Effectiveness of class 1 biological safety cabinet modification on reducing air germ rate

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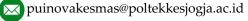
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Article information:		ABSTRACT
Accepted Revised Published	: March 5th 2021 : March 7th 2021 : April 28th 2021	Biological Safety Cabinet (BSC) in the form of a ventilated cupboard using a combination of High-Efficiency Particulate Air (HEPA) filtration system, laminar airflow, and containment to protect laboratory, product, and the environment from harmful biological agents. This research aims to determine the effect of level 1 BSC created to decrease the number of air germs in the laboratory. This study was an observational analytic using a cohort design. The research object is the number of air germs in standard Level 1 BSC Safe-tech ES 199 models and level 1 BSC created from a team in the laboratory. Data analysis using one-way ANOVA and independent t-test. One-way ANOVA test data shows the standard level 1 BSC Safe-tech ES 199 models and the creation of level 1 BSC used in 60 minutes and 90 minutes is the same as significant ($p>0.05$), while the duration of use for 120 minutes has a significant difference ($p<0.05$). Independent t-test analysis showed Sig (2-tailed) = 0.577, so there were no differences between the two tools during the 120-minute use. The creation of level 1 BSC can reduce the number of air germs.
Key word: Biosafety Biological Safety Cabinet (BSC) level 1 Germ number index		
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Introduction

Clinical laboratories in hospitals are one of the places that can cause nosocomial infections.[1] Biological Safety Cabinet (BSC) in the form of a ventilated cupboard that uses a combination of filtration with a High-Efficiency Particulate (HEPA) system, laminar airflow, and containment to protect laboratory, product, and environmental, harmful biological agents. Based on the risk group for biological hazards, the BSC is divided into three levels: Level I, Level II, and Level III[2,3,4] .These three levels provide various levels of protection. The higher the risk group and the level of security, the higher the cabinet-level used.[2,4]

Laboratory activities such as cell culture inoculation, suspension fluids from infectious compounds, homogenization, contagious material shaking, centrifugation of toxic liquids, or working with animals can cause poisonous aerosols.[3] Laboratory workers are usually less aware that particles have arisen and may be inhaled or may cross-contaminate work on the surface material. If the BSC is used correctly, it will be very effective in reducing laboratory infections and cross-contamination in cultures during exposure to aerosols.[2,4]

Bacterial identification studies that can cause nosocomial infections have been carried out in the RSUDZA Clinical Microbiology Laboratory in Banda Aceh. The study took a sample by swab on one of the surfaces in the BSC. The results of culture based on the source of isolates in BSC found Staphylococcus hominis spp hominis bacteria.[5] These normal flora bacteria found in BSC may be obtained from clinical samples. These bacteria can cause disease in patients with a decrease in the immune system.[6]

BSC creations from the production team at the Health Analyst Department in 2018 can be used as an alternative BSC level 1, based on the results of the functional tests conducted at the Clinical Laboratory of PKU Muhammadiyah Hospital in Bantul on the incidence of infection after fecal examination and BTA in BSC use, during January to July 2018. The function test results are obtained 0 (zero) in nosocomial infections or Healthcare-Associated Infections (HAIs).

Level 1 BSC does not have an established air germ number limit. However, level 1 BSC is included in the laboratory room, so the germ number requirements can refer to the germ number requirements based on the decision of the Republic of Indonesia Minister of Health No 1204/Menkes/SK/2004 that laboratory space must be free of pathogenic germs and laboratory air 200-500 CFU/ m^3.[7]

The preliminary level 1 BSC creation test was carried out to determine the effectiveness during the laboratory use process for air germ numbers with 15 minutes, 30 minutes, 45 minutes, and 60 minutes exposure to petri dishes in the cabinet. Based on the test results for the use of 15 minutes to 30 minutes, the germ values remained stable, and there was an increase in germ numbers by 40.19 % during the 30 minutes to 45-minute usage process. There was a 4.6 % decrease in germination during the 45-minute usage process 60 minutes.

