Summary

Surface cleanliness and hygiene

Test done in the project PandemicClean,
Safe and Effective Cleaning in Pandemic Situations

PandemicClean – Safe and Effective Cleaning in Pandemic Situations

Safe and Effective Cleaning in Pandemic Situation

This summary is written by Tarja Valkosalo except the chapter Effect of the cleaning cloth moisture which is written by Helge Alt. The chapter Pre-tests is based on the report written by Tuula Suontamo.

Project partners:
Estonia - Puhastusekspert OÜ (Helge Alt, Jaanika Kasemets)
Finland - Propuhtaus (Tarja Valkosalo)
France – IFPRA Normandie (Justine Gonzalez)
The Netherlands – SVS B.V. (Lydia Huizinga, Frans Tijsse Klasen, André de Reus)

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Contents

INTRODUCTION

One part of the project, PandemicClean – Safe and Effective Cleaning in Pandemic Situations, was to measure surface cleanliness and hygiene in real-life conditions and find out if the set limit values of cleanliness were achieved in daily cleaning. The aim was to receive information so that cleaning organisations could be more prepared for next pandemics and work knowledge based.

All the studies were case studies, not scientific studies. However, the results show the challenges that a cleaning organisation can face in practice.

The tests involved:
- pre-tests
- testing different method sets in classrooms and toilets
- testing the effect of cleaning cloth moisture
- mapping out contact surfaces in different room types.

The goal of cleaning

In different situations we have different goals for cleaning. In ordinary situations, it might be acceptable if there are some dirt even after cleaning, e.g. some attached dirt. Some premises may need to be visually clean, so that dirt is not visible to the naked eye. Chemically clean means that there are no cleaning agent debris on surfaces. This kind of debris can be visible to eye or not, depending on the amount of it. If the goal is to have microbiologically clean surfaces, there should be a minimum number of microbes on the surfaces after cleaning. However, it is worth noting that microbiologically clean does not necessarily mean that the surface is chemically or visually clean.

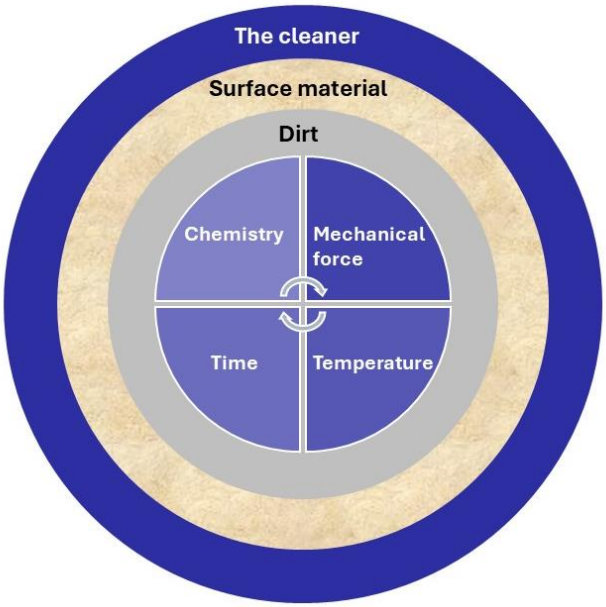
In the pandemic situation, the goal of cleaning is to minimise the number of microbes on the contact surfaces in situations when there is a possibility that the disease will spread via surfaces. This can be done by killing microbes by using biocides or by removing microbes from surfaces by wiping or mopping.

Figure 1. Different goals of cleanliness.

Factors affecting cleaning

When talking about cleaning as an action, we usually refer to the factors in the Sinner's circle: chemistry, mechanical force, time, and temperature. In surface cleaning, the use of those factors, i.e. the cleaning method, is chosen based on the amount and type of dirt and microbes, and on the surface material and its condition (Fig. 2). It is the cleaner's professional competence to choose the dirt removal method based on these factors..

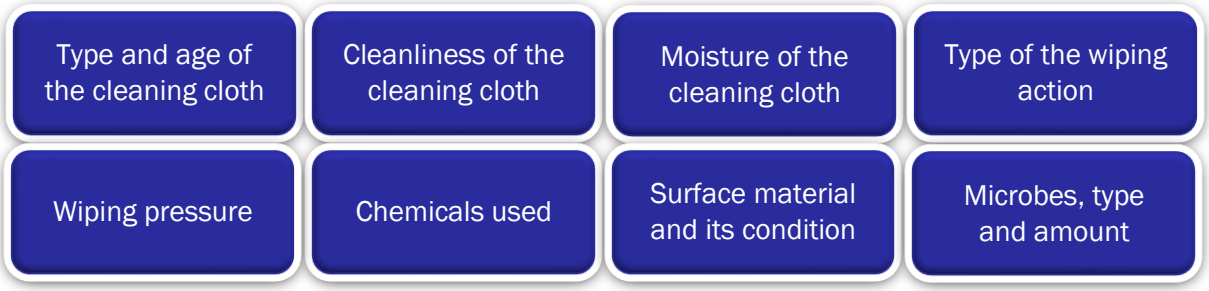
Figure 2. Factors involved in surface cleaning,



In the pandemic situation, the focus is on the contact surfaces which we most often clean manually. Therefore, even though we identify dirt, know how to take into account the surface material and its condition, and have chosen effective products, microbiologically clean surfaces are not necessarily achieved.

The complexity of cleaning result is well described by the factors affecting the efficiency of wiping (Fig. 3). When wiping contact surfaces, the human factor is always involved in. Cleaner's skills play the crucial role.

Figure 3. Factors affecting the efficiency of surface wiping to remove microbes.



Modified from the article Sattar, S. A. & Maillard, J-Y. 2013. The crucial role of wiping in decontamination of high-touch environmental surfaces: review of current status and directions for the future.

How to test surface cleanliness and hygiene

In addition to the visual inspection, e.g. ATP and microbiological sampling and UV light can be used to test the cleanliness of surfaces.

ATP tests measure the amount of organic dirt on surfaces, but they can't tell whether or how much there are microbes on the surface.

Microbiological tests measure the number of microbes on the surface. Depending on the test, it can identify e.g. the total number or a certain type of bacteria or fungi.

With UV light in dark conditions, it is possible to see dirt on surfaces which is not visible to naked eye.

All these methods were used during cleaning tests (Fig. 4).

As a luminometer in pre-test Hygiena® SystemSURE Plus and in surface cleanliness tests Hygiena® EnSURE® Touch was used with UltraSnap® tests. The result could be read immediately after swapping in RLUs.

When needed the RLU values were converted to femtomoles. The following formulas were used:
- when using SystemSURE Plus: 1 RLU = 1 femtomol
- when using EnSURE Touch: 1 RLU = 0,5 femtomol.

The ATP sample area was 100 cm^2 on flat surfaces and in smaller objects the whole item.

As the microbiological test method, Hygicult® TPC dip slides were used to measure the total amount of bacteria and fungi on surfaces. The test is intended for general hygiene monitoring. The medium on dip slides contains neutralising agents which makes the product suitable to be used in environments where disinfectant chemicals have been used.

UV blacklight makes some kinds of dirt visible, e,g, urine and other body fluids, skin fat, various (dyed) textiles, animal or plant dirt, dust, and detergent and lime deposits. UV lamp was used in this project to assess the outcome of cleaning when testing microfibre cloths with different moisture levels.

See the video of test methods on project YouTube channel.

Figure 4. Devices used in tests: ATP and Hygicult devices and UV lamp.

Concepts

In these tests, damp and moist cleaning methods were used. They were defined like this:
- In the damp method, the moisture dries from the surface almost immediately after wiping or mopping.
- In the moist method, moisture dries from the surface within 30 seconds.

MAIN FINDINGS

There was a large variation in RLU values and in CFU values in the tests done. Cleaning wasn't always successful and in fact, some surfaces were dirtier after cleaning than before.
Based on all the tests, the following conclusions were drawn.

1. It's important to recognise the **contact surfaces** in each room/space with the cleaner. The mapping revealed contact surfaces with high ATP values. It may be beneficial to take samples of potential contact surfaces and make sure that these surfaces are always cleaned with care, especially if they are touched by many people.

2. We should not speak about the **aseptic working** order, but about aseptic working. The principle "from cleanest to dirtiest" may be hard to follow, because we do not have this information for every room in every cleaning cycle. Instead, we should emphasise how to work aseptically. The concept "aseptic working" should be clear so that cleaners gain understanding to apply knowledge to the changing situations.

