTH OF MEANS TO ASSESS INDOOR AIR DECONTAMINATION

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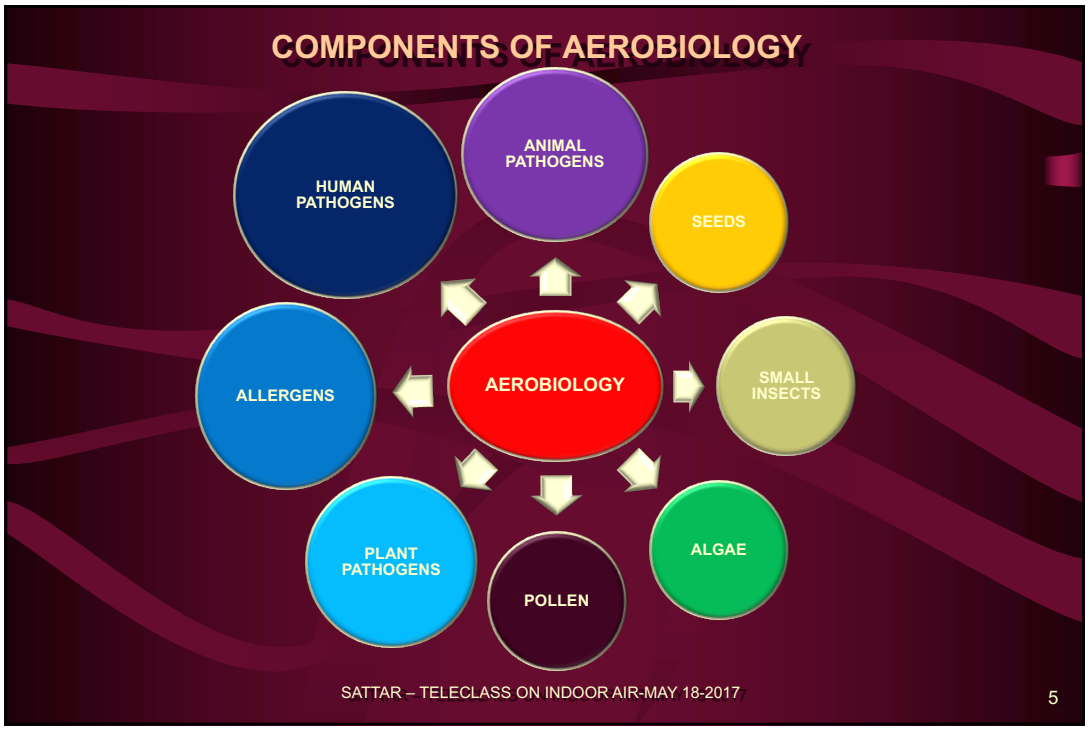
COMPONENTS OF AEROBIOLOGY
HUMAN PATHOGENS
ANIMAL PATHOGENS
SEEDS
ALLERGENS
AEROBIOLOGY
SMALL INSECTS
PLANT PATHOGENS
POLLEN
ALGAE
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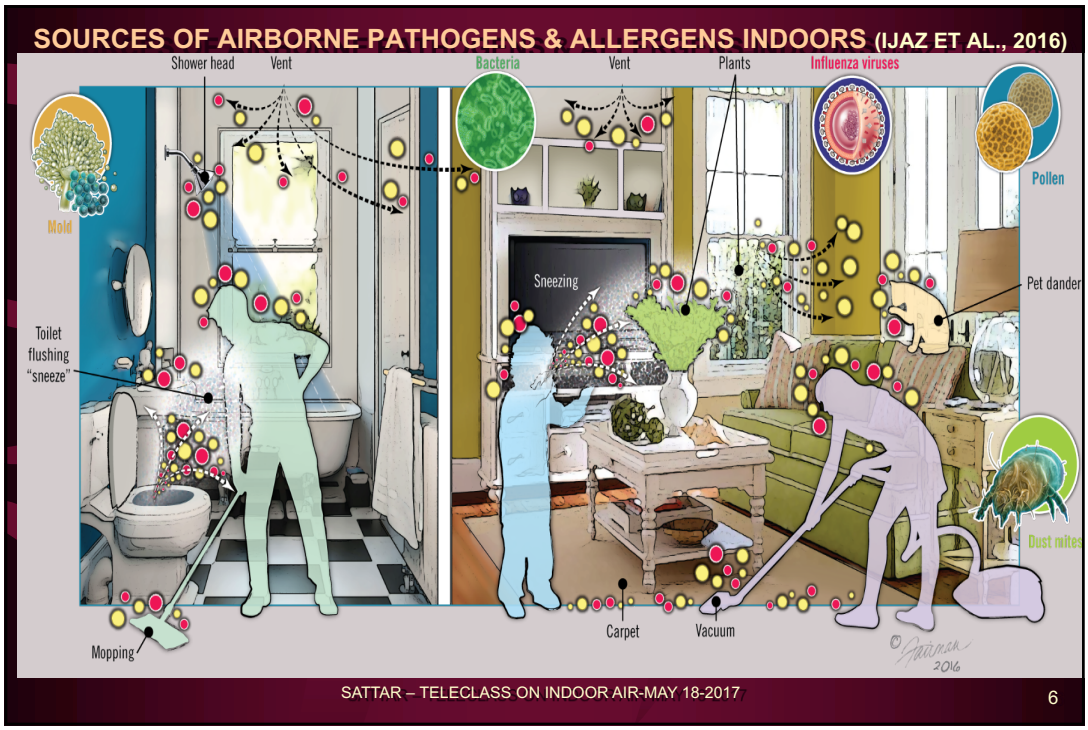
5


