TECHNOLOGY – FRIEND OR FOE?
INVESTIGATING BACTERIA ON KEYBOARDS

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STATEMENT OF THE PROBLEM

Does sharing a keyboard with others put my health at risk? Many people share computer keyboards whether it is in a computer lab or in an office. People often become ill and spread bacteria around the office. Could a leading cause of illness be from contaminated keyboards? If so, does the use of antibacterial wipes reduced the risk of bacterial spread?

HYPOTHESIS

If the keyboard is wiped more often with antibacterial wipes, then the amount of bacteria will be minimised.

BACKGROUND INFORMATION

Introduction to topic

Computer keyboards can be very dirty from food crumbs from eating food at the desk and bacteria that lives on our skin and in our mouths and nasal passageways which come from people's hands. (Miller, Zuckerman, KrennHrubec, 2010) The bacteria from these can cause illness. One bacterium found is *staphylococci* which is a common cause for food poisoning. (Boness, 2012) Antibacterial wipes can be expensive but workers having sick days will be a lot more expensive. Unhygienic working conditions are one of the main contributors to the 131 million working days lost each year in the United Kingdom alone. (Parry, 2014) The aim of this project is to investigate the use of antibacterial wipes on keyboards and how often they should be used. Should they be used daily?

Previous research

Researchers at the Swinburne University of Technology conducted an experiment testing computer keyboards in a multiple user facility. The researchers found that ten of the computers were infected with *coliforms*, which indicated the sanitary quality of food and water, and *staphylococci* which are often a cause of food poisoning. The researchers sampled the computer keyboards and mouses on a weekly basis. After two weeks they used antibacterial wipes on half the computers and introduced a sanitizer and asked for

users to sanitise their hands before using a computer. After another two weeks no *coliforms* were found and the number of *staphylococci* was dramatically decreased. (Boness, 2012)

Researchers from the University of Arizona found that the average desktop has 400 times more bacteria than the average toilet seat. From the samples they took, they also found a woman's desk tends to have more bacteria than a man's desk. (Miller, Zuckerman, KrennHrubec, 2010)

In February of 2007, the US Centre for Disease Control and Prevention reported of an outbreak in a Washington DC elementary school. It was expected that more than 100 students became ill due to the computer keyboards and mouses. Furthermore in the CGC's Morbidity and Mortality Weekly Report, an article stated that a virus which is linked to a disease commonly called the stomach flu was found on the mouse of a computer in a first-grade classroom. (Childs, 2008)

Consumer group Which? conducted tests on thirty three keyboards in an office. Out of these thirty three keyboards swabbed, four were considered potential health hazards and one keyboard had five times the amount of germs than the office's toilet seat. When one microbiologist found out that one of the keyboards was so dirty, he ordered it to be removed from the office to be quarantined and sanitised because it had 500 times the recommended limit for bacteria. The researchers were looking for *staphylococcus aureus* and *E.coli* which are both causes for food poisoning. (BBC, 2008)

The three most commonly used keys on a keyboard are the backspace, being the third most popular, 'e' being the second most popular and space bar being the most popular. (Yarow, 2013)

Past studies have found there to be more than 1,600 organisms per square inch on a mouse and more than 3,000 organisms on a keyboard per square inch. Bacteria and viruses can multiply and remain infectious for up to 24 hours after initial deposition. The average desk is a prime breeding ground for bacteria to grow and spread to other desks. (Parry, 2014)

Researchers have found that per swab, a computer keyboard has 2,100 more bacteria than an average toilet seat. They average computer keyboard contains 7,500 bacteria per swab while the average toilet seat only has 5,400. Other places or areas with high amounts of bacteria per swab include 25,000 bacteria per swab on a bin and 21,000 bacteria per swab of a handle on a London bus. (Keating, 2013)

Each year in the UK alone, 131 million days of work are lost due to people having sick leave from illnesses such as the common cold or the flu. Cleaner workstations and better hygiene could result in less sick days as unhygienic work practices are a key contributor to the mass number of sick days. (Parry, 2014)

Staphylococcus aureus is a common bacterium which lives on the skin and nose. It can be spread via either skin-on-skin contact or via contaminated surfaces such as a computer keyboard. Due to *Staphylococcus aureus* often being spread via contaminated hands, washing your hands with warm soapy water is needed, especially in high traffic areas such as an office. If warm soapy water is not present, alcohol based rubs can be used to combat bacteria. *Staphylococcus aureus* can lead to infections such as food poisoning, but it can also lead to more serious infections such as *pneumonia* or *osteomyelitis.* (Better Health Channel, 2015)

Description of project

Keyboards in a classroom/computer lab will be wiped with antibacterial wipes with different keyboards at different rates of cleaning (i.e. daily or weekly). The space bar on the keyboards will be swabbed daily and the number of bacteria will be recorded. To find the amount of bacterial colonies, the sample will be placed in the warmth of a computer or incubator.

