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Cleaning of Cell Phones in the Neonatal Intensive Care Unit

Kari Wood, DNP, Sandy Ewell MBA BSN, Dale Gerstmann, MD

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Abstract:

Background: *Mobile devices are known to harbor bacteria and viruses. Since these devices, including cell phones, are now more common in the neonatal intensive care unit (NICU), it can be postulated that thorough cleaning of these devices may help protect immunocompromised neonates.*

Purpose: *This project explored whether improvement can be achieved in the routine cleaning of cell phones among providers and families in the NICU and whether a cleaning method using antibacterial wipes and UV-C light is effective.*

Methods: *Participants included parents, visitors, and health care workers entering or working in a community-based level three NICU in Orem, Utah. A survey was developed to assess cleaning practices, attitudes, and barriers to cell phone cleaning. The survey was administered, and cell phone culture swabs were taken before the staff's educational intervention. Educational materials, including a PowerPoint presentation and video of the correct cleaning procedure, were developed. These addressed knowledge deficits and barriers identified in the initial survey. Surveys were administered, and swabs of cell phones were obtained again two weeks after the intervention was completed.*

Results: *50 surveys and 15 swabs were obtained pre- and post-educational intervention. Comparison between surveys showed improvement in the number of people who had changed their cell phone cleaning habits, 62% vs. 84% (p=.009), but not in the number who cleaned their cell phone daily, 38% vs. 44% (p=.685). One hundred percent of cell phones swabbed before educational intervention had bacterial contamination, while only 67% showed bacterial contamination post-intervention (p=.042).*

Implications for Practice and Research: *Decreased bacterial contamination indicated that the cleaning procedure was effective. Although the educational intervention did not improve cleaning frequency, bacterial load and pathogenic organisms were significantly reduced on cleaned cell phones. A comprehensive cell phone cleaning program may reduce infectious exposure to NICU patients.*

Keywords: Cell phone cleaning, NICU, digital device, fomite

Abbreviations: NICU, Neonatal Intensive Care Unit; ICU, Intensive Care Unit; NNP, Neonatal Nurse Practitioner; UV, Ultraviolet.

Introduction：

Problem Description:

Nosocomial, or hospital-acquired infection, is a term that causes clinicians in any specialty, sub-specialty, or hospital department to take pause. It leads to additional care, morbidity, and sometimes death. This issue is especially true in the neonatal population. Neonates are often already challenged by an extremely extended hospital stay, pulmonary inflammation, the need for prolonged indwelling and invasive lines, immature immune systems, poor reserves, and heightened pro-inflammatory systems. (1,2) Extended stays in the intensive care unit expose them to multiple bacteria and viruses through contact with caregivers and during standard procedures. Nosocomial infection significantly increases morbidity and mortality rates. (1,3-5) Neonatal intensive care units (NICUs) have been aware of these issues and have been trying to improve care and minimize nosocomial infection risk for years. (1,6) No single cause has been identified for this multifactorial problem, and no solution has been found. Clinicians have worked on handwashing, skincare, central line education bundles, pneumonia/early extubation protocols, feeding protocols, etc.; this work has improved nosocomial infection rates but has not eliminated nosocomial infection from the NICU.

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It is difficult for neonatal intensive care patients to assess how much of their morbidity and mortality is related to their underlying prematurity and diagnosis versus a newly-acquired nosocomial infection. Unfortunately, we know that nosocomial infections are more common in the most vulnerable and immature infants. (7) Several researchers have tried to differentiate what change in outcomes can be directly attributed to nosocomial infection in hospitalized newborns. (3,7,8) They have linked increased rates of meningitis, chronic pulmonary issues, increased length of stay, and mortality to this disease. (3,7,9) Bizzarro et al. were even able to show that genetic predispositions lead some infants to be more

susceptible to nosocomial infection. (10) The mortality rate with nosocomial infection has been between 29% and 66%. (7,11) Increased levels of illness, such as nosocomial infection, raised risk ratios from 3.15 for intensive care in the NICU to 6.58 for patients who received high-dependency care in the NICU. (12) Because many small and fragile infants go home on oxygen, it is hard to determine whether the oxygen need is related to nosocomial infection or chronic lung disease as a complication of prematurity. Undoubtedly, episodes of inflammation do not improve chronic lung disease and can only exacerbate it. Most neonates are discharged by their due date, so extensions over the due date may be attributable to nosocomial infection. In the neonatal population, it is hard to determine causal relationships with a single patient, so large studies are the only way to obtain good data. (5,9,11)