SOURCES OF AIRBORNE PATHOGENS & ALLERGENS INDOORS (IJAZ ET AL., 2016)
Shower head
Vent
Bacteria
Vent
Plants
Influenza viruses
Pollen
Mold
Sneezing
Pet dander
Toilet flushing "sneeze"
Dust mites
Carpet
Vacuum
Mopping
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6

FACTORS AFFECTING INDOOR AIR QUALITY (SATTAR ET AL., 2016)

INDOOR AIR QUALITY

CHEMICAL	• GASES (CO, CO_2, O_3, NO) • VOLATILE ORGANIC CHEMICALS (PERFUMES, CLEANERS, DISINFECTANTS, PAINTS, PESTICIDES, OFF-GASES) • ASBESTOS
BIOLOGICAL	• HUMANS • PET ANIMALS (CATS, DOGS, BIRDS) • VERMIN (MICE, COCKROACHES) • HOUSE PLANTS • MICROBES (FREE-FLOATING, BIOFILM-BASED, MYCOTOXINS) • POLLEN & ALLERGENS (ANIMAL DANDER, DUST MITES)
PHYSICAL	• RADON • PARTICULATES (CIGARETTE SMOKE, PRINTERS/COPIERS) • SMOKE FROM COOKING & HEATING FUELS • DUST
ENVIRONMENTAL	• OUTDOORS (WEATHER & CLIMATE) • HVAC SYSTEM • LIFE-STYLES (AIR TEMP., RH, OCCUPANT TYPE & DENSITY)

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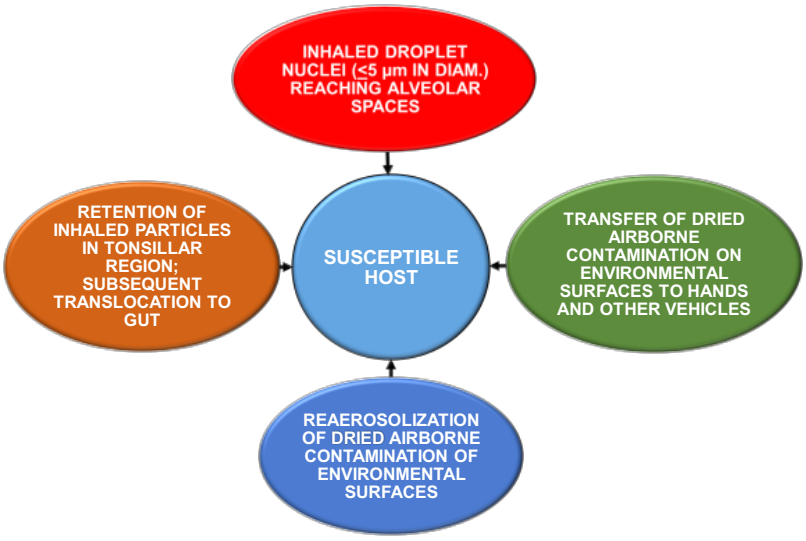
AIRBORNE SPREAD OF HUMAN PATHOGENS (SATTAR ET AL., 2015)



