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CLINICAL RESEARCH / KLİNİK ARAŞTIRMA

Is it Really Clean? Investigation of a "No-Touch Button" for Bacterial Contamination by a Different Technique

Gerçekten Temiz mi? Temassız Butonların Farklı Bir Teknikle Bakteriyel Kontaminasyon Açısından Araştırılması

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Abstract

Objective: No-touch buttons are generally used by patients, patients care givers and healthcare workers. Principal mechanism is based on opening the doors without touching the surface and is supposed to be clean. The objective of this study was to determine the contamination load of no- touch buttons with adenosine triphosphate (ATP) measurement method and to identify microorganisms using microbiological methods in a tertiary pediatric research hospital.

Methods: A total of 65 samples were collected from the surfaces of buttons located the inside and outside of the units and analyzed to assess ATP levels and mircoorganim colony count.

Results: Among the samples taken from the surface of buttons, 53 (81.5%) of the surfaces had microorganism isolation. The relative light unit (RLU) values ranging from 35 to 2048/100 cm^2 were determined by the ATP bioluminescence assay. The median RLU value was 217/100 cm^2 and 41.5% of the values (27 samples) were equal to or higher than 250/100 cm^2. A significant correlation was found between the luminometric and microbiological data obtained for the same surfaces ($p<0.05$). No significant differences in colonization prevalence were clear concerning the location of the buttons ($p>0.05$).

Conclusion: Although not an alternative to cultural methods, the ATP-bioluminescence-assay can be a useful tool for measuring the efficiency of cleaning also in environments. Our data suggest that microbial contamination of no-touch buttons is prevalent. Regarding these results, strict hand hygiene is important since even no-touch buttons might serve as reservoirs for microorganisms.

Keywords: Adenosine triphosphate bioluminescence, cultural method, no-touch button

Öz

Amaç: Temassız butonlar genellikle hastalar, hasta bakıcılar ve sağlık çalışanları tarafından kullanılır. Prensip mekanizması kapıların yüzeyine dokunmadan açılmasıdır ve temiz olması beklenir. Bu çalışmanın amacı, üçüncü basamak bir pediatri araştırma hastanesinde adenozin trifosfat ölçüm yöntemi ile temassız butonların kontaminasyon yükünü belirlemek ve mikroorganizmaların mikrobiyolojik yöntemle tanımlanmasıdır.

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Öz

Yöntem: Ünitelerin iç ve dış kısımlarında yer alan buton yüzeylerinden toplam 65 adet numune alındı ve adenozin trifosfat düzeyleri ve mirkoorganim koloni sayımı için analiz yapılmıştır.

Bulgular: Buton yüzeyinden alınan numunelerin 53'ünde (%81,5) mikroorganizma izole edildi. Adenozin trifosfat biyolüminesans testi ile 35 ila 2048/100 cm^2 arasında değişen bağıl ışık birimi değerleri saptandı. Medyan bağıl ışık birimleri değeri 217/100 cm^2 idi ve değerlerin (27 numune) %41,5'i 250/100 cm^2'ye eşit veya daha yüksekti. Aynı yüzeyler için elde edilen luminometrik ve mikrobiyolojik veriler arasında anlamlı bir korelasyon bulundu ($p<0,05$). Butonların yeri ile ilgili olarak kolonizasyon prevalansında belirgin bir fark yoktu ($p>0,05$).

Sonuç: Kültürel yöntemlere bir alternatif olmasa da, adenozin trifosfat biyolüminesans tahlili, ortamlarda temizliğin etkinliğini ölçmek için yararlı bir araç olabilir. Verilerimiz, temassız butonların mikrobiyal kontaminasyonunun yaygın olduğunu göstermektedir. Bu sonuçlara göre, temassız butonlar bile mikroorganizmalar için rezervuar görevi görebileceğinden sıkı el hijyeni önemlidir.