3. Microbiological cleanliness is **not only about which chemical** to use even though it was discussed a lot during the corona pandemic. Surface hygiene tests didn't show clear differences between cleaning agents. However, using disinfectant in toilet cleaning seems to be a safe choice during the pandemic.

4. Tools, techniques how to use them, and cleaning methods matter. Wiping **technique and pressure** affect the cleaning result. The tests showed that good ATP results were received when cleaning small items like a flush button, maybe because of the stronger wiping pressure on a small area. **Moist methods** appeared to be better than damp methods. Machines should be used for floor cleaning everywhere but definitely in rooms where floor is the contact surface.

5. It's better to fold the cleaning cloth so that it is the **same size as your hand**. In this manner it's easier to have an even pressure on the surface and follow that the whole surface area will be cleaned properly.

6. You'll get better results with a folded microfibre cloth if you **turn a clean side of the cloth** after wiping each contact surface. In this manner you won't spread dirt with the cloth.

7. **It does not help to clean more frequently**, if the methods used are not good enough.

8. When instructing, we should speak e.g. like "Remove the dirt from a handle by moist wiping with a microfibre cloth". Not like "Moist wipe a handle with a microfibre cloth". **The focus should be on the result**, not on the work method.

9. **The amount of dirt before cleaning affects the cleaning results**. The problem is that normally we can't see microbes. So, it could be good occasionally to measure surface cleanliness before and after cleaning to have some idea about the real-life situation.

10. **Cleaners need feedback** on their own cleaning results to learn the most effective methods. ATP tests or UV light can be used to show the efficiency of cleaning.

11. In the **pandemic situation**, sufficient time should be given for **cleaning contact surfaces thoroughly**, systematically, and carefully if the microbe causing the pandemic spreads also via surfaces.

12. **Surface materials** and their **condition** affect how easily dirt and microbes can be removed. A worn surface can be difficult to get clean.

13. **Thorough (deep) cleaning** is efficient, but the effect is **short-lived**, if the daily cleaning continues as before.

14. The **users of the premises** have an impact on how much and what kind of dirt there is in spaces and how quickly the spaces will get dirty.

15. **Cleaner's motivation and skills are crucial**. Attention should be paid to that especially in the pandemic situation.

See also the recommendation videos on the project's YouTube playlist.

PRE-TESTS

The aim of the pre-tests was to find out how the following factors affect cleanliness result:
- chemical; tap water vs. all-purpose cleaner, for cleaning table surfaces
- cleaning equipment; floor mop, squeegee mop and scrubber drier, for floor cleaning, and microfibre cloth, disposable cloth, and interior mop for table surface cleaning
- cleaning method; damp compared to moist method.

The tests were carried out in a nursing home in Finland. The effectiveness of the wiping methods was tested on table surfaces in the dining room and the effectiveness of the floor cleaning methods in the lobby.

Pretests were done by Tuula and Samuli Suontamo in Autumn 2022.

The cleaning performance of flat surfaces was assessed by comparing the ability of wipes moistened with tap water and a detergent solution to remove organic dirt (ATP method) and bacteria capable of growth (Hygicult TPC method) from table surfaces. The tests were performed on three tables (replicates) with three samples per table (parallel measurements), first before wiping (9 samples in total) and then again after wiping (9 samples). From the readings obtained, method-specific means were first calculated, and then method-specific cleanliness percentages were derived.

The correct moisture of microfibre cloths was determined by measuring the time taken for the surface to dry.
- In the damp method, the moisture dries from the surface almost immediately after wiping.
- In the moist method, moisture dries from the surface within 30 seconds.

Results

Many tests gave negative cleaning results (Table 1). This means that there was more organic dirt (RLU) or viable bacteria (CFU) on the surface after wiping than before wiping. These results were obtained when the dining table was wiped with
- a microfibre cloth dampened with tap water (RLU)
- a microfibre cloth moistened with a cleaning agent solution (CFU)
- a disposable wipe dampened with tap water (RLU).

Similarly, in the floor tests, a negative cleaning result was obtained when the floor was wiped with
- a mop dampened with tap water (RLU)
- a mop dampened with a cleaning agent solution (RLU)
- a mop moistened with a cleaning agent solution (CFU)
- a squeegee mop moistened with tap water (RLU)
- a scrubber drier with tap water (RLU and CFU).

Conclusions that can be drawn from the results include (Table 2):
- RLU: a moist microfibre cloth with tap water performed better than a damp one
- RLU: damp and moist microfibre cleaning cloths with a detergent solution worked equally well
- RLU: both the damp and moist microfibre cloth worked better than the disposable cleaning cloth and the furniture mop
- RLU: a moist floor mop worked better than a moist squeegee mop
- RLU: the cleaning solution performed better than tap water when using a scrubber drier
- RLU: after the first cleaning time with a scrubber drier, the floor was dirtier than before the run and the cleaning result was negative (-15%)
- RLU: after the second run, the floor was cleaned better (cleaning result 85%)
- RLU: after the third run with a scrubber drier, the result was poorer than after the second run (cleaning result 4,8%)
- CFU: a microfibre cloths dampened and moistened with tap water, and a damp microfibre cloth with cleaning agent solution gave equally good cleaning results
- CFU: a moist furniture mop gave poorer cleaning results than a microfibre cloth and a disposable cloth
- CFU: a damp floor mop and squeegee mop worked better than moist ones

- CFU: when using a scrubber drier, the cleaning result was better after the first run (63%) than after the second (3%) and third runs (32%).

Table 1. Negative cleaning results in the pre-tests.

	RLU		CFU	
	Damp	Moist	Damp	Moist
TABLE SURFACES				
Microfibre cloth with tap water	−			
Microfibre cloth with cleaning agent solution				−
Disposable cloth with tap water	−			
FLOOR SURFACES				
Floor mop with tap water	−			
Floor mop with cleaning agent solution	−			−
Squeegee mop with tap water		−		
Squeegee mop with cleaning agent solution				
Scrubber drier with tap water		−		−
Scrubber drier with cleaning agent solution				

Table 2. In the pre-tests, the following methods gave the best cleaning results.

	RLU		CFU	
	Damp	Moist	Damp	Moist
TABLE SURFACES				
Microfibre cloth with tap water		+	+	+
Microfibre cloth with cleaning agent solution	+	+	+	
Disposable cloth with tap water				
Furniture mop				
FLOOR SURFACES				
Floor mop with tap water		+		
Floor mop with cleaning agent solution				
Squeegee mop with tap water				
Squeegee mop with cleaning agent solution				
Scrubber drier with tap water				
Scrubber drier with cleaning agent solution		+		

The pre-tests revealed also that on floor surfaces there are residues of cleaning agents (chemifilm) and possibly biofilm. When using a scrubber drier with tap water, there was foam in the dirty water tank even after the third drive (Fig. 5).

Figure 5. Dirty water tank after cleaning with tap water and green diamond pad

After one drive

After two drives

After three drives

Folding the cleaning cloth

During the pre-tests, the effective folding of a cleaning cloth was tested.

Carbon black (soot) was dissolved in water and sprayed on a plastic surface as evenly as possible. Then the surface was wiped with a microfibre cloth which was folded into four or six parts.

The pictures show that it is more effective to fold the cloth to the size of the hand (Fig. 6) when it's also easier to follow that the whole surface area is cleaned properly.

Figure 6. Microfibre cloth folded to four parts (on the left) and six parts (on the right).

See also the video in PandemicClean YouTube channel

SURFACE CLEANLINESS AND HYGIENE TESTS

After the pre-tests, surface cleanliness and hygiene tests were planned to get answers to the following questions:

Cleaning during a pandemic
1. does it matter which tool and cleaning agent is used?
2. does it matter which method or technique is used?
3. which are the cleanest surfaces before and after cleaning?
4. what is the effect of thorough (deep) cleaning?
5. does the surface affect cleanliness result?
6. does it matter who are using the space?

The goal was to find the most effective cleaning methods in pandemic situations.

Tests were carried out in a primary school in Finland. A school was chosen as the sampling site because tests wanted to carry out in a non-healthcare facility, which however had many users of space enabling infections to spread easily. In addition, very little research data was available on cleaning of this kind of premises during the corona pandemic.

390 pupils in grades 1-5 and 40 staff members worked at the school. The school building is old but had undergone renovation in 2011. To prevent the entry of dirt, pupils leave their footwear in the entrance hall.