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CHALLENGES IN STUDYING AEROBIOLOGY OF PATHOGENS (SATTAR ET AL., 2016)

FACTOR(S)	REFINEMENTS REQUIRED
EXPERIMENTAL SET-UP	SPACE, BIOSAFETY, FIELD-RELEVANCE, EASE OF CONTROL & MONITORING OF TEST PARAMETERS
CHALLENGE-MICROBE SELECTION	REPRESENTATIVE OF AIRBORNE PATHOGENS, EASE OF CULTURE & RECOVERY, STABILITY DURING AEROSOLIZATION & IN AIR, PREP, CONC., PROTECTION
SUSPENSION TO BE NEBULIZED	SAFE & STANDARDIZED SOIL LOAD REPRESENTING BODY FLUIDS, ANTI-FOAM, PHYSICAL TRACER (IF NEEDED)
NEBULIZATION & PARTICLE SIZE DISTRIBUTION	SAFETY FOR MICROBE, GENERATION OF AEROSOLS/DROPLET NUCLEI, GRANULOMETRICS, UNIFORM DISTRIBUTION
AGING & EXPOSURE CONDITIONS	BETTER CONTROL OF AIR TEMP. & RH; TESTING AT RH BELOW 20%; HARMONIZED FOR MAJOR MICROBIAL TYPES
AEROSOL COLLECTION & SIZING	PROTECTION OF VIABILITY, OPTIMAL GROWTH CONDITIONS, NEUTRALIZATION OF ACTIVES,
ASSESSING DECONTAMINATION	PROPER CONTROLS, REALISTIC EFFICACY CRITERIA FOR METHOD/DEVICE AIR-DECONTAMINATION TECHNOLOGIES, NUMBER OF REPEATS
INTERPRETATION OF DATA	STATISTICAL ANALYSES, FIELD RELEVANCE & REGULATORY REQUIREMENTS

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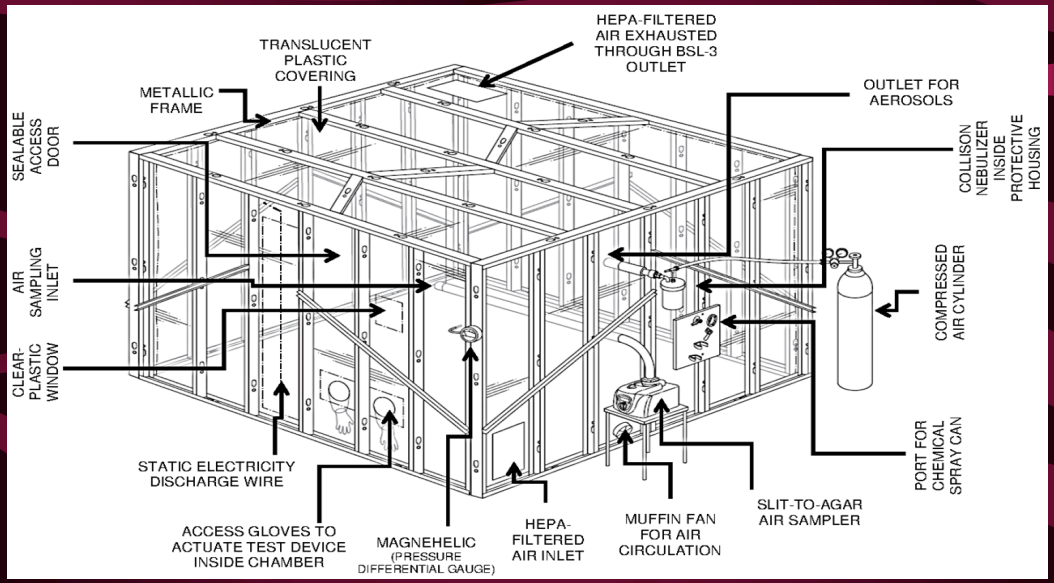
AEROBIOLOGY CHAMBER TO STUDY MICROBIAL SURVIVAL & DECONTAMINATION IN INDOOR AIR (IJAZ ET AL., 2016)