Subsequent research was carried out in the level 1 BSC Safe-tech ES 199 model compared with level 1 BSC creations. Level 1 BSC creations are expected to reduce the number of air germs, especially pathogenic germs, at a price that is cheaper and easier to maintain. Thus, this tool can effectively be used in the laboratory. This study aims to know the effectiveness of using level 1 BSC creations on air germ numbers in the laboratory.

Material and method

This study is an analytical observational study with a cohort research design.[8] The object of this research is the number of air germs in standard Level 1 BSC Safe-tech ES 199 models and level 1 BSC modification tools in the laboratory. Sampling using standard level 1 BSC Safe-tech brand ES 199 model and level 1 BSC modification in laboratory space. Three petri dishes medium PCA plates were placed open for 60 minutes, 90 minutes, and 120 minutes for each tool, then the medium was closed and incubated for 48 hours at 37°C. Germ breeding is complete, then calculate the germ number index. The data collected in this study were analyzed by one-way ANOVA test and independent t-test.

Result and discussion

The study used two tools, namely the standard level 1 BSC Safe-tech ES 199 model measuring 0.118 m^3 with drainage pipes in the form of U pipes and tubes installed above the roof exit tool and without HEPA filter, and level 1 BSC creation tools measuring 0.108 m^3 with a pipe drain measuring 35,5 cm long with HEPA filters. The number of colonies and germ numbers of the standard BSC level 1 Safe-tech ES 199 model and level 1 BSC modification were obtained by counting colonies on PCA medium with the exposure plate [9] method for 60 minutes, 90 minutes, and 120 minutes each of the 11 samples carried out germ culture on petri

dishes after incubation for 48 hours.

Based on table 1 shows that the comparison of the percentage number of germ index on level 1 BSC modification equipment is lower than using standard level 1 BSC Safe-tech ES 199 model because during the use of 60 minutes, there was a decrease in the germ number index of 5,2 %, a 90-minute decrease in the germ number index of 4,9 %, and 120 minutes in the germ number index decrease of 4,8 %.

The data obtained are primary data and scale ratio, which is the data measured by the number of germ index numbers from 66 petri dishes. The ANOVA test results got a p = 0.000 because the value of p <0.05, the study results on the standard level 1 BSC Safe-tech brand ES 199 model and level 1 BSC modification tools are significant differences between 60, 90 minutes, and 120 minutes. The 60 minutes and 90 minutes long groups of use did not differ significantly (p>0,05), while the 120-minute duration of use was quite different (p<0,05).

Significantly different groups in the standard level 1 BSC Safe-tech ES 199 model and level 1 BSC modification tools occur during 120 minutes of use. An independent t-test carried out the difference in the average value between the two groups of devices. The sig value (2-tailed) = 0,577 was obtained, so there was no difference in the standard Level BSC Safe-tech ES 199 model and level 1 BSC modification for 120 minutes of use.

Air bacterial examination results on standard Level 1 BSC Safe-tech ES 199 models and level 1 BSC modification tools using PCA media, all groups were obtained during 60 minutes, 90 minutes, and 120 minutes positive samples of bacterial growth with an average germ number index ranging from 60,6 CFU/m³ and the highest 144,1 CFU/m³, after being compared with the germ number index based on Kepmenkes RI No. 1204/Menkes/SK/2004 for air quality standards for room and unit functions in the laboratory space of 200-500 CFU/m³, that the germ number for the standard level 1 BSC Safe-tech ES 199 model and level 1 BSC modification tools are still following hospital environmental health requirements.