The **Independent, Dependent** and **Constant Variables**

Independent variable: How often a keyboard is wiped

Dependent variable: The number of bacteria on the keyboard

Constant variables:

- Keyboards in same computer lab
- Sample keyboards at the same time of day
- Sample same key on each keyboard (i.e. spacebar)
- Same amount of heat/light from incubation

Relating to and expanding on previous research

Due to the number of cases where potentially harmful bacteria such as *Staphylococci* is found in public places, this experiment is going to test how often antibacterial wipes should be used to minimised potential threats. With the dramatic increase in use of technology, spending almost half of waking hours on technology now

is one of the most important times to be aware of the bacteria on our technology. Sixteen to twenty four year olds cram two hours of technology use into just under two hours due to multitasking. (Thomas, 2010)

Unique Procedures

Many other people have done experiments to do with bacteria on keyboards. The procedure in this project is similar to the method done by the researchers from the Swinburne University of Technology in the way we are testing bacteria on keyboards. (Boness, 2012) However, the researchers conducted the tests at the end of each week, whereas I will sample the keyboards daily. In my version of the experiment I am also only going to be swabbing one key on the keyboard, the spacebar which is the most used key. (Yarow, 2013)

Unfamiliar terms

Coliforms: a bacterial indicator of the sanitary quality of food or water (Boness, 2012)

Escherichia coli (E.coli): a bacteria found in food, the environment and intestines which can cause illness such as diarrhoea and can lead to pneumonia (CDC, 2015)

Organism: An individual animal, plant, or single-celled life form (Oxford, Unkown)

Pneumonia: an infection of one or both lungs (Better Health Channel, 2015)

Staphylococci: a bacterium which is a common cause for food poisoning (Boness, 2012)

MATERIALS

- 25x Q-Swabs
- 25x Compact Dry Total Aerobic Count (microbiological plates)
- 5x Computer Keyboards
- 19x Antibacterial wipes
- 1x incandescent light with shade OR an incubator
- 1x cake cooling tray (if using incandescent light)

PROCEDURES

1. Label the Compact Dry Total Aerobic Count
2. Do not wipe the spacebar on the first keyboard with antibacterial wipes as it is the control.
3. Wipe the spacebar on the second keyboard twice a day with antibacterial wipes on Day 1, Day 2, Day 3, Day 4 and Day 5
4. Wipe the spacebar on the third keyboard with antibacterial wipes at the start of Day 1, Day 2, Day 3, Day 4 and Day 5
5. Wipe the spacebar on the fourth keyboard with antibacterial wipes at the start of Day 1, Day 3, and Day 5
6. Wipe the spacebar on the fifth keyboard with antibacterial wipes at the start of Day 1 only
7. Allow Q-SWAB to acclimate to ambient temperature
8. Take a sterile Q-SWAB and swab the spacebar in a crisscross pattern on each keyboard daily to keep this a constant variable.
9. Apply sufficient pressure to the swab when collecting data, but do not touch the swab shaft as this will render the result inaccurate.
10. Rotate the swab while collecting data.
11. Replace swab in tube
12. Bend the snap-valve forward and backward.
13. Squeeze snap-bulb twice to expel 1 millilitre of liquid into tube.
14. Shake tube for 5 seconds.
15. Remove lid of Compact Dry TC by twisting and lifting.

16. Pour 1 millilitre of liquid from Q-SWAB tube into Compact Dry TC.
17. Place lid back onto plate and ensure lid is on tight to avoid dehydration during incubation.
18. Invert the plate and place it on top of a cake cooling rack above an incandescent light bulb or in an incubator for 48 hours.
19. Ensure that all the Compact Dry TCs get a similar amount of light to keep the amount of bacterial growth constant.
20. After incubation, count all colonies regardless of colour intensity.
21. Record results in a table or graph.
22. Repeat experiment at least 3 more times.

