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Provide one completed IRB-approved nursing research study.

Introduction:

Comparing Adenosine Triphosphate (ATP) results in disposable ECG cables vs. non-disposable ECG cables in the postoperative cardiovascular pediatric patient

IRB-HSR # 16107

Research question and hypothesis:

Research Question: Do non-disposable electrocardiogram (ECG) leads have a higher ATP count than disposable leads?

Hypothesis: The non-disposable ECG leads will have a higher ATP count than the disposable ECG leads.

Study rationale:

With mediastinal infection rates above the target goal, the clinicians in the Pediatric Intensive Care Unit (PICU) were interested in exploring potential risks and implementing strategies to reduce infections. Understanding that contaminated ECG leads posed a threat to the cleanliness of the mediastinal surgical site, clinicians designed a study to examine the ATP levels on ECG leads. The purpose of the study was to collect ATP levels on disposable and non-disposable ECG leads from postoperative cardiovascular patients in the PICU.

Literature review:

Mediastinitis, a healthcare associated infection (HAI) involving the mediastinal space of the chest, costs hospitals thousands of dollars each year and increases the incidence of patient morbidity and mortality.¹ HAIs such as mediastinitis erode patient and family satisfaction while increasing a patient's length of stay. The adverse effects of infections stretch across all patient populations, including pediatrics. Many factors contribute to surgical site infections (SSIs), specifically mediastinitis; many sources can contaminate the surgical wound.¹ ECG lead wires are just one potential source that could contribute to a mediastinal surgical site infection.

Research reveals that stringent cleaning of non-disposable ECG lead wires reduces microbial load²; however, cleaning non-disposable ECG lead wires and cables is a challenge. The lead wires are prone to collecting blood and fluid, thus providing an environment for bacterial growth. Moreover, contaminated ECG lead wires may be a contributing factor to the development of surgical site infections.^{3,4} ECG lead wires lying directly on a patient's skin are in close proximity to open wounds on the chest and



surgical incisions. The potential for cross contamination from an unclean ECG lead wire to the surgical site is highly concerning.^{3, 4} In one report, 37.8% of reusable ECG leads swabbed in ready-to-use rooms and storage areas were colonized with at-risk or potential-risk bacteria.⁵ In another study, researchers sampled over 400 cleaned and disinfected ECG lead wires throughout four intensive care units and one post-anesthesia care unit.⁶ More than half of the reusable lead wires were contaminated with bacteria or other risky pathogens.⁶ In addition, one team of investigators identified drug-resistant organisms on clean, ready-to-use lead wires and storage containers in a large academic hospital.⁷ These findings raise concerns about the continued practice of incorporating reusable lead wires into patient care.

ATP is the energy molecule found in all living organisms, including plants, bacteria, yeast and mold.^{8,9} ATP testing is a universally supported instrument for measuring the cleanliness of hospital environments.^{8,9} When ATP comes into contact with the reagent on the testing swab, light is released in direct relationship to the amount of ATP present. Results display in relative luminescence units (RLUs).⁸ The higher the reading, the more contamination is present. When examining patient care items, 100 RLUs or below is considered acceptable per institutional policies and procedures.

Participants:

NK1EO Table 1. Participants in Comparing Adenosine Triphosphate (ATP) results in disposable ECG cables vs. non-disposable ECG cables in the postoperative cardiovascular pediatric patient

Name	Discipline	Title	Department
Nancy Addison	Nursing	Primary Investigator: RN Clinician IV	Pediatric Intensive Care Unit
Virginia Syptak	Nursing	Data Collector: RN Clinician III	Pediatric Intensive Care Unit
Lisa Fuzy	Nursing	Data Collector: RN Clinician III	Pediatric Intensive Care Unit
David Strider	Nursing	Data Collector: Advanced Practice Nurse 2-Nurse Practitioner	Cardiovascular Surgery
Virginia Rovnyak, Ph.D.	Statistician	Senior Scientist	School of Nursing / Office of Nursing Research



Lisa Letzkus	Nursing	Advanced Practice Nurse 2-Nurse Practitioner / Assistant Director of Nursing Research	Pediatrics
Beth Quatrara	Nursing	Advanced Practice Nurse 3-Clinical Nurse Specialist / Director of Nursing Research	Nursing Governance

Methods:

Study design:

Quantitative Experimental Study with Random Assignment

Study timeline:

- Start date: April 2012
- Completed date: October 2012

IRB approval date:

Approved as expedited study on April 27, 2012.