A total of 1010 ATP and microbiological test samples were taken between 2 February and 11 November 2023 (Fig. 7). During that period, cleaning was performed according to the test plan by two qualified cleaners who were instructed to the set of methods in the test plan and informed about sampling points. During the test period, the trainer of the cleaning company supported the cleaners at the site.

During the spring, the cleaning result was measured twice in classrooms and toilets. The first tests also measured cleanliness and hygiene of surfaces before cleaning. Because of rather poor cleanliness results, tests about wiping pressure, wiping technique, and methods were carried out before the school summer holidays.

During the summer holidays all the test rooms were cleaned thoroughly (deep cleaned). This made it possible to test how deep cleaning affected the cleaning result.

In the autumn, the cleaning result was tested twice both before and after cleaning. After them additional tests about wiping techniques were performed.

Figure 7. Test dates and tests carried out.

2.2.2023	• ATP and microbiological tests before and after cleaning
23.2.2023	• ATP and microbiological tests after cleaning
April and May 2023	• ATP and microbiological tests about wiping pressure, methods, and techniques
Summer 2023	• Deep cleaning, ATP and microbiological tests after that
August 2023	• ATP and microbiological tests before and after cleaning
September/October 2023	• ATP and microbiological tests before and after cleaning
November 2023	• ATP and microbiological tests about wiping techniques

Sampling

Samples were taken from classrooms and toilets by the cleaning company at the site. The persons responsible for taking the samples were trained.

ATP samples were also taken from microfibre cloths. The cleaning cloths and mops were washed in the washing machine for professional use. The measurements proved the cloths to be clean.

Three different sets of methods were tested in both facilities (see Table 3.)

Samples were taken from nine classrooms and nine toilets. In both types of spaces, three different sets of methods were tested, i.e. the same set of methods were used in three parallel rooms. All of the co-sampled facilities were not identical in all respects. The main variables were the users of the facilities, including the age of the pupils and the number of users. In each classroom there was around 20 pupils. The rooms were situated in three different floors. The surface materials were mostly the same, but there were differences in how worn they were.

Table 3. Sets of methods in classrooms and toilets.

CLASSROOMS	TOILETS
Test 1: Tap water Desks: Interior mop Floor: Floor mop	Test 1: Slightly alkaline detergent Contact surfaces: Microfibre cloth Sink: Microfibre pad Floor: Floor mop
Test 2: Slightly alkaline detergent Contact surfaces: Microfibre cloth Floor: Squeegee mop	Test 2: Tap water Contact surfaces: Microfibre cloth Sink: Microfibre pad Floor: Squeegee mop
Test 3: Tap water Contact surfaces: Microfibre cloth Floor: Squeegee mop + Scrubber drier once a week	Test 3: Disinfectant Contact surfaces: Disposable cloth Sink: Dishwashing brush Floor: Squeegee mop
At first, damp wiping methods, but changed to moist method after the first tests because damp method was not sufficient. Slightly alkaline detergent changed to more alkaline in the autumn.	Moist wiping and mopping methods, or according to dirt.

Tools, detergents, and the working instructions, see Annex 1.

Sampling points

Six ATP and six microbiological samples were taken from each room (Table 4). In the test batches, samples were taken either before and after cleaning or after cleaning only. Samples were taken during the school day.

After cleaning, the surfaces were left to dry for 15 minutes before the samples were taken.

The aim was to take ATP and microbiological samples from the same points. Because some contact surfaces were too small for that (e.g. door handle, flush button), samples were taken from other points.

Table 4. Sampling points in the classrooms and toilets.

	ATP samples	Microbiological samples
Classrooms	Door handle, outside the room First cleaned desk, front middle Last cleaned desk, front middle Floor, mopping starting area Floor, mopping finishing area Chair back, middle	Door side, outside the room First cleaned desk, front sides Last cleaned desk, front sides Floor, mopping starting area Floor, mopping finishing area Chair back, sides
Toilets	Door handle and lock, inside the toilet Tap lever Hand paper dispenser, below Seat ring, middle Lid, sides Flush button	Door side, outside the room Door side, inside the room Sink, front edge Toilet paper dispenser, below and front Seat ring Lid, inside

Limit values

There are no official limit values for surface cleanliness and hygiene. Different limit values were mapped, e.g. consensus values used in Finland, test manufacturer's values, and values stated in the standard.

In these measurements, limit values according to the Danish standard "DS 2451-10:2014 Infection control in the health care sector – Part 10: Requirements for cleaning", were used (Tables 5 and 6).

Table 5. Limit values for ATP tests.

Good	< 50 femtomoles	
Requires observation	50–100 femtomoles	
Requires intervention	>100 femtomoles	

In the surface cleanliness tests, the corresponding RLU values are <100 RLU, 100–200 RLU and > 200 RLU.

Table 6. Limit values for microbiological tests.

Good	≤ 2,5 CFU/cm^2	
Fail	>2,5 CFU/cm^2	

In the surface hygiene tests, the corresponding CFU values / plate are ≤ 23 CFU and >23 CFU.

Results and discussion

After cleaning, surfaces looked visually clean both in toilets and classrooms. However, that was not the case according to the ATP and microbiological tests. Both ATP and microbiological tests showed that cleaning was not always successful – a surface could be even dirtier after cleaning. This was the case in 20-33% of different sets of methods.

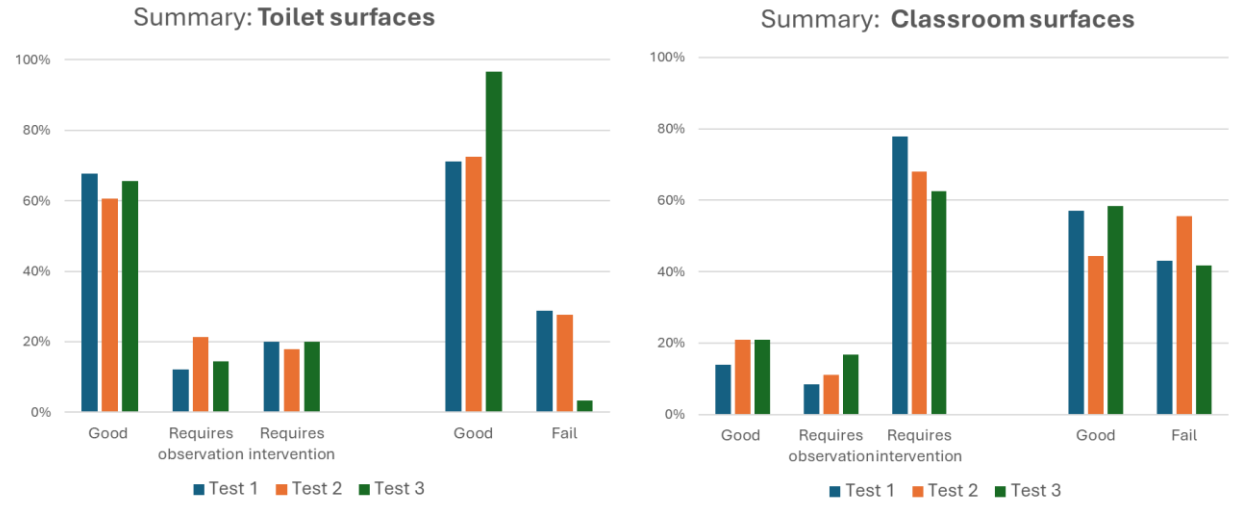
In general, ATP and microbiological tests did not correlate. Microbiological tests gave better cleanliness results than ATP tests. However, there was a large variation especially in RLU values, also on the same kinds of surfaces.

It is possible that the ATP tests themselves affected the results, because some tests were drier than others.

Does it matter which tool and cleaning agent is used?

According to the tests, toilet cleaning in general was more successful than classroom cleaning. Both ATP test results and microbiological test results after cleaning were better in toilet cleaning (Fig. 8).

Figure 8. Summary of surface cleanliness and hygiene tests after cleaning in toilets and classrooms.



In toilet cleaning, using slightly alkaline detergent with microfibre products (test 1) gave a bit better ATP results than using disinfectant with the disposable cloth and dishwashing brush (test 3). However, microbiological test results were better when using the disinfectant with the disposable cloth. The most challenging surfaces according to ATP measurements were the inside door handle and lock, toilet seat ring and toilet seat lid edge. Microbiological tests showed quite good results except for the sink front edge (Fig. 9). When cleaning the sink tap lever with a microfibre pad or dishwashing brush, the results were equally good.