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Over the past several years, digital devices have become more ingrained in medical and nursing practice. Most neonatal intensive care nurseries require charting, order entry, and reference data to be in an electronic format. This digitization has led to increasing providers carrying digital devices and cell phones. Families have also begun to take their own digital devices and cell phones into hospital units and to feel that they are essential to their care and vital for their families. (13)

Available Knowledge:

One of the new sources of bacterial load found in the NICU has been electronic devices. (13-16) Initially, it was felt that these devices were unlikely to be carriers of opportunistic bacteria, but that belief has been disproven.

These digital devices can be a severe source of bacterial and viral contamination associated with nosocomial infections. (13) This is especially concerning in the NICU because the premature infant is immunocompromised. Guidelines on cleaning these devices have been inconsistent and early studies suggested that good handwashing may be adequate to reduce the transmission of organisms. (14) However, Beckstrom et al. found that good hand hygiene and anti-microbial gel did not eliminate bacterial contamination of the cell phone in the NICU. (14) Russotto et al. showed that current cleaning products used in the ICU do not adequately clean inanimate objects. (18)

Given these findings, new and more effective cleaning methods must be identified and implemented. Neonatal intensive care units around the country are attempting to implement guidelines and protocols for cleaning electronic devices used in the NICU.(16,19)

Rationale：

Many NICU care practices are guided by habit or routine. The theory that guides this clinical process proposal is the Practice Theory, which describes how habits are formed. A habit can be defined as routine behavior that does not require motivation or even a specific choice. (20) It is a way of reproducing the same behavior with each corresponding element, such as scrubbing upon entry to a medical unit. This theory started with Triandis' 1977 "Theory of Interpersonal Behavior" (21), which appears to be one of the only theories that discuss habits and their formation in behavior change. (20) It is a theory that seeks to understand why we develop behaviors that require multiple steps, without significant decision making, in an everyday manner. (20,22) Practice theory explains how routines can become habits and how the behavior or habit becomes a common practice. (20) The theory is not individually focused but instead works on changing behavior through modifying the environment and social behavior norms until the habit or practice takes place without specific individual motivation. (20,22) The environment can be adjusted to facilitate behavior change.

This project focuses on creating a cleaner environment in the NICU by teaching health care workers and families to wipe down their cell phone at a cell phone cleaning station at or near a scrub sink with a sanitizing wipe and to place it into a sanitizing light box as soon as they enter the NICU, before starting their scrub. Families check into the front to gain access to the NICU. Both families and caregivers complete lengthy handwashing as they enter the patient care area.

Establishing an environment where everyone who enters the NICU performs this same routine and sees others do the same produces societal pressure, which encourages normalizing the behavior.(20,22) Thus, the cell phone cleaning routine will become a habit. This means that the environment can be very conducive to encouraging the behavior. The task can be easy to perform without significant one-on-one education. The process is openly visible so that there are social norms to follow.(20,22)

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Specific Aims:

This project aims to improve routine cell phone cleaning frequency among neonatal providers and families in a neonatal intensive care unit. While the project does not look at nosocomial infection rates, the hope is that this may decrease fomite exposure and nosocomial infection in the NICU.

Methods:

Context：

This intervention was performed in a community-based level three neonatal intensive care unit of 24 beds in Orem, Utah. Admissions to the facility have minimal diversity. Most patients are Cauca-