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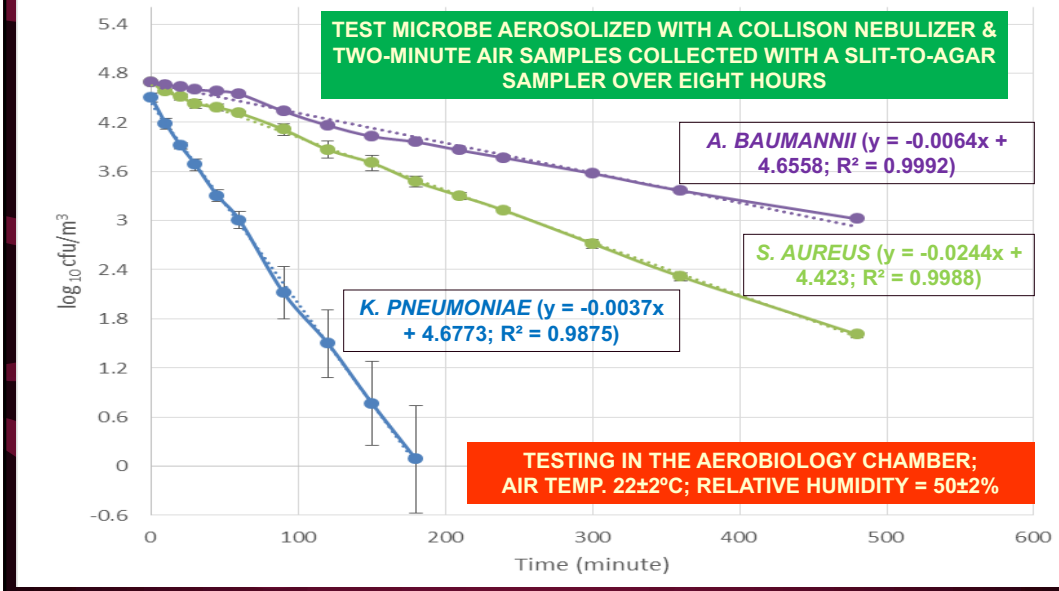
SURVIVAL OF BACTERIAL PATHOGENS IN INDOOR AIR (IJAZ ET AL., 2016)



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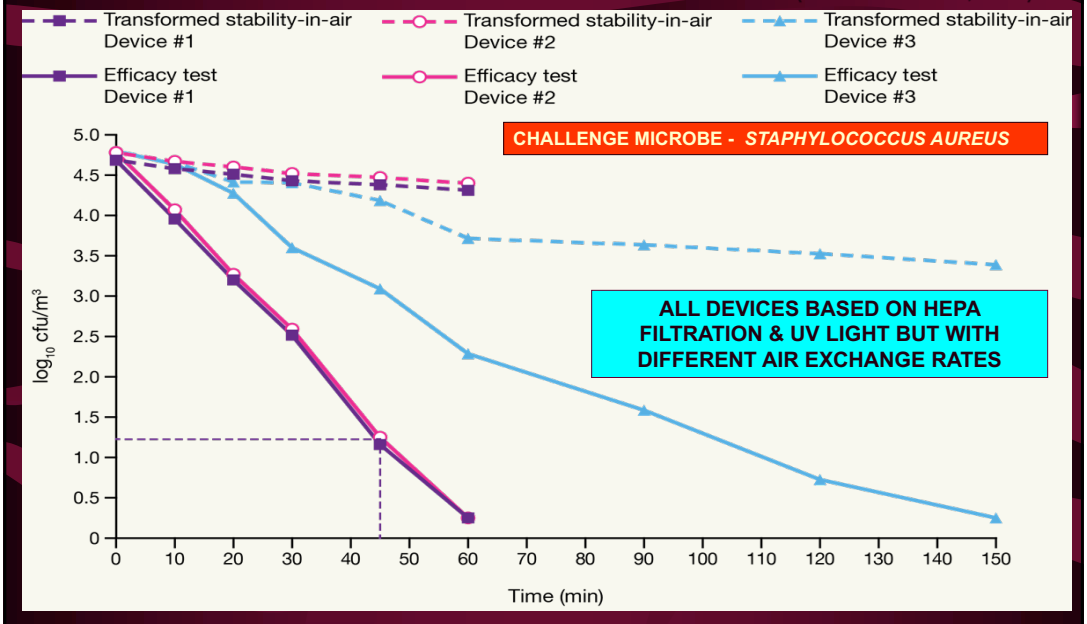
TESTING PATHOGEN SURVIVAL & DECONTAMINATION (ZARGAR ET AL., 2016)