Research sample:

A convenience sample of postoperative cardiothoracic patients in the PICU were consented and enrolled as subjects. Once verbal consent was obtained from a parent or guardian, the patient was randomized into the designated study arm using his or her medical record number. Patients with an odd number received the intervention of the disposable ECG leads, and those with an even number received standard care with the non-disposable leads.

Data collection methods:

Upon enrollment in the study, the appropriate lead was placed and a sign hung at the head of the bed to designate study involvement. At three intervals, 20-24, 44-48 and



68-72 hours postoperative, a member of the study team performed ATP swab testing on the right and left upper chest electrode leads. Each team member measured 12 inches of ECG lead and swabbed the lead from the top to the bottom using a twirling motion to fully expose the lead to the Ultrasnap™ swab. The swab tip was then activated, which premoistened it with a reagent. Although there were no known sensitivities to the skin, a drape was used under the lead cable so that no reagent came in contact with the subject's skin during the swabbing process. The drape was removed as soon as there was no longer visible moisture on the cable. After the swabbing was performed and the reagent was activated, the swab was inserted into a luminometer to obtain an ATP reading. The results were displayed on the front of the device within one minute of activation. ATP levels were recorded in the research notebook using a coding system. Only the subject number and the specified ATP reading were recorded in the book. After the 72-hour ATP measurement was taken, participation in the study was complete. Patients who were randomized to receive the disposable leads had them replaced with the non-disposable leads and the compatible ECG pads in accordance with institutional standards. The study identification card was removed from the bedside.

In accordance with standard PICU practice, the lead cables of all patients, regardless of study status, were cleaned upon admission, and twice a day (0600 and 1800) with germicidal wipes.

Results:

A total of 51 patients completed the study over a five-month period (April-October 2012) resulting in 123 ATP swabs. Thirty patients were assigned the disposable ECG lead wires (study intervention), and 21 were assigned the non-disposable ECG lead wires (standard care). The majority of patients were infants (56.5%) and female (53.6%). The majority of children were also Caucasian (55.1%). Most notably, 15.7% of the children had open chest sternotomies for 24 or more hours postoperatively, prior to the closure of the chest wound.

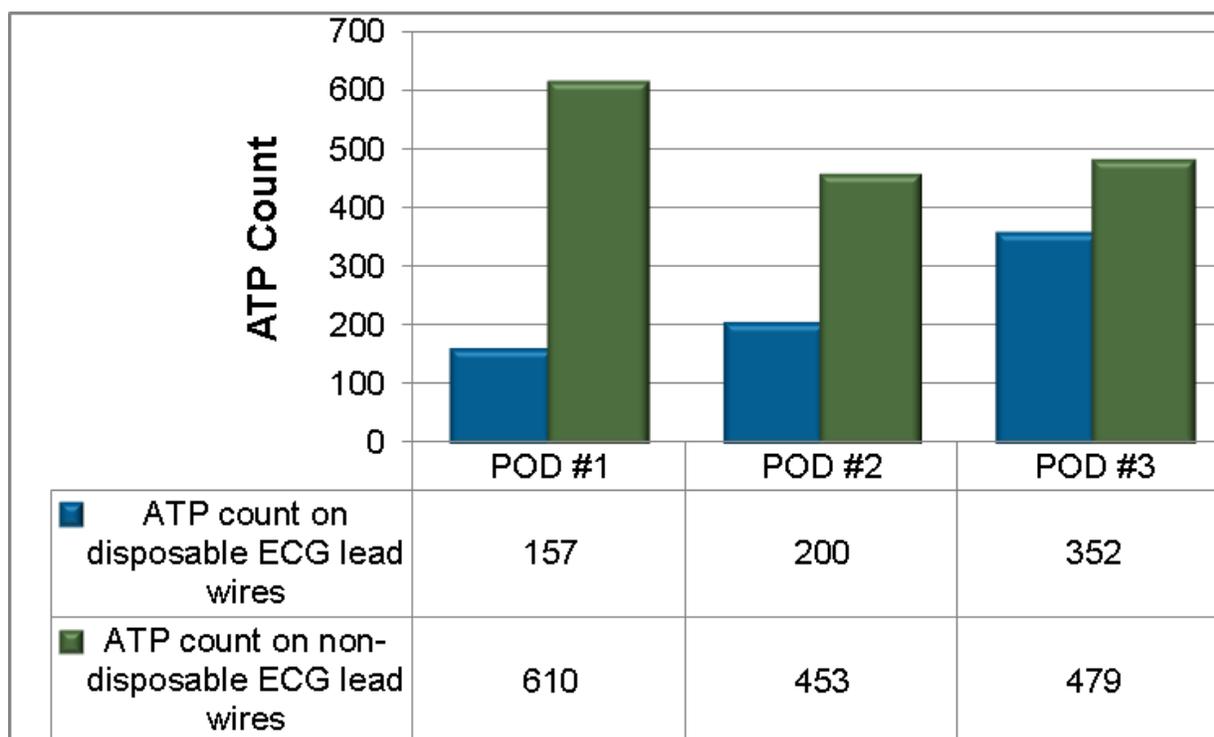
ATP counts were measured in RLUs. A two-sided Mann–Whitney U test was used to compare ATP distributions in the disposable and non-disposable lead wire groups on postoperative days 1, 2 and 3. The statistical program nQuery Advisor 7.0 was used to calculate the power. The observed probability that an RLU count in the non-disposable lead group was smaller than an RLU count in the disposable group was .80. A sample size of 21 in each group would have 92% power to detect a probability $P(X < Y) = .80$ using a two-sided Mann-Whitney U test with a $\alpha = .05$.