Figure 9. Test results after cleaning the toilets, means of each three tested set of methods.

	ATP measurements						Microbiological measurements					
		2.2.2023	23.2.2023	30.8.2029	18.9.2023	9.10.2023		2.2.2023	23.2.2023	30.8.2029	18.9.2023	9.10.2023
Test 1	Inside door handle and lock	268	162	187	48	75	Outside door edge	11	10	3	7	1
Test 2		507	42	344	48	289		5	0	4	1	1
Test 3		105	111	527	101	273		4	3	0	0	2
Test 1	Sink tap lever	102	42	41	9	5	Inside door edge	29	8	3	3	4
Test 2		28	14	67	9	38		10	4	4	4	1
Test 3		25	7	41	20	45		2	3	0	1	0
Test 1	Handpaper dispenser, below	407	200	21	21	19	Front edge of the sink	23	67	69	61	39
Test 2		513	71	37	21	101		31	50	15	80	42
Test 3		198	1	140	27	71		17	9	2	10	4
Test 1	Toilet seat ring	193	80	100	46	36	Toilet paper dispenser	53	11	7	23	19
Test 2		104	45	352	46	276		12	5	12	46	20
Test 3		115	220	763	605	123		5	5	3	1	52
Test 1	Toilet seat lid edge	31	707	65	183	332	Toilet seat ring	13	27	6	60	11
Test 2		23	171	196	183	276		44	40	16	10	15
Test 3		45	299	182	77	111		2	2	3	0	1
Test 1	Flush button	64	50	30	13	20	Toilet lid, inside	15	17	5	48	10
Test 2		20	15	51	13	377		23	38	9	13	4
Test 3		24	34	71	12	49		2	2	0	4	2

None of the sets of methods in classroom cleaning gave good results (Fig. 8). The limit value “Good” was rarely reached.

It is worth noting that the ATP values were much higher in classrooms than in toilets (Fig. 10).

In these measurements the highest RLU values before cleaning were found from classroom desktops (mean values RLU 752-2428) and in toilets from inside door handle and lock (mean values RLU 874-1076).

After cleaning the highest ATP values were found from desktops (mean values RLU 282-1750) and in toilets from toilet seat ring (mean values RLU 91-365).

According to both test methods, the outside door handle and lock were best cleaned. We wonder if the reason is the size of the item – is it easier to clean effectively small objects than large desktop and floor areas?

Organic dirt was left on desktops in every set of methods but using the microfibre cloth gave better results than using the interior mop. In floor cleaning, the use of a scrubber drier improved results. The high number of furniture makes mopping difficult. To gather, hold and remove dirt, proper mopping technique is needed.

Figure 10. Test results after cleaning the classroom, means of each three tested set of methods.

	ATP measurements						Microbiological measurements					
		2.2.2023	23.2.2023		25.8.2023	9.10.2023		2.2.2023	23.2.2023		25.8.2029	9.10.2023
Test 1	Outside door handle and lock	42	299		125	105	Outside door edge	8	1		0	40
Test 2		54	28		184	235		70	21		1	3
Test 3		147	236		91	340		6	8		1	2
Test 1	Floor, the first area	556	1157		932	1061	Floor, the first area	30	32		14	27
Test 2		416	461		1151	1440		60	73		33	27
Test 3		316	522		340	252		26	26		10	72
Test 1	Floor, the last area	332	999		346	664	Floor, the last area	34	45		67	10
Test 2		720	1204		157	2528		63	32		21	43
Test 3		367	352		205	477		21	37		17	57
Test 1	Desk, the first one	2728	384		2023	1866	Desk, the first one	15	13		11	14
Test 2		189	762		447	255		69	77		19	17
Test 3		383	180		102	461		14	35		12	29
Test 1	Desk, the last one	368	762		1442	1585	Desk, the last one	10	97		17	28
Test 2		245	1269		899	575		55	62		13	9
Test 3		470	540		380	372		16	70		37	29
Test 1	Chair back	94	382		337	361	Chair back	17	13		56	62
Test 2		107	243		373	562		57	51		16	37
Test 3		313	112		293	314		23	44		34	21

Figures 11 and 12 visualise the ATP measurements and microbiological measurement results as examples.

Figure 11. ATP results varied a lot.

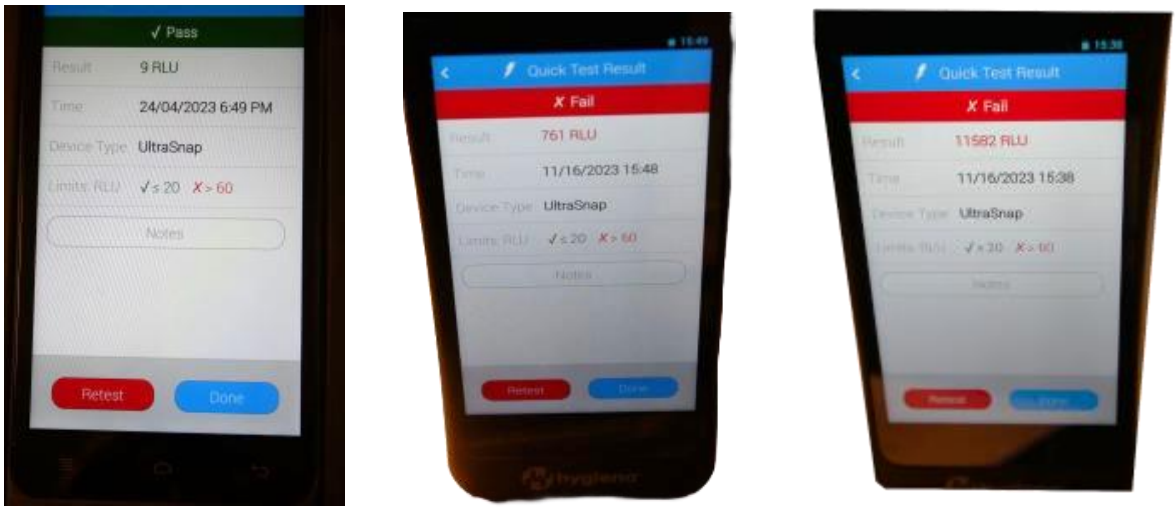
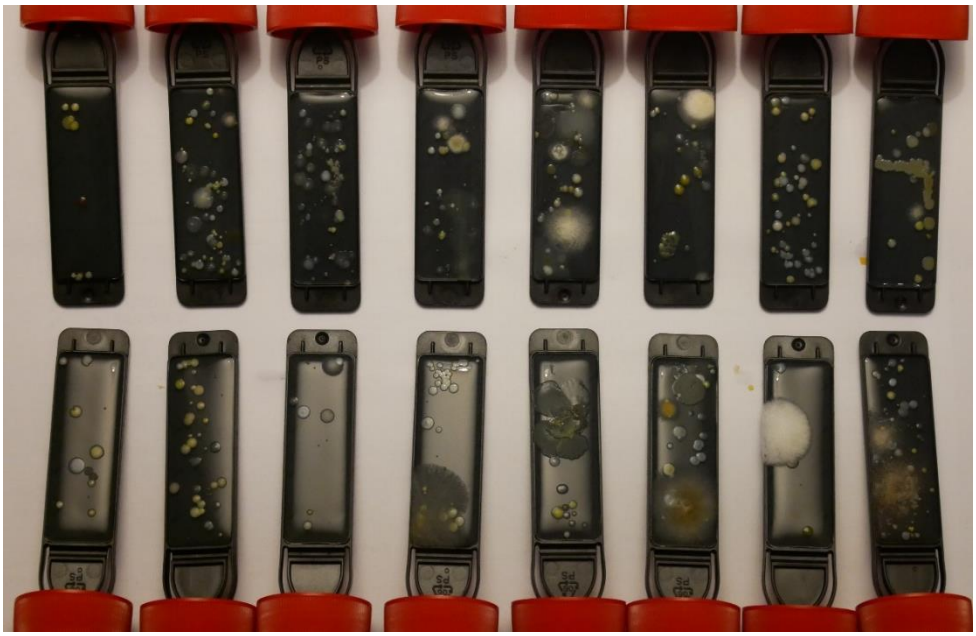


Figure 12. Example of microbe growth on different classroom surfaces before cleaning (above) and after cleaning (below).