Amount of Bacteria Found	Keyboard 1 (control)	Keyboard 2	Keyboard 3	Keyboard 4	Keyboard 5
Day 1					
Day 2					
Day 3					
Day 4					
Day 5					

RISK ASSESSMENT

Hazard	Likelihood Score	Severity Score	Overall Risk Score	Actions already taken to reduce risk
Illness from handling bacteria	2	2	4	Wash hands after coming into contact with keyboard.
Results could be bio-hazardous	2	2	4	Q-Swabs can be disinfected by soaking in 20% bleach for 1 hour.

RESULTS - Summary

According to the average of my results, my hypothesis was mostly correct. My hypothesis was: 'If the keyboard is wiped more often with antibacterial wipes, then the amount of bacteria will be minimised.' The reason my hypothesis is only mostly correct is some days, there was more bacteria on the keyboards which were wiped either twice or once a day, than on the keyboards which were either never or only wiped once a week (seen in TABLE 3: Day 5, Keyboard 2 which is wiped twice per day, has more than three times the bacteria of Keyboard 1, which is never wiped with an antibacterial wipe.)

The independent variable in this experiment is how often the computer keyboards are wiped with an antibacterial wipe, the dependant variable was the amount of bacteria found on the keyboards, and the constant variables were that Keyboards are in the same computer lab, sample the keyboards at the same time of day, sample the same key on each keyboard (i.e. spacebar) and the same amount of heat/light in incubation.

The results are quantitative and ratio because the number of bacteria colonies is counted.

In general, on average, Keyboard 1, which is never wiped with an antibacterial wipe, has more bacteria than the other keyboards which were wiped twice per day, once per day, once every two days, and once per week (respectively). However, looking at TABLE 5, on Day 1, Keyboard 3 has 15.25, more than twice the amount of bacteria of Keyboard 1, which has 7.5. Another thing to note is Keyboard 5 on Day 5, in the average, has 27.75. This is due to Day 5 Keyboard 5 in TABLE 2 having 101 bacterial colonies found. If this outlier is left out of the equation when getting the average, it would only be 3.3 (rounded to 1 decimal place).

RESULTS - Tables

TABLE 1: AMOUNT OF BACTERIA ON KEYBOARD WEEK 1

Amount of Bacteria Found	Keyboard 1 (control, never)	Keyboard 2 (twice a day)	Keyboard 3 (daily)	Keyboard 4 (every two days)	Keyboard 5 (once a week)
Day 1	10	18	20	12	11
Day 2	1	1	1	3	1
Day 3	2	1	0	3	0
Day 4	6	0	2	1	1
Day 5	0	0	0	0	0

TABLE 2: AMOUNT OF BACTERIA ON KEYBOARD WEEK 2

Amount of Bacteria Found	Keyboard 1 (control, never)	Keyboard 2 (twice a day)	Keyboard 3 (daily)	Keyboard 4 (every two days)	Keyboard 5 (once a week)
Day 1	4	0	6	0	1
Day 2	16	0	1	1	3
Day 3	4	1	7	4	2
Day 4	17	8	6	0	5
Day 5	0	0	2	0	101

TABLE 3: AMOUNT OF BACTERIA ON KEYBOARD WEEK 3

Amount of Bacteria Found	Keyboard 1 (control, never)	Keyboard 2 (twice a day)	Keyboard 3 (daily)	Keyboard 4 (every two days)	Keyboard 5 (once a week)
Day 1	9	2	31	6	1
Day 2	13	0	4	1	0
Day 3	19	0	3	4	3
Day 4	41	0	0	13	4
Day 5	3	10	4	6	10

TABLE 4: AMOUNT OF BACTERIA ON KEYBOARD WEEK 4

Amount of Bacteria Found	Keyboard 1 (control, never)	Keyboard 2 (twice a day)	Keyboard 3 (daily)	Keyboard 4 (every two days)	Keyboard 5 (once a week)
Day 1	7	12	4	10	5
Day 2	0	0	1	7	4
Day 3	0	0	14	0	1
Day 4	1	0	1	0	0
Day 5	3	1	2	0	0

TABLE 5: AVERAGE AMOUNT OF BACTERIA ON KEYBOARD

	Day 1	Day 2	Day 3	Day 4	Day 5
Keyboard 1 (never)	7.5	7.5	6.25	16.25	1.5
Keyboard 2 (twice per day)	8	0.25	0.5	2	2.75
Keyboard 3 (once per day)	15.25	1.75	6	2.25	2
Keyboard 4 (once every two days)	7	3	2.75	2.5	1.5
Keyboard 5 (once per week)	4.5	2	1.5	2.5	27.75

