



## CHRISTMAS 2023

# Bug in a mug: are hospital coffee machines transmitting pathogens?

*For many, coffee is the elixir of life. But is it also a cradle of life?* **Sarah Victoria Walker and colleagues peer into the depths of the hospital coffee machine**

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Coffee is an easily available stimulant that sustains the workforce. Healthcare workers in particular are renowned for their coffee dependence, and the coffee machines found in break rooms or at employees' home are well used—and regularly touched by bare hands.

The World Health Organization recommends eliminating any potential vector in the transmission of nosocomial infections, and the search for hazards within hospitals is ongoing. Various personal objects, and doctors' attire, have been investigated as transmission sources for pathogenic bacteria, notably leading to the nationwide ban on wearing ties in UK hospitals (limited data on contamination with methicillin resistant *Staphylococcus aureus* led to their classification as a potential hazard).<sup>1</sup> Even hospital Bibles have been examined, though not (yet) deemed abolishable.<sup>2,3</sup>

What, then, of the coffee maker? Pathogenic, multi-resistant species have been detected in household appliances such as dishwashers that are typically located in the kitchen.<sup>4</sup> And the hands of hospital staff are a known source of spreading pathogens with the accompanying risks for nosocomial outbreaks, increased morbidity and mortality, and the financial burden on healthcare system<sup>5</sup> (hands can't yet be eliminated without severely hampering staff—so handwashing, gloves, and instruments must suffice for now).

While the microbiome of coffee machines in general has already been described,<sup>6</sup> their potential as a source of nosocomial pathogens has not been explored. Until now.

## By whatever beans necessary

We assessed the microbial population in healthcare associated coffee machines, with a focus on WHO's high priority "ESKAPE" pathogens (*Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *Enterobacter* species). They pose an increasing threat because of possible nosocomial transmission and infections, such as fatal bloodstream or catheter associated infections. Resistance to many first line antibiotics (if not all) renders these infections difficult to treat.<sup>7,8</sup>

From 31 October to 31 December 2022 we swabbed a total of 25 coffee makers (with their owners' consent) spanning a range of fully automatic, capsule (such as Nespresso), and espresso machines. Seventeen were from break rooms and offices at a university hospital's Department of Anaesthesiology and Operative Intensive Care and at the Institute for Medical Microbiology, Immunology, and Hygiene, both in Cologne, Germany. A further eight were in staff members' homes. All coffee makers had been in use for at least a year, and none was specially cleaned before sampling. There was no current disease outbreak at any of the locations at the time of sampling.

Each of the coffee makers was swabbed at five specified sites on the machine (fig 1): the drip tray, the outlet, the buttons, the handle of the water tank, and the inside of the water tank. Swabs were then streaked out on agar, and species were identified using spectrometry.

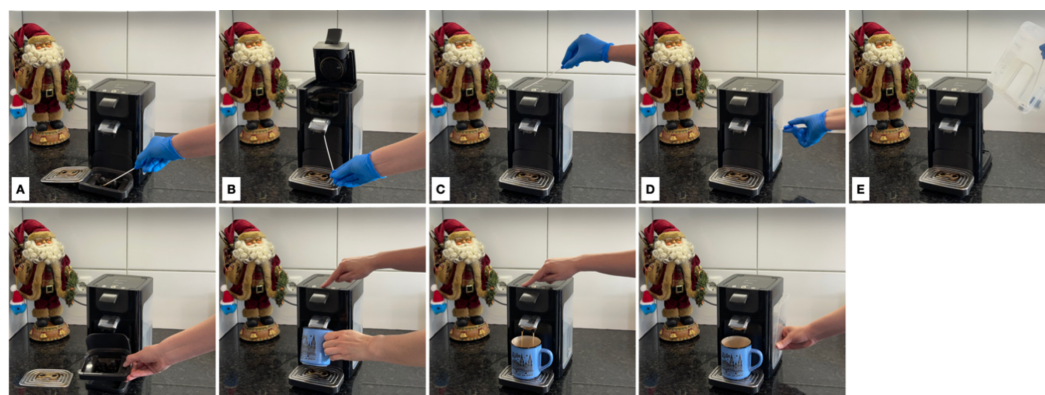


Fig 1 | Sampling re-enactment. A: drip tray; B: outlet; C: buttons; D: water tank (outside handle); E: water tank (inside). Pictures beneath A-D show the parts that regularly come into contact with bare hands (A, C, D) or with the side of the mug that touches the mouth (B)

# Daily grind

The hospital based coffee makers showed 360 strains of micro-organisms isolated from 72 positive swabs (table 1): 126

isolates from 17 positive swabs from the drip tray; 61 of 10 from the outlet; 41 of 14 from the buttons; 59 of 15 from the outer water tank; and 73 of 16 from the inner water tank.