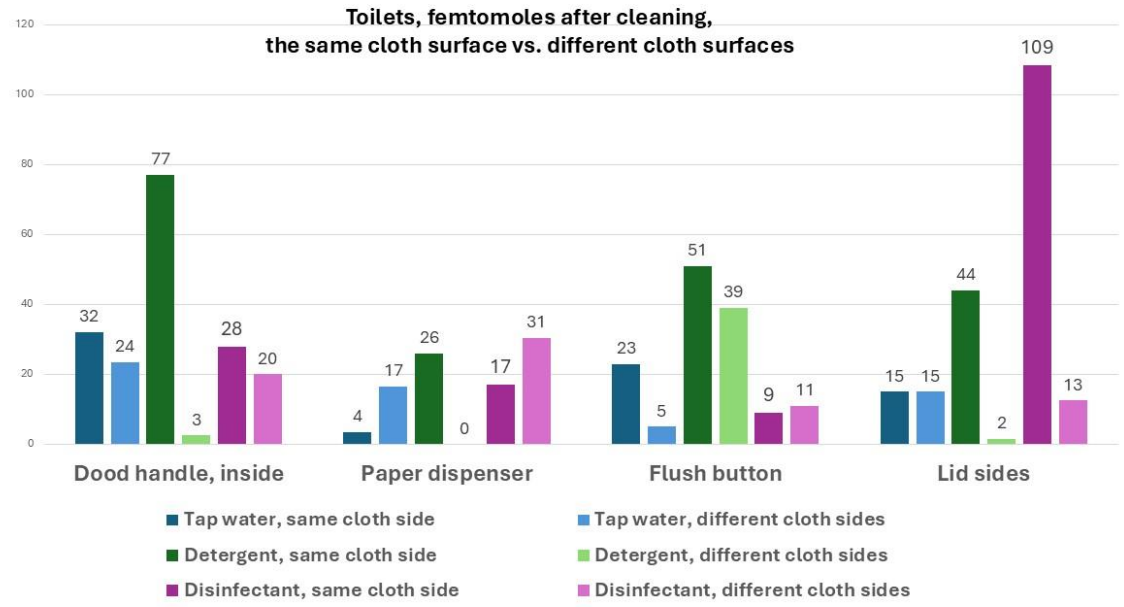


Does it matter which method or technique is used?

Because the planned sets of methods did not give acceptable results, additional tests were carried out on the effect of the wiping technique and cleaning methods.

The importance of changing the microfibre cloth side when moving to another contact surface was tested in toilet cleaning. Most of the tests showed that changing the clean side of a microfibre cloth after each contact surface was beneficial (Fig. 13). When using only one cloth surface for the door handles and sink area and another one for the toilet seat, the acceptable limit value (50 femtomoles) was occasionally exceeded.

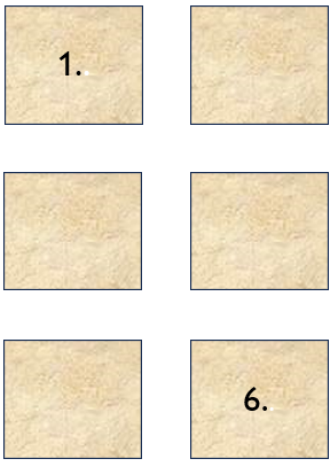
Figure 13. ATP measurement values in femtomoles after cleaning toilet surfaces with the same cloth side and with different clean cloth sides.



Wiping technique in classroom cleaning was tested by wiping six desktop surfaces different ways with the same cloth side. The purpose was to compare tap water and slightly alkaline detergent, different wiping techniques when using damp, moist and wet wiping.

The results show that even when we wipe only six desktop surfaces with the same microfibre cloth side, the cleanliness level gets poorer and, in some cases, the cleanability-% is negative which indicates that the surface is dirtier after cleaning than before (Fig 14).

Figure 14. Cleanability-%s when cleaning desk surfaces with the same microfibre cloth in different ways. Numbers in red colour mean that the result is over the limit value.



Tap water and microfibre cloth				
	1. desk		**6. desk**	
	ATP, %	CFU, %	ATP, %	CFU, %
Damp, one wipe	98	90	94	-38
Damp, 2 overlapping wipes	89	83	-13	4
Moist, one wipe	92	95	73	83
Moist, 2 overlapping wipes	94	77	-25	43
Wet, one wipe	53	71	52	51
Wet, 2 overlapping wipes	84	-48	99	79

S. alkaline detergent and microfibre cloth				
	1. desk		**6. desk**	
	ATP, %	CFU, %	ATP, %	CFU, %
Damp, one wipe	79	43	46	86
Damp, 2 overlapping wipes	99	68	49	81
Moist, one wipe	99	86	72	63
Moist, 2 overlapping wipes	62	70	-57	31
Wet, one wipe	98	-100	96	-13
Wet, 2 overlapping wipes	90	8	98	36

It seems that there is need to change cloth side more often and pay attention to clean the entire surface and use sufficient mechanics. Damp and moist methods removed quite well organic dirt but not equally well microbes from the first desktop. When using wet methods, the use of a detergent gave better results than the use of tap water.

Several tests about wiping technique when using different detergents and tools were carried out. As whole, moist wiping methods gave better results. The best result with an interior mop and tap water was achieved when the desktop surface was moist wiped with sideways movement. With a microfibre cloth the result was better when wiping movement was forwards and back.

Finally, tests were performed to find the way to have a clean desktop surface in daily cleaning. The acceptable cleanliness was reached when moist wiping the surface with pressure and supervising that every part of the desk was wiped. It's worth noting, that this method took around 1,5 - 2 times more working time than what was calculated for cleaning a desktop surface (according to Finnish time standard for cleaning work).

Which were the cleanest surfaces before and after cleaning?

Aseptic working order is a basic concept in cleaning. It means, among other things, cleaning from cleaner areas, rooms, and surfaces towards the dirtier.

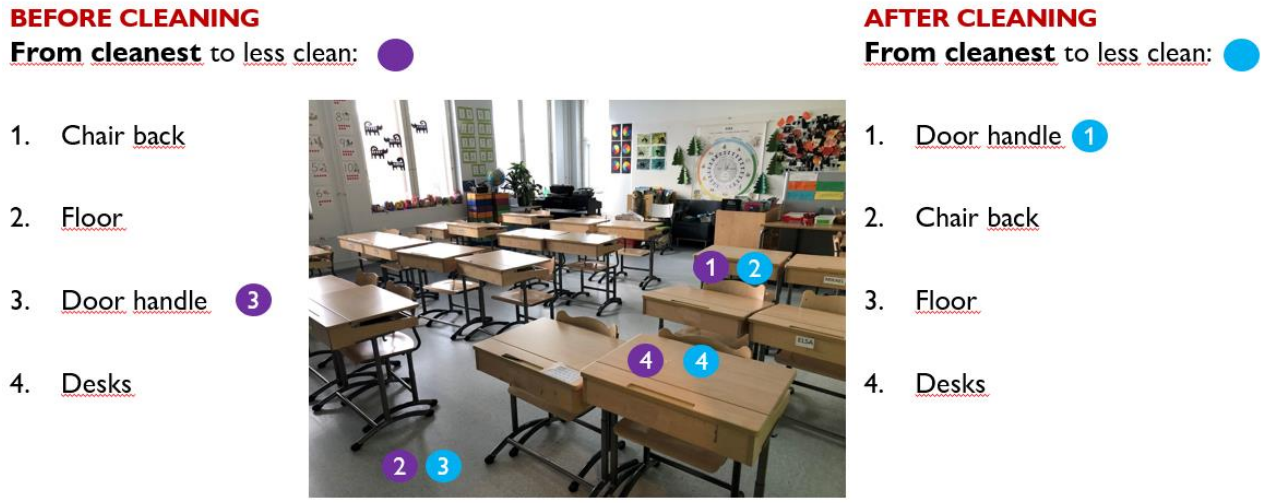
In daily cleaning this may be hard to follow, because the amount and placement of dirt may differ from day to day. Instead of talking about aseptic working order, it might be better to talk about aseptic cleaning and to emphasise techniques that hinder spreading dirt.

When guiding daily cleaning, we should concentrate on results. When instructing, we should speak e.g. like "Remove the dirt from a handle by moist wiping with a microfibre cloth". Not like "Moist wipe a handle with a microfibre cloth". The focus should be on the result, not on the work method.