RESULTS - Graphs

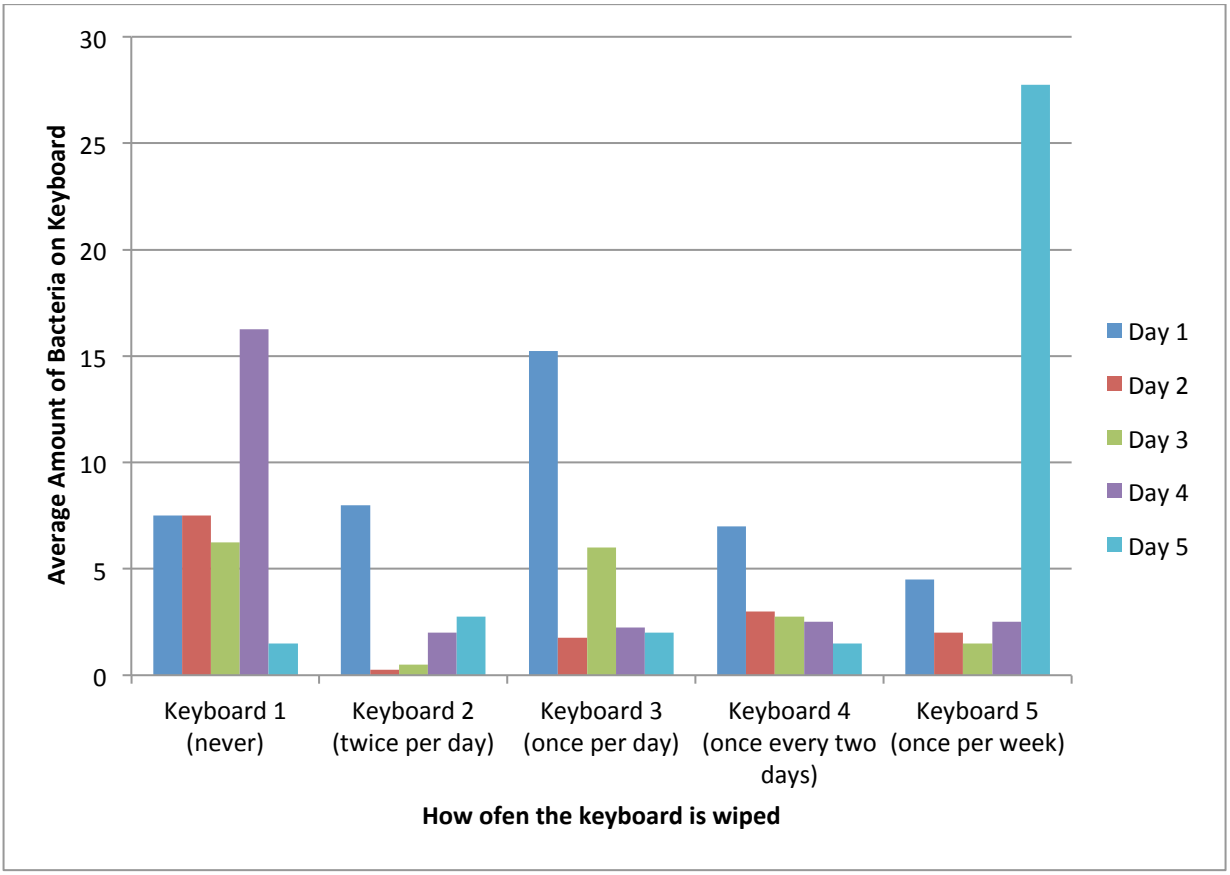

FIGURE 1: AMOUNT OF BACTERIA ON KEYBOARDS

DISCUSSION

What was the purpose of the experiment?

The purpose of this experiment was to see how often keyboards should be sanitised with an antibacterial wipe to kill bacteria.

Is the hypothesis supported or refuted?

My hypothesis is mostly correct as usually if the keyboard was wiped more often, then there would be fewer bacteria. In FIGURE 1, you can see that Keyboard 2, which was wiped with an antibacterial wipe twice per day, has the least amount of bacteria and Keyboard 1 has the most amounts of bacteria (with the exception of Day 5 Keyboard 5) as it was never wiped with an antibacterial wipe.

What do the results mean?