Anahtar Kelimeler: Adenozin trifosfat biyolüminesans, kültürel yöntem, temassız buton

Introduction

The contamination of hospital surfaces was reported to play an important role in the transmission of several healthcare-associated microorganisms[1]. No-touch buttons are ubiquitous and have been actively used inside hospitals. Not only the healthcare workers (HCWs) including nurses, doctors, interns, consultant doctors, radiology technicians, but also patients, patient caregivers, and visitors use these buttons. Although these buttons open the doors of the ward and isolation room without touching any associated surface and prevent contamination of hands from the surfaces, every button has different degrees of motion sensitivity and distance, thus unintentional contact with the surface might occur by HCWs and mostly patient caregivers.

The culture-based colony counting method is the most widely used analytical technique for monitoring microbial contamination[2]. However, this method requires several days for colony formation. In the recent decade, the measurement of organic adenosine triphosphate (ATP) on environmental surfaces with ATP bioluminescence assay has gained popularity because of its speed, objectivity, and commercialization. ATP is the basic source of energy for all plant, animal, and microbial cells and consequently, its presence on environmental surfaces provides an estimate of the presence of organic matter, including microbiological contamination[3].

In this study, we investigated the bacterial contamination of the surfaces of "no-touch buttons" with conventional culture and determines the load with using an ATP bioluminescence assay in a tertiary pediatric teaching hospital.

Materials and Methods

This prospective study was conducted out at Dr. Behçet Uz Children's Diseases and Surgery Education and Research Hospital that a 375-bed pediatric teaching hospital, during 01 June 2019-01 July 2019. This hospital is a referral center for pediatric patients in the Aegean Region of Turkey with annual 600.000 outpatients and approximately 24.000 hospitalizations in 2018. The hospital had a 24-bed pediatric intensive care unit (PICU), a 60-bed neonatal intensive care unit (NICU), a 30-bed hematology-oncology department, and a 12-bed bone marrow transplantation unit. Among the hospital, there are 65 no-touch buttons inside and outside the clinics.

During the study 65 sample was collected from the surfaces of no-touch buttons located in the inside and outside of the units. The localization of the buttons was as follows: NICU, PICU, pediatric cardiovascular surgery intensive care, and pediatric surgery intensive care units.

The samples taken were placed in a prepackaged Horse Blood Agar plate (horse blood agar plate GBL Gul Biological Laboratory, İstanbul, Turkey). The blood agar plates were incubated at 37.8 °C, 5% CO_2, for 48 h, according to the national laboratory guidelines. The microorganisms were identified with BD Phoenix TM M50 Automated Microbiology System. Identification and antibiotic susceptibility tests were performed using PMIC Gram-positive identification card, NMIC Gram-negative identification card, and Yeast ID. Colonization was defined as a microorganism count equal to or higher than 15 CFU/plate in semiquantitative culture[4].

The same surface samples were analyzed for ATP detection using an ATP bioluminescence kit purchased from 3M (3M Clean-Trace ATP System; 3M Co., St. Paul, MN, USA) at the same time. ATP swabs were taken from fully dried surfaces of areas immediately adjacent to the areas sampled for the culture assays. After sampling, the ATP swabs were placed in ATP bioluminescence reaction tubes. After this, the

tubes were inserted into a luminometer, and ATP readings were obtained and expressed in relative light units (RLU). Currently, there is no consensus on the universal objective standard method for measuring surfaces, and there are no official limits of contamination that can be used as standards at an international level for the microbiological screening of surfaces. The total viable count (TVCs) in the hand-touch surfaces should not exceed 5 CFU (expected value), whereas values >5 and ≤15 CFU are considered acceptable, and TVC >15 CFU indicates colonization, as well as detection of *Staphylococcus aureus*, *Enterobacteriaceae*, *Pseudomonas* spp., *Aspergillus* spp.[5].