To find out the cleanest contact surfaces before and after cleaning, ATP mean values of all samples were calculated. The results are visualised in figures 15 and 16.

Figure 15. The cleanest surfaces in toilets before and after cleaning. Summary of ATP results of all samples.

Figure 16. The cleanest surfaces in classrooms before and after cleaning. Summary of ATP results of all samples.



What is the effect of deep cleaning?

The aim of the long test period was to find out how deep cleaning affected cleanliness results and if it would be beneficial to clean contact surfaces thoroughly in the beginning of the pandemic.

During the school summer vacation, all the test rooms were thoroughly cleaned. In the autumn before school started, ATP and microbiological samples were taken. Low RLU and CFU values showed that deep cleaning had been successful.

The first samples after deep cleaning were taken after 2,5 school weeks. Both in classrooms and toilets, deep cleaning had no major effect on RLU values, but some effect on CFU values (Fig. the 9 and 10).

Does the surface matter?

As stated before, cleaning results were better in toilets than in classrooms. One reason for that may be the surface materials in the toilets. Non-porous even chrome plated materials and porcelain surfaces are easier to get clean than porous, uneven or worn surfaces. If the surface tested was worn, the measurement value was normally also high and the cleanliness-% was poor.

Does it matter who are using the space?

In classrooms, desks used by grades 3 and 4 were cleaner before cleaning than desks used by younger pupils according to these test results.

It's worth noting that toilets could get dirty very soon after cleaning, sometimes after the first toilet user.

EFFECT OF CLEANING CLOTH MOISTURE

When we noticed that despite our careful measures the results were sometimes unexpected and incomprehensible, we started to look for reasons why the ATP and Hygicult samples show that in many cases the surfaces are dirtier after cleaning than before cleaning. This means that the work was done but the goal was not achieved and worse, the surface cleaning increased the amount of dirt or transferred it from one surface to another. In pandemic situations, this is a significant risk.

A well-known problem is surface soiling, caused by the use of wet methods without drying the surface, excessive use of cleaning products and /or dirty cleaning equipment. Years of experience, for example when examining toilet seats with a UV lamp, show that surface soiling is left on the surface long before the layer is visible to the naked eye.

We tested at which moisture level dirt is most effectively removed when water is used to moisten the microfibre cloth. We conducted the experiment as follows:
- We tested six different types of microfiber cloths.
- The cloths were moistened with 10 different levels of tap water (5 ml, 7 ml, 10 ml, 12 ml, 15 ml, 17 ml, 20 ml, 22 ml, 25 ml, 30 ml per cloth).
- The moistened cloths were placed in plastic bags.
- One cloth was used for one wiping only, an area the size of one tile was wiped.
- The normally dirty toilet walls were cleaned under the UV lamp. The tiles were clean in regular light, but quite dirty when viewed under the UV lamp.
- When wiping, the aim was to apply force equally to all methods.
- The UV lamp was used to assess whether the dirt had been removed.

Conclusions:

- If the method is too dry, the surface will not get clean. All cloths were not able to clean the surface when moistened with water less than 10 ml.
- All cloths, when they were too wet, dissolved dirt well, but without additional wiping a layer of dirt or stains remained on the surface (Fig. 17). This limit was 22 ml for 5 cloth types and 17 ml for one smaller cloth. If such a layer dries out, it will be considerably more time consuming to remove and will require more thorough cleaning. Such layers are a favourable environment for the growth of micro-organisms.
- When using more than one side of the cloth, the difference in moisture between the first and last side is noticeable and affects the wiping result.

Therefore, it is important to know the appropriate moisture level and it is recommended to test it under certain conditions, as the appropriate moisture level can be influenced by several factors such as the age of the fabric, the surface material, etc.

Figure 17. The toilet wall before wiping (on the left) and after wiping showing the wiping marks as a result of insufficient cleaning (on the right).

MAPPING OF CONTACT SURFACES

Because recognising contact surfaces is important, ATP and microbiological samples were taken from different rooms in nursing homes, kindergarten, and school.

The samples were taken **before cleaning**. The results of each room are presented in Annex 2.

The results show e.g. that high RLU values were found on table edges. Is it so that tabletops are cleaned well but the edges forgotten? However, e.g. in a nursing home resident room, the tray table edge is touched by nurses and the resident, and the edge is for that reason an important surface to be wiped clean.

In the resident room, high RLU values were found on appliances that the resident touches, like remote controls, a bed grab rail, lifting pole handle, and rollator handle. May the reason lay on poor hand hygiene of the resident or lack of clarity about who is responsible for cleaning them?

Handles of appliances (kettle, microwave oven), kitchen surfaces and furniture in the staff break room in a nursing home showed high RLU values. Is the space cleaned too seldom or are the responsibilities of cleaning unclear?

In kindergarten dining room the dirtiest surfaces were armrests and table edges. In toilet, the highest values were found from the sink and toilet seat ring.

DISCUSSION

Achieving microbiological cleanliness through cleaning is not a certainty. There are many factors that influence the outcome of cleaning which cannot be controlled by the cleaner and the cleaning service organisation alone.

In addition to identifying the contact surfaces, each cleaning organisation should measure and determine the level of cleanliness produced by the cleaning methods it uses: does it also produce microbiological cleanliness where appropriate?

The lack of limit values makes it difficult to define optimal cleanliness - there is no answer to the question "how clean is clean enough?" when it comes to the role of cleaning in combating the spread of infections.

This case study was performed in real-life conditions highlighting the many variables that are present in daily cleaning that do not show up in laboratory tests. Cleaning can be successful and remove organic dirt and microbes from surfaces, but it can also be unsuccessful. Dirt can be smeared to other surfaces and they can therefore be dirtier after cleaning than before.

Before the next pandemic, the outcome of the cleaning processes as whole should be studied more in real-life conditions. Also, more studies are needed on the cleaning performance of the cleaning equipment and the effectiveness of chemicals.

Annexes

Annex 1

Tools and detergents used in surface cleanliness and hygiene tests

	Classroom cleaning		Toilet cleaning	
Detergents	Tap water		Tap water	
	Slightly alkaline	Non-ionic surfactants 15-30%, soap <5% pH of the dilution 8.0 Changed to: Non-ionic surfactants < 5% pH of the dilution 9.5	Slightly alkaline	Non-ionic surfactants 15-30%, soap <5% pH of the dilution 8.0 Changed to: Non-ionic surfactants < 5% pH of the dilution 9.5
			Disinfectant	Cleaner and disinfectant. Hydrogen peroxide 5-15 %, non-ionic and anionic surfactants and phosphonate and phosphate < 5% pH of the dilution 1.5
Tools	Microfibre cloth	100% microfibre, 70% recycled 	Microfibre cloth	100% microfibre, 70% recycled 
	Interior mop	100% microfibre 	Disposable cloth	Non-woven 
			Dish washing brush	
			Microfibre pad	
	Floor mop	100% microfibre mop 	Floor mop	100% microfibre mop 

	Squeegee mop with floor cloth		Squeegee mop with floor cloth	

Working instructions

Toilet cleaning

1. (Check the toilet and remove blood and body fluids, if any. Also remove large loose dirt (waste) from the floor and flush the toilet).
2. Clean (wash or disinfect) your hands.
3. Put on disposable protective gloves.
4. Fill in toilet and hand paper and soap dispensers, if necessary.
5. Empty the trash can and replace the plastic bag and, if necessary, clean the trash can. Leave the trash can outside the toilet.
6. Spread the agent into toilet bowl and spread it around with a toilet brush.
7. Spread the cleaning agent solution into the sink.
8. Clean the sink with a dishwashing brush / pad.
9. Fold the moist microfibre cloth into four and wipe the contact surfaces:
   1. surface: door handles from both sides of the door and areas around them,
   2. surface: light switches, dispensers especially from the touch area, and the hand shower handle.
   3. surface: dry the faucet, clean the wall behind the sink and clean the mirror, if visibly dirty.
   Fold a clean cloth surface also when the cloth surface gets visibly dirty.
10. Clean the toilet bowl with a toilet brush.
11. Close the toilet bowl lid and flush the bowl and toilet brush.
12. Wipe the toilet seat with a cleaning cloth starting from the water tank: first the flush button, then the tank, both sides of the lid and seat, and in case there is visible dirt, the base.
13. Wipe the walls around the toilet bowl if there is visible soiling.
14. Take off protective gloves and clean hands.
15. Wipe the floor with a squeegee and moist floorcloth on it and collect loose dirt from the floor with a floor brush with a semi-long handle and dustpan.