Most of the time, the keyboards which are wiped more often, have fewer bacteria. In FIGURE 1, Keyboard 2, which is wiped with an antibacterial wipe twice per day, generally has the least about of bacteria.

What is the reason for the results?

The reason for the results that are shown in FIGURE 1 is that the antibacterial wipes, are killing the bacterial colonies. With keyboards such as Keyboard 2 and Keyboard 3, there is less time for bacteria to reproduce, thus there are fewer bacterial colonies. Keyboard 1, which is never wiped by the antibacterial wipes, usually has the most amounts of bacteria. This is because it is never wiped, so the bacteria don’t die, they keep on reproducing.

How do your results compare to the results of other related experiments discussed in the background section?

My results are similar yet different to the experiment done by the researchers at the Swinburne University of Technology. The reason their results are different is because their experiment is slightly different. They swabbed keyboards in a computer lab at the end of a week. The next week they gave out antibacterial wipes and hand sanitizer and found that the number of bacteria had reduced. This is similar to my experiment where the keyboards that were wiped more often had less bacteria than the keyboard which was never wiped with an antibacterial wipe.

Any possible sources of error?

Some of the results could become inaccurate due to incorrect use of the Q-SWABS. Either not putting enough pressure on the shaft or touching the shaft can change the results.

Another potential error is the computers not receiving enough traffic to make a fair comparison. On some days the computers could have only been used once or twice while other days the computers could be used by five of six different sets of people.

Was any new information discovered?

One interesting result found was that on keyboard 1, which was never wiped with the antibacterial wipe, some days there would be fewer bacteria than the day before. This could be a result of two things; either there was an inaccuracy with swabbing and incubation, or it could be that some bacteria can't live longer than one day. As seen in TABLE 1, for Keyboard 1 Day 4 has six colonies of bacteria, however on Day 5 of the same week there are zero bacteria found.

What value does this information have to society?

After doing this experiment, it is shown that computer keyboards are breeding grounds for bacteria. People should wash their hands before and after use of a public keyboard and after the use of the toilet as this can contribute to added bacterial growth. Companies and offices should supply some form of hand sanitation to help reduce the risk of illness.

How could this experiment be improved?

The experiment could be improved by using keyboards in a higher traffic area. This will make results more consistent, giving a better insight to the amount of bacteria on keyboards. Some days, due to the keyboards being in a low to medium usage, had very small amounts of bacteria.

To make the experiment fairer, brand new keyboards could be used. New keyboards would ensure that all the keyboards start with zero bacteria, rather than different keyboards beginning with different amounts.

Any other ideas for experimentation in the future?

An idea for future experimentation is the amount of bacteria on certain keys on the keyboard. It would be interesting to see which keys have more bacteria than others and if it is different for gamers who use w, a, s and d frequently compared to an author who uses more of the keyboard.

Do you have plans to continue?

I do not have plans to continue. However, if I did, I would change the experiment by using brand new keyboards, in a higher traffic area such as a computer room, rather than just the computers in the back of a classroom.

CONCLUSIONS

The major finding of the project.

The major finding of the project was that the use of antibacterial wipes reduces the amount of bacteria on the keyboard. I found that even the keyboard that was wiped with an antibacterial wipe twice per day still had bacteria on it; however, it was usually less than other keyboards. There was an instant where 101 bacterial colonies were found. Use of this keyboard could make you ill. This shows that the use of antibacterial wipes is important, if using a computer after someone else.

Was it an expected result? (Was the hypothesis supported?)

The hypothesis for the experiment was partially expected. Most of the time the keyboards which were wiped more often, such as Keyboard 2 and Keyboard 3, had less bacterial colonies than Keyboard 1, which was never wiped with the antibacterial wipes.

The effect of the results on individuals or on society.

Many people spend their lives sitting in front of computers, in an office, using a keyboard. Often office workers share their computer station with others. They can use these results to show that computer keyboards are a literal breeding ground for bacteria. The results show that there are fewer bacteria if the keyboards are wiped with antibacterial wipes. If people wipe down the keyboard before and after using a keyboard, this can dramatically reduce the number of bacteria, thus lowering the chance of becoming ill. If employers supply employees with wipes, the health of the whole office can become better with the reduction of bacteria.

Acknowledging all people that directly helped your project (any mentors)

Mum – helped with idea generation for a project to do

Robert from Arrow Scientific – helped choose which products to buy for the experiment (Q-SWABs and Compact Dry TC)

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