Statistical Analysis

Analysis of the data was carried out using the IBM Statistical Package for the Social Sciences Statistics 17.0 program (IBM Corporation, Armonk, NY, USA). The quantitative data were described as the means and standard deviation or medians with interquartile range if data followed a non-normal distribution. For categorical variables, percentages and frequencies were calculated. Chi-square test or the Fisher exact test for categorical variables were used for intergroup comparisons. A p value <0.05 was considered statistically significant. Holm-Bonferroni correction method was used to overcome the family-wise error rate. The relationship between the RLU value and total colony counts was investigated using the Spearman correlation coefficient.

Instutional approval was obtained from the Institutional Board of Dr. Behçet Uz Children's Hospital (protocol no: 13399118-799, date: 09.08.2019).

Results

During the study period, 65 swabs from no-touch buttons were taken. Among the samples, most of the buttons were located in NICU 33 (50.7%) and PICU 28 (43.1%) followed by pediatric surgery intensive care units 2 (3.1%) and pediatric cardiovascular intensive care units 2 (3.1%). Among the 65 buttons, 36 (55.3%) of them were located inside the intensive care units and 29 (44.6%) were located outside the intensive care units.

On the samples taken from the surface of buttons, 53 (81.5%) had microorganism isolation. The number of colonization (equal or higher than 15 CFU/plate in semiquantitative culture) was 8 (12.3%), while colony count was ≤5 CFU in 50.8% of samples (33 buttons) and was between 5 and 15 CFU in 18.5% (12 buttons). *Coagulase-negative staphylococci* (CoNS) were responsible for the colonization of surface of the buttons (>15 CFU/plate) (Table 1).

ATP bioluminescence assay revealed the RLU values changing from 35 to 2048/100 cm^2. The median RLU value was 217/100 cm^2 and 41.5% of the values (27 samples) were equal to or higher than 250/100 cm^2.

The RLU values in the colonized buttons (>15 CFU/plate) and buttons with colony count between 5 and 15 CFU/plate were 755.75±678 and 359.91±269.21 consecutively and significantly higher compared to the non-colonized group (226.35±181.00) (p=0.002 and 0.007) (Table 2) (Holm-Bonferroni correction method was used to overcome family-wise error rate). The ratio of values RLU >250/100 cm^2 was significantly higher in the group with equal or higher than 15 CFU/plate (75%) and with colony count between 5 and 15/CFU (75%) compared with the group with no bacterial growth (p=0.019 and 0.006 consecutively) (Table 2) (Holm-Bonferroni correction method was used to overcome family-wise error rate). The relationship between the RLU value and total colony counts was investigated using the Spearman correlation coefficient. There was a strong, positive correlation between the two variables (r=0.695, n=65, p<0.0001); the presence of higher colony counts was associated with higher RLU levels (Figure 1).

The median RLU values of the switches located inside and outside the ward entrance were 274.00 (ranging from 35.00 to 2.048) and 205.00/100 cm^2 (ranging from 59.0±1520.0) and no statistically significant present between these two groups (p>0.05). Comparing the ratio of switches with high RLU values, 55.6%[20] of the switches inside intensive

Table 1. The culture results of buttons (total viable counts divided to three groups, as ≤5 CFU; 6-15 CFU; >15 CFU)

Isolation	TVC ≤5 CFU n=33 (50.8)	TVC: 6-15 CFU n=12 (18.5)	TVC >15 CFU n=8 (12.3)
CoNS	26	10[&]	8
Micrococcus spp.	5	3[&]	0
Alpha-hemolytic Streptococcus	0	1	0
Gram-negative bacillus	1	0	0

CoNS: *Coagulase-negative staphylococcus*, [&]: 2 were *CoNS* plus *Micrococcus* species, TVC: Total viable count