On postoperative day 1, the ATP distributions were significantly different ($p < .001$) in the disposable lead group ($n = 30$, median = 157 RLUs) and in the non-disposable lead group ($n = 21$, median = 610 RLUs), with the disposable lead group having lower counts. On postoperative day 2, no significant differences between groups were apparent ($p = .06$), although the counts were numerically higher in the non-disposable group ($n = 28$, median = 200 RLUs) than the disposable group ($n = 18$, median = 453 RLUs). On postoperative day 3, the ATP distributions were not significantly different ($p = .62$) in the



disposable lead group (n=16, median=352 RLUs) versus the non-disposable lead group (n=10, median=479 RLUs). (See **Figure 1**).

NK1EO Figure 1. ATP Count on Disposable ECG Lead Wires, Post-Op Days 1, 2, 3



Discussion:

Summary of key findings:

The study demonstrates a reduction in ATP counts with the disposable ECG lead wires, as compared to the non-disposable lead wires, in the early postoperative period after pediatric cardiac surgery. This difference in ECG lead wire ATP count between the ECG leads was statistically significant on day 1. High ATP counts during the first few postoperative days are particularly concerning because the sternal incision is most tenuous and vulnerable during this time period. Elevated ATP counts are concerning in terms of the numbers, and also in terms of the types of microbia that might be present.

Analysis of key findings:

In this study, microbial cultures were not taken. Therefore, the researchers were unable to determine what type of organism was present on the lead wires. However, the findings of ATP counts above the institutional standard (>100 RLUs on the ECG lead wires) in 82.9% of the entire study sample of 123 lead wires deserve attention. This is the first published study of ECG lead wire measuring ATP levels in postoperative



pediatric cardiac surgery patients. The strengths of this research include the homogeneity of the surgical population (one surgeon, one postoperative unit, one group of core nursing staff), a small group of data collectors, one consistent test machine for the duration of the study, one lot number for all of the ATP reagent testing cuvettes, and strict adherence to the ATP sampling methodology. This study is valuable in terms of its methodology and results as well as its focus on a very small and vulnerable patient population.

Limitations to this study include the variation in sample sizes among the two groups and within each postoperative day, as well as the lack of microbic analysis on each of the ECG lead wires. The randomization process did not yield equal numbers of patients in each group. Furthermore, the sample size of each group diminished every day as patients recovered and transitioned out of the study. Moreover, both the disposable and non-disposable groups could have ATP levels that were influenced by extraneous conditions. The variation between the lead wire types was visible to the staff. Staff, despite training to the contrary, may have cared for and cleaned the wires differently. Additionally, the clean gloves worn by the researchers to swab the lead wires could have contained contaminants from the glove box, thus contributing to falsely elevated ATP levels. Furthermore, data were not collected on patient conditions, such as wound conditions or emesis events, which may have adversely influenced contaminant levels. Lastly, only the lead wires were sampled. If the crevices of the lead snaps or stickers to which the leads attached were tested, the ATP numbers may have been higher. This study needs to be replicated in broader pediatric patient populations. Additional studies should also consider performing culture and sensitivity testing for the ECG lead wire at either day 2 or day 3. Clearly identifying the microbes present on the ECG leads during the first and most vulnerable days of wound healing would be enlightening. Finally, a multicenter comparison is warranted to obtain a larger sample size to determine correlation with surgical-site wound infections as a function of ECG lead wire type, and to introduce controls for the deficits noted above.