Classroom cleaning

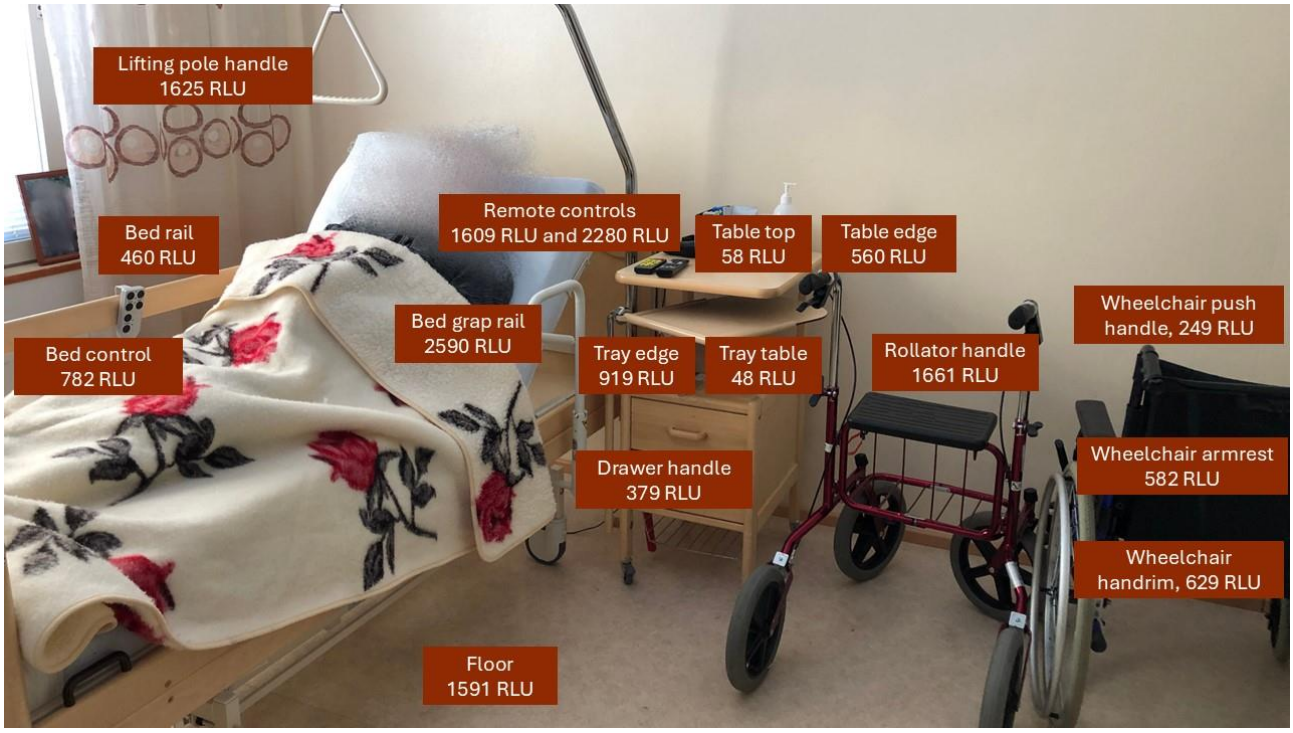
1. Clean your hands.
2. Put on protective gloves.
3. Fill in dispensers, if necessary.
4. Empty a trash can and replace the plastic bag and, if necessary, clean the trash can.
5. Clean the blackboard and/or whiteboard, if necessary.
6. Fold the moist microfibre cloth into four and wipe the contact surfaces: e.g., door handles and other door touch points, light switches, and other. Fold a clean cloth surface after moving to another contact surface and when the cloth surface gets dirty.
7. Check windowsills, clean if necessary.
8. Wipe all table surfaces with a damp/moist microfibre cloth or with an interior flat mop.
9. Wipe chairs, especially surfaces that pupils touch.
10. Wipe other furniture.
11. Clean the sink and surfaces around it: dispensers, table, wall behind.
12. Take off protective gloves and clean your hands
13. Wipe the floor with a moist mop / squeegee. Collect loose dirt from the floor with a floor brush with a semi-long handle and dustpan

Annex 2

ATP test results before cleaning from different rooms in different premises.

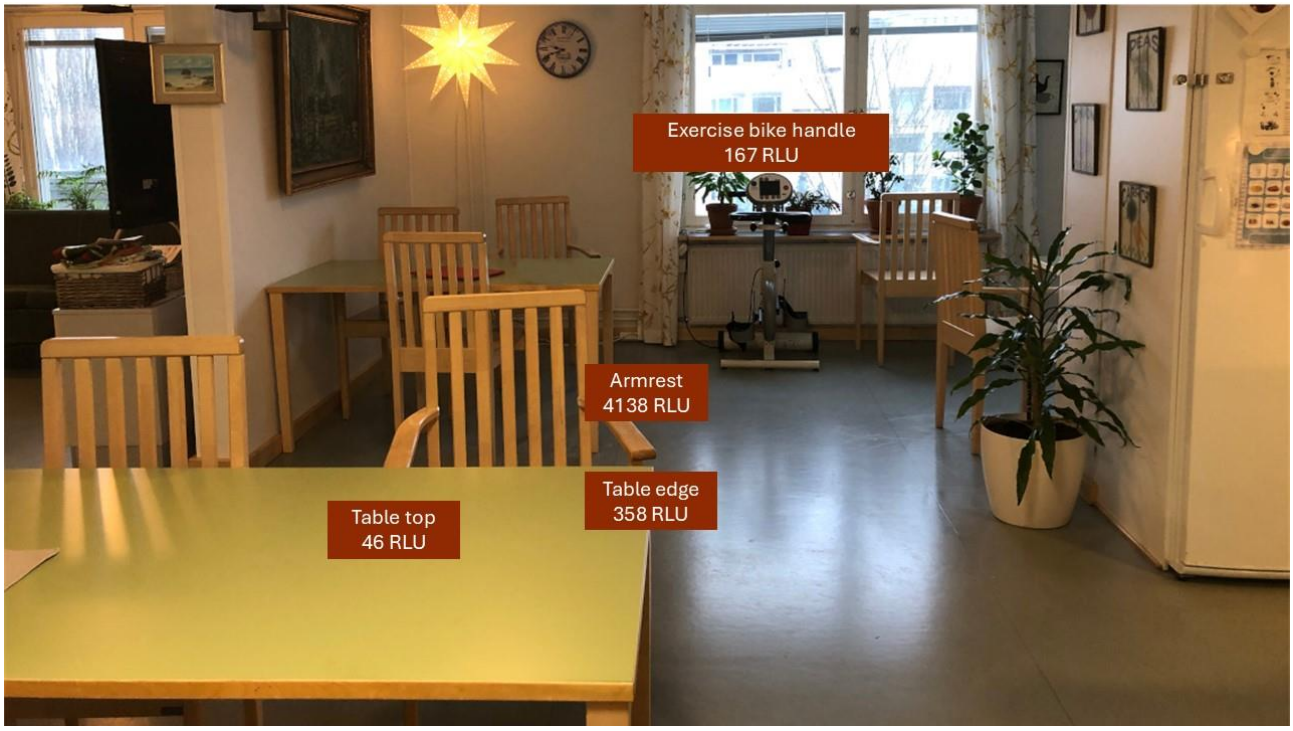
Measured with Hygiena EnSURE Touch luminometer.

RLU values in an **elderly care home resident room** before cleaning.