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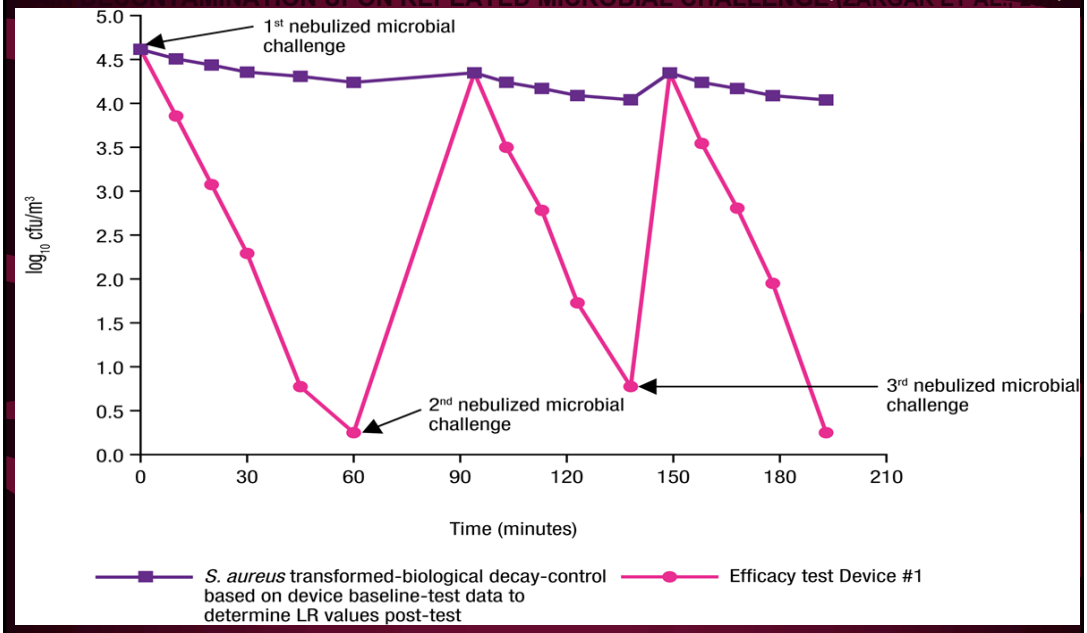
AIR DECONTAMINATION UPON REPEATED MICROBIAL CHALLENGE (ZARGAR ET AL., 2016)



DOES IN-CAR AIR POSE A RISK TO HUMAN HEALTH? (SATTAR ET AL., 2016)

- WORLD TOTAL OF PASSENGER CARS TO INCREASE FROM CURRENT ONE BILLION TO >2.5 BILLION BY 2050; FAMILY CARS REPRESENT ~74% OF WORLD'S YEARLY OUTPUT OF MOTORIZED VEHICLES
- ~80% OF N. AMERICAN COMMUTERS USE THEIR OWN CAR WITH ANOTHER 5.6% TRAVELLING AS PASSENGERS
- WITH A LIFE-EXPECTANCY OF ~79 YEARS, THE AVERAGE N. AMERICAN SPENDS 4.3 YEARS DRIVING A CAR!
- THIS EQUATES TO DRIVING ~100 MINUTES/DAY WITH A LIFE-TIME DRIVING DISTANCE OF NEARLY 1.3 MILLION KM INSIDE THE CONFINED & OFTEN SHARED SPACE OF THE CAR
- EXPOSURE TO A MIX OF POTENTIALLY HARMFUL POLLUTANTS