Table 2. Correlation of relative light units with total viable counts			
ATP-bioluminescence assay	**TVC ≤5 CFU n=45 (69.3%)**	**TVC: 6-15 CFU n=12 (18.5)**	**TVC >15 CFU n=8 (12.2)**
Median (range) RLU/100 cm^2	181 (35-758)	282.5 (182-1178)	545.5 (167-2048)
Number of samples RLU >250/100 cm^2	13 (28.8%)	9 (75%)	6 (75%)
RLU: Relative light unit, ATP: Adenosine triphosphate, TVC: Total viable count			

care units and 27.6%[8] of the switches outside intensive care units had RLU values higher than 250/100 cm^2 and significantly higher in the switches inside the intensive care units (Table 3). No significant difference in rates of bacterial colonization (>15 CFU/plate) and colony counts between 5 and 15 was present between switches inside and outside the intensive care units (p>0.05) (62.5% vs 37.5% and 66.7% vs 33.3%) (p>0.05).

Discussion

In this study, bacterial contamination of no-touch button switch was been investigated using standard culture-based environmental sampling techniques and an ATP bioluminescence assay. The contamination rate of buttons in our study was 81.5% and the most common organisms cultured were CoNS and 41.5% of the RLU values measured by ATP bioluminescence assay were equal to or higher than 250/100 cm^2 and a significant correlation was found between the luminometric (RLU) and microbiological (CFU) data obtained for the same surfaces.

The prevalence of colonization of no-touch button switches in our study was higher than more frequently touched objects in hospital-like elevator buttons, door handles, telephone sets and computer keyboards in some of the reported previous studies[6-9]. In these studies, *Staphylococcus aureus* and

Table 3. Comparison of relative light units between push release button switches located inside anda outside the ICUs		
ATP-bioluminescence assay	**Inside buttons n=36**	**Outside buttons n=29**
Median (range) RLU/100 cm^2	274 (35-2048)	205 (59-1520)
Number of samples RLU >250/100 cm^2	20 (55.6%)	8 (27.6%)
ICU: Intensive care unit, RLU: Relative light unit, ATP: Adenosine triphosphate		

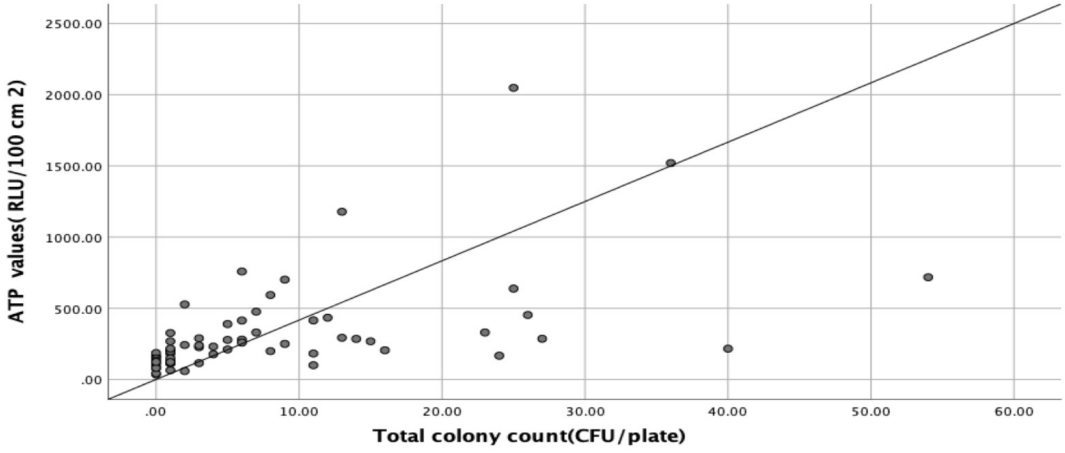

Figure 1. The relationship between RLU value and total colony counts

RLU: Relative light unit, ATP: Adenosine triphosphate

CoNS were the most common isolates cultured as supported by our findings.