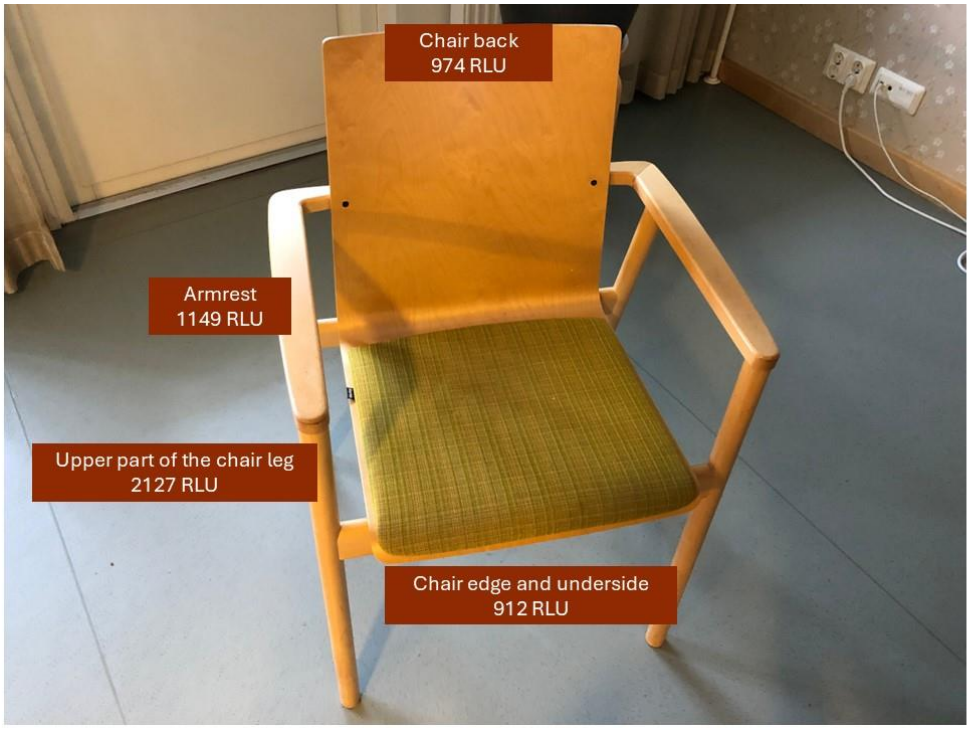
RLU values in an **elderly care home toilet** before cleaning.

RLU values in an **elderly care home dining room** before cleaning.



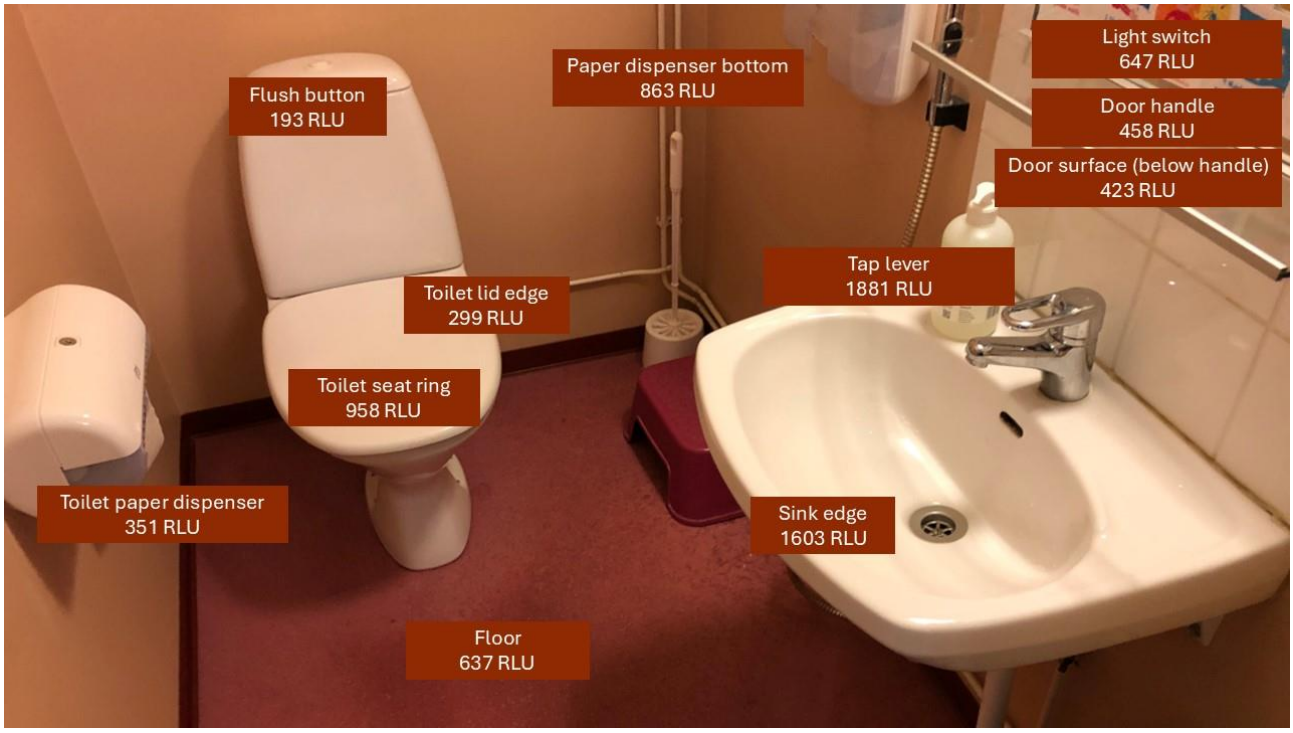
RLU values in an **elderly care home staff break room** before cleaning.

RLU values in an **elderly care home: break room's chair** before cleaning.

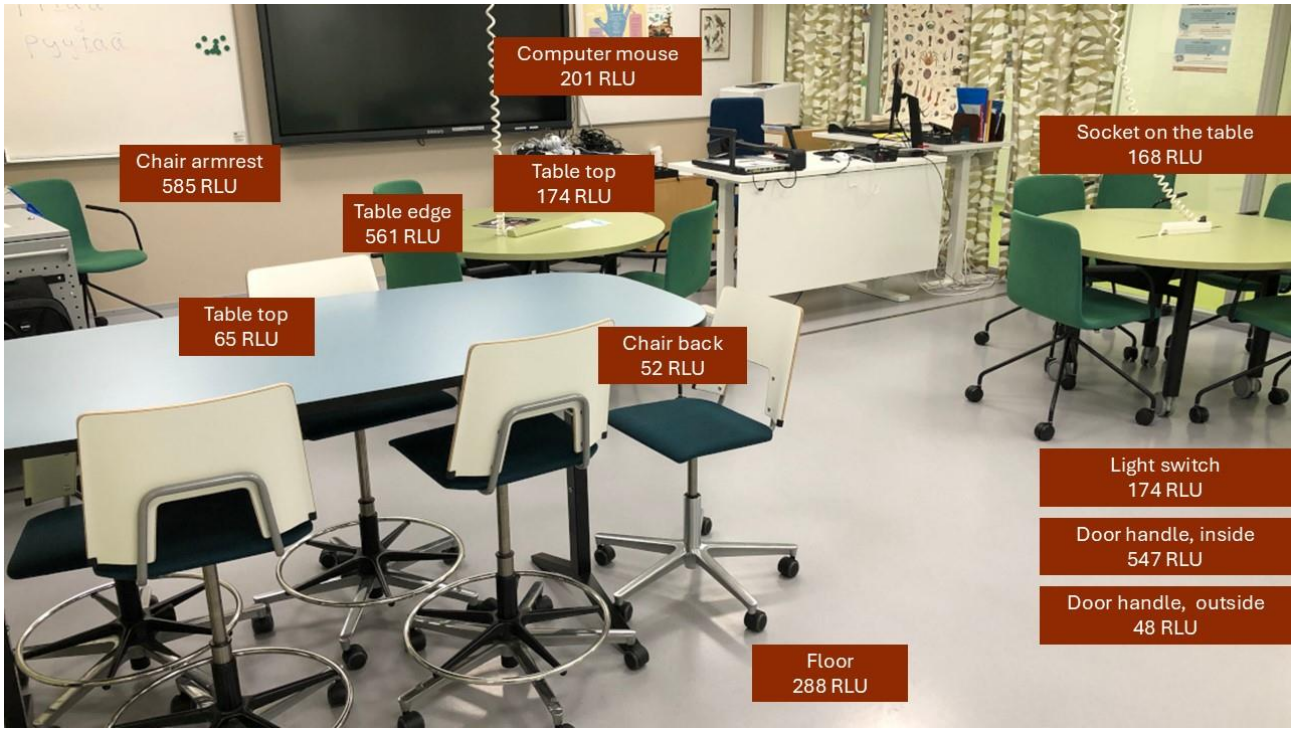


RLU values in a **kindergarten dining room** before cleaning.

RLU values in a **kindergarten toilet** before cleaning.



RLU values in a **classroom** before cleaning.



RLU values in a **teacher's room** at school before cleaning.

RLU values in a **teacher's room** at school before cleaning.