RISK FACTORS FOR IN-CAR SPREAD OF PATHOGENS (SATTAR ET AL., 2016)

FACTORS	IMPACT
LENGTH OF COMMUTE	RISK OF EXPOSURE TO HARMFUL AIRBORNE CONTAMINANTS INCREASES IN DIRECT PROPORTION TO LENGTH & FREQUENCY OF COMMUTE
CAR-POOLING	RISK OF EXPOSURE TO HARMFUL AIRBORNE CONTAMINANTS INCREASES IN DIRECT PROPORTION TO THE NUMBER OF OCCUPANTS
IMMUNOSUPPRESSION	INCREASING PROPORTION OF THE IMMUNOSUPPRESSED IN SOCIETY
POTENTIAL HOSTS	WIDE VARIATION IN THE AGE & GENERAL HEALTH STATUS OF OCCUPANTS
STRESS OF DRIVING	STRESS OF DRIVING MAY LOWER BODY'S GENERAL RESISTANCE MECHANISMS
RESPIRABLE PARTICLES (E.G., PM 2.5)	INHALATION OF SUCH PARTICULATES MAY ENHANCE EXPOSURE & SUSCEPTIBILITY TO INFECTIOUS AGENTS
VOLATILE ORGANIC CHEMICALS (VOCs)	EXPOSURE TO VOCs MAY OCCUR SIMULTANEOUSLY WITH INHALATION OF RESPIRABLE PARTICULATES & MICROBES WITH POTENTIAL NEGATIVE ADDITIVE EFFECTS ON HEALTH

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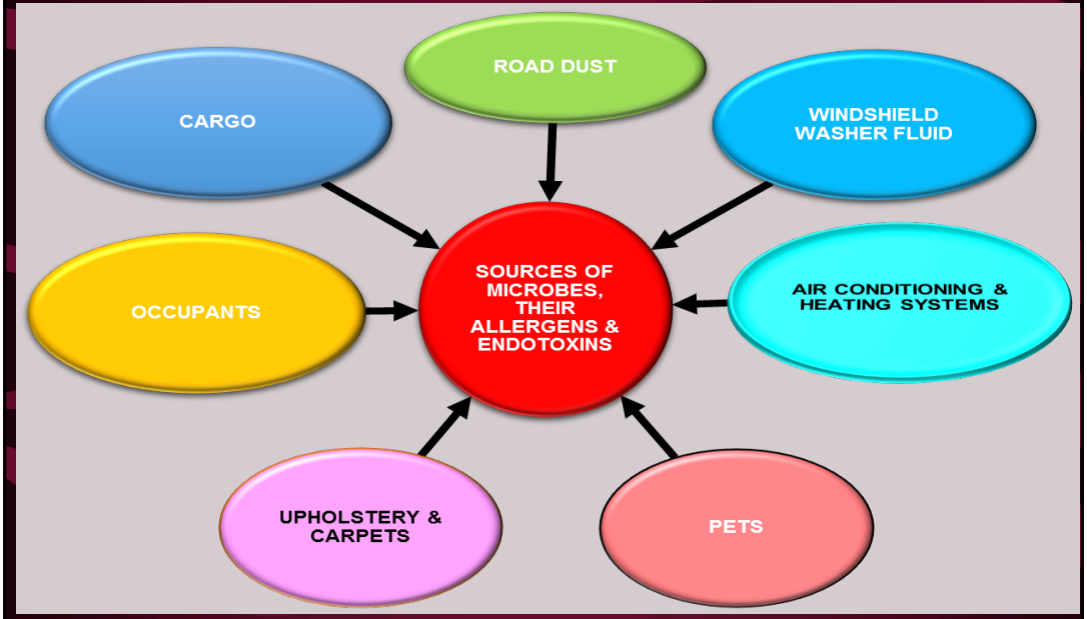
SOURCES OF MICROBES, ALLERGENS & ENDOTOXINS IN IN-CAR AIR (SATTAR ET AL, 2016)