Comparing the percentage number of germ index on level 1 BSC creation tools is lower than using standard level 1 BSC Safe-tech ES199 models. There is an increase in the germ number index in the standard level 1 BSC Safe-tech ES 199 model in the laboratory research location was caused by the use of tools since 2001 which carried out poor maintenance including laboratory personnel every day only wiping the outside and inside of the cabinet from dust, then in 27th day every month checking the fluorescent lights, UV lights and fans on or not, resulting in iron-based tools that become rusty and dirty dusty fans. It is at risk of air pollution and contaminants when using the device. Working safely in the BSC, maintenance is carried out including two times a day surface disinfection, and weekly UV lights must be cleaned, monthly all vertical surfaces cleaned, the annual intensity of UV lamps verified, decontamination with formaldehyde gas and certification.[4]

During the use of the tool, there was a difference in the percentage increase in germ rate on the level 1 BSC modification tool compared to the standard level 1 BSC Safe-tech ES 199 model during the process of using 60 minutes up to 90 minutes increased by 1,4 % and during the process of use 90 minutes up to 120 minutes increased by 0,4 %. This increase was due to a larger capacity, capacity PC fan level 1 BSC creation tool compared to the standard level 1 BSC Safe-tech ES 199 model. Standard level 1 BSC Safe-tech ES 199 model tool with a capacity of 900 spin/min with an airflow rate of less than 0,2 m/s, while the level 1 BSC modification tool uses a PC fan with a capacity of 6000 spin/min which produces airflow rates of 0,3 m/s. The fan structure consists of a propeller and a driving mechanism such as a motor can produce axial airflow,[10] so that the ability of the PC fan on level 1 BSC creation devices is more incoming airflow and results in an increase in bacterial colonies in the cabinet because the air space is not sterilized so above the surface of the work area cannot consistently provide product protection.[4]

PC fan speed capacity is caused by differences in the design of the drainpipe. The level 1 BSC creation tool is designed to use a HEPA filter on a drainpipe. The presence of HEPA filters when using a BSC tool aims to separate the air from the impurity particles so that the air that is input into the clean space is free of contaminants,[11] so it requires a PC fan power that is greater than the standard level 1 BSC Safe-tech ES 199 model which is designed without a HEPA filter on a drainpipe. HEPA filters are designed to filter particulate dust, moisture, smoke, bacteria, and odors. Levels of dust, moisture, bacteria, mold spores > 2,5 μm in size will not escape the HEPA filter.[10] This allows the HEPA filter to filter all infectious compounds effectively and ensure that only microbial-free air is removed from the cabinet.[12]

The lowest number of colonies on level 1 BSC creation tools during the use of 60 minutes mean value of 60,609, 90 minutes for the mean value of 79,136, and 120 minutes for the mean value of 137,209. Therefore level 1 BSC modification tools can be used and help work aseptically with UV light application for 30 minutes before use.[13] UV lights commonly used on the laminar flow biological safety cabinet are UV type C lamps [14], This type of UV can kill or deactivate organisms such as bacteria and germs for the sterilization process.[14,15]

Table 1. Calculation Results of Average Colony Amount and Germ Number Index (CFU / m^3) Standard Level 1 BSC Safe-tech Brand ES 199 Model and Level 1 BSC modification Tools.

Duration of Use (minutes)	The average number of colonies		Average germ number index (CFU/m³)		Difference in decline	Percentage decrease (%)
	a	b	a	b		
60	7.5	6.5	63.9	60.6	3.3	5.2
90	9.8	8.5	83.2	79.1	4.1	4.9
120	17	14.8	144.1	137.2	6.9	4.8

noted: a= Safe-tech ES 199 Model; b= modification model

Conclusion

Level 1 BSC modification are effectively used for 60 minutes, 90 minutes, and 120 minutes to reduce air germs. From the results of this study are that relevant agencies are expected to maintain the hygiene of the room, especially laboratory units, based on regulations made by the Minister of Health of the Republic of Indonesia No 1204/Menkes/SK/2004 for hospital rooms. Health workers are expected to use level 1 BSC to reduce airborne germ contamination in the isolation of the sample they are working on. Further research is needed regarding the germ number index for the whole level 1 BSC creation tool.

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