REDUCING THE SPREAD OF INFECTIONS IN PUBLIC TOILETS: A NOVEL ENGINEERING MODEL FOR SAFER DESIGN

Why public toilets could be a hidden threat to your health & how engineering can fix it.

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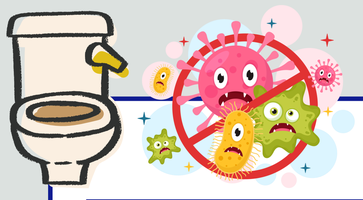


Toilet Flushing = A Germ Explosion?

Everybody poops. Unfortunately, nobody wants to talk about it. But if we want to protect public health, we have to!
Public toilets are everywhere; restaurants, hospitals, stadiums, train stations, parks, museums, airports and schools. But are they designed with health and safety in mind? Not really.
Every time you flush a toilet, an invisible cloud of germs, called **toilet plume bioaerosols**, is released into the air. These particles can carry dangerous pathogens like:

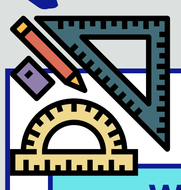
- **C. difficile** – a hospital superbug linked to deadly infections.
- **Norovirus** – the highly contagious stomach flu.
- **MRSA** – an antibiotic-resistant infection that's tough to treat.
- **SARS -COV-2** - the virus responsible for the COVID-19 pandemic, which spreads through airborne droplets and aerosols.

The Hidden Danger

Research shows that bioaerosols can settle on the frequently touched surfaces in the toilet (like door and toilet flush buttons, sink taps, etc.) or linger in the air for hours, and be inhaled by other toilet users. This increases the risk of infections.
So how do we fix this? That's where our research comes in.

The Problem

Ventilation, toilet design, and time after flushing have all been suspected to increase exposure to bioaerosols. Until now, research has only examined **one factor at a time. But the reality is**, the toilet environment is a complex system where **multiple factors interact** simultaneously, leaving major gaps in understanding how **they collectively influence exposure risk.**



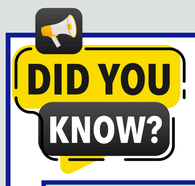
The Science Behind It.

What makes this study different?

- First to use a **Design of Experiments** (DoE) approach to investigate bioaerosol spread in public toilets.
- DoE examines **multiple interacting factors together**, rather than in isolation.
- Produces a **predictive model** that engineers and policymakers can use to **design safer public toilets.**

How was this study conducted?

- A **realistic toilet cubicle** was built to replicate public toilets in hospitals and hospitality settings.
- **Non-toxic bacteria** (C. difficile) were introduced to simulate infectious pathogens.
- An **air sampler** were used to track how bioaerosols spread under different conditions:
  - ✅ **With & without a toilet lid**
  - ✅ **Different ventilation setups**
  - ✅ **Time elapsed after flushing**
  - ✅ **Distance from the flush source**
  - ✅ **Concentration of bacteria**

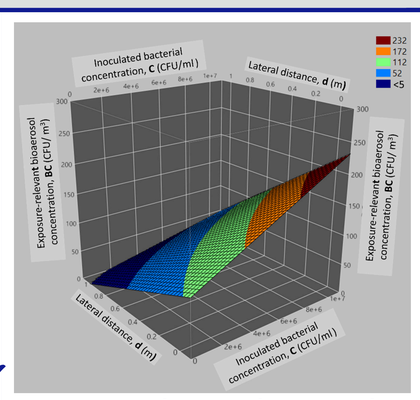


£1.2 Billion down the toilet. Every. Single. Year.

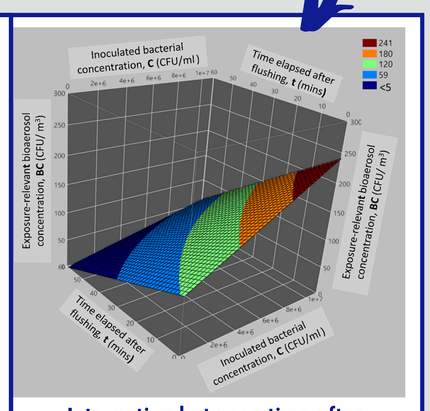
The **UK spends £1.2 billion** every year treating infections linked to public toilet-related pathogens.
Safer toilets=Fewer infections=Lower healthcare costs.
Every unsafe flush costs money. Smarter sanitation saves both lives and pounds!

Key Discoveries

- The highest risk occurs **immediately after flushing** and within **1 meter of the toilet.** That's right where people stand!
- **Flushing increases relative humidity by up to 33%,** creating an environment where bioaerosols can survive longer in the air.
- **Ventilation can reduce airborne pathogens by 70%;** but only when properly designed.
- **Waiting 60 seconds post-flush significantly reduces exposure** - a simple but overlooked hygiene practice.



Interaction between distance and bacterial concentration



Interaction between time after flushing and bacterial concentration

Public Toilets: The Missing Link in Infection Control

As the UK ramps up efforts to combat antimicrobial resistance, the WHO stresses s**anitation as a key defence**. Yet, despite their widespread use, public toilets are **still overlooked** in **hygiene policies and building regulations.**

What needs to change?

- **Stronger ventilation standards** – Public toilets should have optimized airflow to minimize airborne pathogen exposure.
- **Touch-free infrastructure** – Sensor-activated lid-closing, flushing, taps, and soap dispensers should become standard.
- **Time-based cleaning protocols** – Cleaning schedules should consider bioaerosol persistence, ensuring disinfection occurs at strategic intervals.

It's time to rethink how we design, regulate, and use public toilets. Not just for convenience, but for public health.

DON'T FORGET

Next time you use a public toilet, think about this:

- **Don't enter a cubicle immediately after someone else**. If possible, wait a few minutes or choose another stall.
- **Hands off high-touch surfaces!** Use tissue for door handles, flush levers, and taps..
- **Choose touchless** facilities whenever possible. Look for automatic flush systems, sensor-activated taps, and soap dispensers to reduce germ exposure.
- **Wash hands properly** after use. Scrub for **at least 20 seconds**.
- **Good ventilation** matters. If possible, avoid toilets with signs of poor ventilation (mouldy walls and surfaces, misty mirrors).

THIS RESEARCH IS ALREADY MAKING IMPACT! WANT TO LEARN MORE?

SCAN ME

RELATED LITERATURE

● Johnson et al. (2013). Lifting the lid on toilet plume aerosol. Am J Infect Control, 41(3), 254-258. ● WHO. (2015). Global Action Plan on Antimicrobial Resistance. ● Paddy et al. (2023). Toilet plume bioaerosols in healthcare and hospitality: A systematic review. Am J Infect Control, 51(3), 324-333. ● Paddy et al. (2024). Exploring toilet plume bioaerosol exposure using a Design of Experiments approach. Sci Rep, 14(1), 10665.