In this study, the evaluation of contamination was performed in the presence of ATP with a luminometer. For the assessment of the hygienic quality of surfaces, a benchmark value of 250 RLU/100 cm^2 as an alert value was determined regarding the manufacturer's suggestions[10]. In our study, the median RLU value was 217/100 cm^2 and 41.5% of the values were equal to or higher than 250/100 cm^2. No consensus on the RLU values and prior studies used various RLU targets ranging from 250 to 500 and below values were reported to be associated with decreased bacterial colony counts on various inpatient care surfaces. Although many inanimate objects harbor bacteria and studies have focused on immobile and mobile objects, including cell phones, door handles, computer keyboards, there is limited information about "no-touch buttons" in the English literature[11-14]. Most of the HCWs think that "no-touch buttons" are clean since no one touch them because their working mechanisms might be a reason for underestimating that these objects are important for microorganism contamination. A previous study focusing on cell phones in the operating room had found that 98% of the phones were not clean with regarding ATP measurement, which was relatively higher compared to no-touch buttons[15]. Since the high and continuous usage of cell phones for texting, calling, internet, and e-mailing, it was not surprising to expect a high rate of contamination with organic material of the cellphones. However, although our contamination rate was 41.5%, it is a warning sign too, since no one is supposed to touch them.

The present study showed a significant correlation between the luminometric (RLU) and microbiological (CFU) data obtained for the same surfaces. Other studies found contrasting results in the comparison between luminometric data and microbial counts, reporting no correlation, or moderate correlation, or a significant correlation between ATP levels and TVC values[16-19]. Currently, there is no consensus on the standard method for objectively measuring hospital cleanliness, and there are no official limits of contamination that can be used as standards at an international level for the microbiological screening of surfaces[20]. For instance, Willis et al.[21] reported an inconsistent correlation between the RLU count and positive growth on culture. However, this study plus previous studies support the that bioluminescence assays could help to measure the hygienic quality of hospital surfaces that can be a useful proxy of microbial contamination[15,18].

With regard to the comparison between inside and outside buttons, inside buttons had higher ATP values, but we found no statistically significant difference regarding ATP values. This finding could indirectly show the compliance of hand hygiene of the HCWs and visitors. Independent of the colonization of the environment, including no-touch buttons, hand hygiene is the most effective, simplest, cheapest, but least compliant medical practice in preventing and controlling infections associated with health care[22]. For this reason, all HCW's should be aware of buttons and other devices used in a clinical setting can be a source of hospital-acquired infections and strictly adhere to the World Health Organization guidelines on hand hygiene before patient contact[23].

Study Limitations

This study has some limitations. First, we did not follow the patients in the intensive care units for healthcare-associated infections which could be linked to contaminate the buttons. Secondly, we did not observe the intensity of the usage of the doors and buttons, or the compliance of the HCWs and visitors for not touching the buttons. Additionally, since there was more environmental and skin flora bacterial growth in the results, it is difficult to comment on the pathogen transmission, which is the causative agent of hospital infection, with these results. However, this study is the first study focusing on the no-touch buttons serve as reservoirs for bacterial colonization and contamination.

Conclusion

In conclusion, our study showed that no-touch buttons are frequently colonized by microorganisms and not clean although they are supposed to be untouched and might harbor the potential for risk of cross-contamination. The HCWs, visitors, and patients should not underestimate the indications for hand hygiene after using these buttons.

Ethics

Ethics Committee Approval: Instutional approval was obtained from the Institutional Board of Dr. Behçet Uz Children's Hospital (protocol no: 13399118-799, date: 09.08.2019).

Informed Consent: Patient consent was not required in our study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.A.K., İ.D., G.G., Y.A., Concept: A.A.K., İ.D., Design: A.A.K., İ.D., T.Ç., S.N.B., Data Collection, or Processing: A.A.K., N.D., Y.O., İ.Ç., E.B., E.K., İ.Y., Analysis, or Interpretation: A.A.K., İ.D, T.Ç., S.N.B., Literature Search: A.A.K., İ.D., G.G., Y.A., İ.Ç., E.B., E.K., Writing: A.A.K., İ.D., S.N.B.

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