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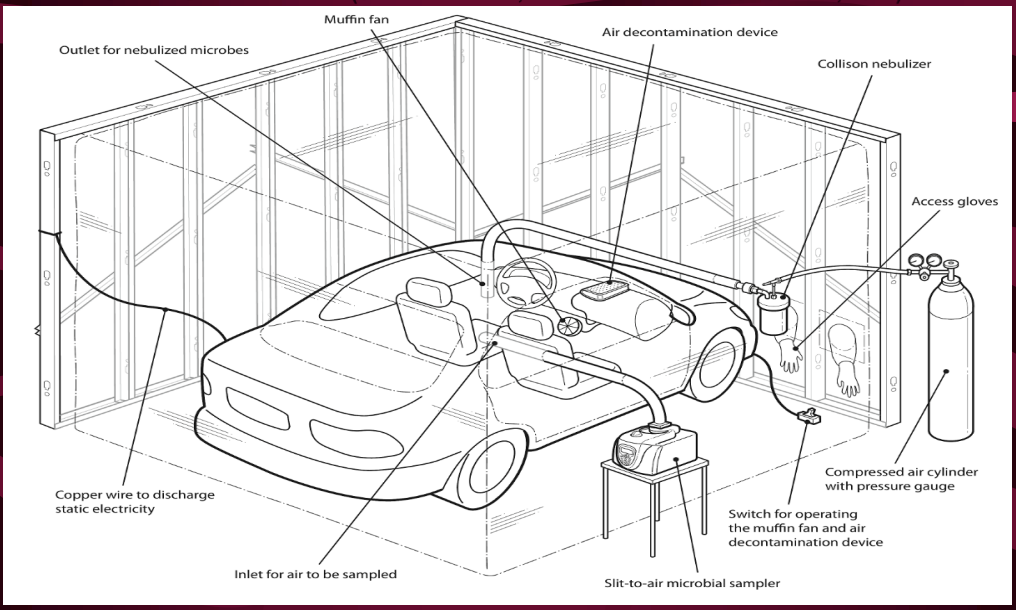
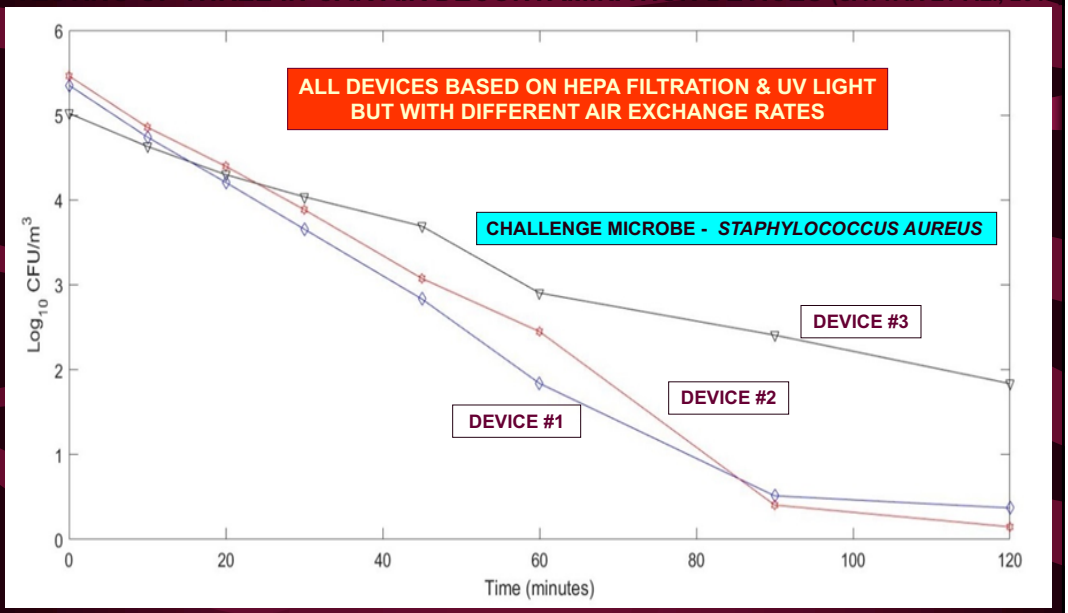
CAR CHAMBER (SATTAR ET AL., APPL. ENVIRON. MICROBIOL., 2017)