Table 1 | Micro-organisms found on different parts of coffee makers after swab sample

Swab location	Number of micro-organism strains found	
	Hospital based coffee makers	Home based coffee makers
Drip tray	126	46
Outlet	61	26
Buttons	41	16
Outer water tank	59	13
Inner water tank	73	34
Total	360	135

Home based coffee makers showed 135 strains of micro-organisms isolated from 34 positive swabs: 46 of 8 from the drip tray; 26 of 6 from the outlet; 16 of 7 from the buttons; 13 of 6 from the outer water tank; and 34 of 7 from the inner water tank.

We classified the micro-organisms into two categories: “medically relevant/typical pathogens,” consisting of species on WHO’s high priority list plus typical pathogens responsible for most nosocomial infections; and “atypical pathogens/commensals.” We also tested

all species defined as high risk pathogens for antimicrobial susceptibility.

We differentiated between Gram positive and Gram negative bacteria (the latter have an outer membrane, which aids antibiotic resistance). *S aureus* was the only Gram positive, possibly disease causing species cultivated: once on the buttons of an at-home coffee maker and once on the inside of a water tank at the hospital (table 2).

Table 2 | Overview of typical/atypical pathogens detected from sample sites

	Typical pathogens		Atypical pathogens		P value
	Home	Hospital	Home	Hospital	
Drip tray	5	15	41	111	1
Outlet	2	8	24	53	0.72
Buttons	1	1	15	40	0.49
Water tank (outer handle)	0	5	13	54	0.58
Water tank (inner)	0	1	34	72	1
Total	8	30	127	330	0.45

Among the eight genera of “medically relevant” Gram negative species detected, 81% were found in coffee makers at the hospital. These genera were *Acinetobacter baumannii* complex, *Citrobacter freundii* complex, *Enterobacter cloacae* complex, *Escherichiacoli*, *Klebsiella* spp, *Pantoea* spp, *Pseudeschierichia vulneri*, and *Pseudomonas aeruginosa*.

In total, 72% of all cultivated Gram negative isolates (148/209)—“medically relevant” and “commensals” combined—derived from hospital based coffee makers.

No statistically significant differences were found regarding sample sites and locations of the coffee machines. “Medically relevant” Gram negative isolates were predominantly collected from drip trays, outlets, and water tank handles.

## Smell the coffee

Microbial growth was detected on every coffee machine. We live in a microbial world, so this isn’t surprising. But few medically relevant and no multi-resistant pathogens were identified—thereby also excluding any potential resistance against standard antibiotics used to treat severe infections. The majority of cultivated species were commensals or atypical pathogens.

However, hospital based machines were about three times as heavily colonised by bacterial species as those at home, reflecting transmission from the hands operating these machines—and only family members at home.

Gram negative pathogens and commensal species were common. Potentially medically relevant Gram negative species were predominantly detected on the drip tray and water tank handle. In hospital settings, where coffee makers are typically handled by a lot more bare hands than those at home, this may pose a transmission risk and newly discovered reservoir, especially if hygienic protocols such as hand disinfection are disregarded.

Interestingly, only one isolate of each of those pathogens—*E coli*, *Kpneumoniae*, and *P aeruginosa*—was cultivated, even though they are the predominant Gram negative nosocomial pathogens. While the *P aeruginosa* was cultivated from a hospital machine, the other two species derived from staff members’ private machines—perhaps indicating adherence to hygiene protocols at work and suggesting a need for hand hygiene at home.<sup>8</sup>

*S aureus* was cultivated only twice, indicating either impeded colonisation on coffee makers or consistent compliance with hand disinfection protocols. Of concern, however, are the detection sites.

*S aureus* is mainly transmitted through skin contact, with colonised buttons posing a risk of transmission. Growth inside the water tank indicates that users' hands touch even unlikely parts of the machines.

## Hug in a mug

To our great relief, despite their potential for pathogen origins in nosocomial outbreaks, a general ban on coffee makers doesn't seem necessary. Commensal species—the majority of detected species—are of no concern and are expected. The finding of medically relevant species emphasises the necessity of following WHO's *Five Moments for Hand Hygiene*,<sup>9</sup> which considerably reduces the risk of transmission. Regular and thorough cleaning of coffee machines further diminishes the risk of nosocomial outbreaks.

The curiosity that led us to conduct this study had a knock-on effect: the results were anticipated by all coffee machine owners, and our feedback has reportedly resulted in extensive cleaning measures. All but one of the coffee machines are still in use—although now being cleansed regularly. The owner of the other machine replaced it because of the indestructibility of the lime based biofilm found in the study.

Our thoughts now turn to tea drinking nations. Are teapots, kettles, and hot water spouts similar breeding grounds for bacteria? Are the high temperatures in the pots sufficient to kill all potential pathogens? And what about the handles?

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