Implications of findings:

ECG lead wires may harbor a significant amount of microorganisms that could, based on proximity to the sternotomy incision, readily serve as a vector for a mediastinal surgical wound infection. Inconsistency in the frequency, as well as the thoroughness, in which the health care staff may wipe down the ECG cables with antiseptic solution raises questions about transitioning to disposable ECG lead wires.

This study supports the use of disposable ECG leads. The high ATP counts detected on the non-disposable leads give credence to concerns about the introduction of microbes to the patient.

Impact for the organization:

As a result of the study findings, UVA removed non-disposable leads from the inpatient care settings and the outpatient surgery center. The non-disposable leads were



replaced with disposable leads. This decision was supported by the Infection Control Committee, Supply Chain Management and hospital administration.

Dissemination:

Publication:

Addison, N., Quatrara, B., Letzkus, L., Strider, D., Rovnyak, V., Syptak, V. & Fuzy, L. (2014) Cleanliness of Disposable vs. Nondisposable Electrocardiography Lead Wires in Children. *American Journal of Critical Care*, 23 (5)

Podium:

Addison, Nancy; Fuzy, Lisa; Strider, David & Syptak, Virginia (April 23, 2013) “Do Disposable ECG Lead Wires Have Decreased Bacteria Counts Compared to Non-Disposable ECG Lead Wires?” at the UVA PNSO 2013 Evidence-Based Practice Symposium.

Posters:

Addison, Nancy (February 1, 2013) “Bacterial Counts on Disposable vs. Non-Disposable Electrocardiographic Cables in the Early Post-Operative Period for Pediatric Cardiac Surgery” at the Virginia Patient Safety Summit, Richmond, VA.

- Also presented at VA Magnet Consortium meeting in June 2013.
- Also presented at VNA Education Day in September 2013

Addison, Nancy (February 5-7, 2014) “Which Are Cleaner? Disposable vs. Non-Disposable ECG Lead Wires” at the 2014 ANA Quality Conference in Phoenix, AZ.

References:

1. APIC (2008) Guide for the prevention of mediastinitis surgical site infections following cardiac surgery.
2. Reshamwala A, McBroom, Choi Y, et al. Microbial colonization of electrocardiographic telemetry systems before and after cleaning. *Am J Crit Care*. 2013; 22: 382-389.
3. Brown D. Disposable vs reusable electrocardiography leads in development of and cross-contamination by resistant bacteria. *Crit Care Nurs*. 2011; 31(3): 62-68.
4. Barnett T. The not-so-hidden costs of surgical site infections. *AORN J*. 2007; 86(2): 249-258.
5. Albert N, Hancock K, Murray T, et al. Cleaned, ready-to-use, reusable electrocardiographic lead wires as a source of pathogenic microorganisms. *Am J Crit Care*. 2010; 19, e73-e80. doi: 10.4037/ajcc2010304.
6. Lestan T, Ryll S & Kramer A. Microbial contamination of manually reprocessed, ready-to-use ECG lead wire in intensive care units. *GMS Hyg Infect Cont*. 2013; 8(1): 1-7.



7. Safdar N, et al. Telemetry leads as reservoir for nosocomial pathogens. *Int J Infect Control*. 2012; 8(2). doi: 10.3396/ijic.v8i2.012.12.
8. Hygiena Inc. SystemSUREII ATP hygiene monitoring system: rapid and simple solutions for hygiene testing.
9. Chollet R & Ribault S. Use of ATP bioluminescence for rapid detection and enumeration of contaminants: The milliflex rapid microbiology detection and enumeration system. In: Lapota D, ed. *Bioluminescence-Recent Advances in Oceanic Measurements and Laboratory Applications*. In Tech. 2012: 99-118.