TESTING OF THREE IN-CAR AIR DECONTAMINATION DEVICES (SATTAR ET AL., 2017)



SUMMARY OF THE MAIN FINDINGS

- PATHOGENS INDOORS COME FROM HUMANS, PETS, PLANTS, PLUMBING, TOILETS, SHOWERHEAD, HEATING/COOLING/VENTILATION SYSTEMS
- VACUUMING/MOPPING/DUSTING RESUSPEND SETTLED DUST
- *A. BAUMANNII* MORE STABLE THAN *K. PNEUMONIAE* IN AIR; POTENTIALLY A BETTER SURROGATE FOR GRAM-NEGATIVES
- DEVICES #1 & #2 REDUCED TEST MICROBES BY ≥3-LOG$_{10}$ IN ~45 MINUTES
- DEVICE #1 REMAINED EFFECTIVE AFTER 3 MICROBIAL CHALLENGES
- TESTING OF PATHOGEN SURVIVAL & DECONTAMINATION IN IN-CAR AIR
- AEROBIOLOGY PROTOCOL APPROVED BY U.S. EPA!
- TREATING INDOOR AIR TO PREVENT ENVIRON. SURFACE CONTAMINATION

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FUTURE DIRECTIONS FOR R&D

- STUDY OF AEROBIOLOGY OF HUMAN PATHOGENS IS IN ITS INFANCY!
- STANDARDIZED TEST FACILITIES, PROTOCOLS & GUIDELINES NEEDED
- EFFICIENT WAYS TO DETECT LOW LEVELS OF AIRBORNE PATHOGENS
- BETTER FIELD INVESTIGATIONS WITH UNEQUIVOCAL RESULTS
- MORE INFORMATION ON HEALTH IMPACT OF VARIOUS LEVELS OF RH/TEMP. ON HUMANS & THEIR SUSCEPTIBILITY TO AIRBORNE PATHOGENS
- COMBINED HEALTH IMPACT OF AIRBORNE POLLUTANTS
- RELEVANCE OF DATA FROM MOLECULAR STUDIES TO ASSESS RISKS?
- BETTER & LONGER-TERM RESEARCH FUNDING

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FURTHER READING

- Ijaz MK, Zargar B, Wright KE, Rubino JR, Sattar SA (2016). Generic Aspects of the Airborne Spread of Human Pathogens Indoors and Emerging Air Decontamination Technologies. Am J Infect Control. 44(9 Suppl):S109-120.
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"CLEAN AIR IS A BASIC REQUIREMENT OF LIFE. THE QUALITY OF AIR INSIDE HOMES, OFFICES, SCHOOLS, DAY CARE CENTRES, PUBLIC BUILDINGS, HEALTH CARE FACILITIES OR OTHER PRIVATE AND PUBLIC BUILDINGS WHERE PEOPLE SPEND A LARGE PART OF THEIR LIFE IS AN ESSENTIAL DETERMINANT OF HEALTHY LIFE AND PEOPLE'S WELL-BEING. ……..." - WHO, 2010

Airborne Spread of Infectious Agents
Prof. Syed A. Sattar, University of Ottawa
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May 30, 2017	*(European Teleclass)* THE GOOD THE BAD AND THE UGLY METHODS FOR BEDPAN MANAGEMENT Speaker: **Gertie van Knippenberg-Gordebeke**, International Consultant Infection Prevention, The Netherlands *Sponsored by CleanIs (www.cleanis.com)*
June 1, 2017	USING UNOFFICIAL SOURCES TO MONITOR OUTBREAKS OF EMERGING INFECTIOUS DISEASES: LESSONS FROM PROMED Speaker: **Prof. Lawrence Madoff**, Harvard University Medical School, Editor of ProMED Mail
June 7, 2017	*(South Pacific Teleclass)* THE IMPACT OF CATHETER ASSOCIATED URINARY TRACT INFECTION Speaker: **Prof. Brett Mitchell**, Avondale College of Higher Education, Australia
June 8, 2017	*(FREE Teleclass)* ESTABLISHING A NATIONAL IPC PROGRAM ON A SHOESTRING BUDGET Speaker: **Prof. Shaheen Mehtar**, Infection Control Africa Network, and Stellenbosch University, Cape Town

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