Table 1 - Demographics Frequency Table			
Occupation		**Pre-Education Survey (n=50) n (%)**	**Post-Education Survey (n=50) n (%)**
Health Care Worker			
	MD	0 (0%)	3 (6%)
	NNP	2 (4%)	2 (4%)
	Lab Tech	0 (0%)	0 (0%)
	X-Ray Tech	0 (0%)	0 (0%)
	Student	0 (0%)	2 (4%)
	Other (RN, RT, Misc)	26 (52%)	20 (40%)
	Unspecified	3 (6%)	4 (10%)
Family/Visitors			
	Parent	10 (20%)	15 (30%)
	Grandparent	5 (10%)	2 (4%)
	Sibling	0 (0%)	0 (0%)
	Other	2 (4%)	0 (0%)
	Unspecified	2 (4%)	1 (2%)
Racial Heritage			
	American Indian or Alaskan Native	0 (0%)	2 (4%)
	Asian	0 (0%)	2 (4%)
	Black or African American	0 (0%)	0 (0%)
	Hispanic or Latino	3 (6%)	2 (4%)
	Native Hawaiian or Other Pacific Islander	0 (0%)	0 (0%)
	White	46 (92%)	44 (88%)
	Missing	1 (2%)	0 (0%)
Gender			
	Male	9 (18%)	14 (28%)
	Female	40 (80%)	36 (72%)
	Other	0 (0%)	0 (0%)
	Missing	1 (2%)	0 (0%)
Age			
	< 20 years of age	2 (4%)	1 (2%)
	20-29 years of age	14 (28%)	14 (28%)
	30-39 years of age	17 (34%)	15 (30%)
	40-49 years of age	3 (6%)	11 (22%)
	50-59 years of age	11 (22%)	7 (14%)
	60-69 years of age	3 (6%)	2 (4%)
	70-79 years of age	0 (0%)	0 (0%)
	>79 years of age	0 (0%)	0 (0%)

sian, of European descent, and have families belonging to the predominant religion in the area. However, the presence of three large universities within 50 miles attracts more diverse patients and families. Most mothers who have infants in the NICU are over 18 years of age, have received adequate prenatal care, and have at least a high school education. There is a low rate of homeless families in the NICU, and many families have social support structures. This NICU serves approximately 300 infants per year.

Table 2 - Descriptive Statistics: Pre and Post-Education Survey Questions and Data

	Pre-Education Survey (n=50) n (%)	Post-Education Survey (n=50) n (%)	*p*-value
Respondents who have cleaned their cell phone today			
Yes	27 (54%)	38 (76%)	0.035
No	23 (46%)	12 (24%)	
How often respondents think of cleaning their cell phone			
Daily	25 (50%)	26 (53%)	0.842*
Weekly	15 (30%)	16 (33%)	
Monthly	4 (8%)	1 (2%)	
Yearly	0 (0%)	2 (4%)	
Never	6 (12%)	4 (8%)	
Missing	0 (0%)	1 (0%)	
Respondents typically clean their cell phone			
Daily	19 (38%)	22 (44%)	0.685*
Weekly	19 (38%)	16 (32%)	
Monthly	5 (10%)	9 (18%)	
Yearly	1 (2%)	2 (4%)	
Never	5 (10%)	1 (2%)	
Missing	1 (2%)	0 (0%)	
What respondents typically use to clean cell their phone			
Pant or shirt edge	5 (10%)	4 (8%)	
Wet Washcloth	2 (4%)	4 (8%)	
Screen cleaner wipe or spray	4 (8%)	4 (8%)	
Antibacterial wipe	13 (25%)	11 (22%)	
UV light	1 (2%)	2 (4%)	
None of the Above	3 (6%)	0 (0%)	
A combination of the above	21 (42%)	24 (48%)	0.685*
Missing	1 (2%	1 (2%)	
Respondents that have changed cleaning habits since NICU			
Yes	31 (62%)	42 (84%)	0.009
No	18 (36%)	6 (12%)	
Missing	1 (2%)	2 (4%)	
I have been told/taught to clean my cell phone in the NICU			
Yes	28 (56%)	41 (82%)	0.004
No	22 (44%)	8 (16%)	
Missing	0 (0%)	1 (2%)	
Respondents who have been taught how to clean their phone in the NICU			

Table 2 - Descriptive Statistics: Pre and Post-Education Survey Questions and Data

	Yes	21	(42%)	41 (82%)	0.0001
	No	28	(56%)	8 (16%)	
	Missing	1	(2%)	1 (2%)	
I think about bacteria or viruses on my cell phone					
	Yes	38	(76%)	44 (88%)	0.282
	No	10	(20%)	6 (12%)	
	Missing	2	(4%)	0 (0%)	
How many bacteria/viruses people think are on their cell phone (Likert Scale, 0-5)					
	Few - 0	7	(14%)	3 (6%)	
	1	0	(0%)	0 (0%)	
	2	0	(0%)	2 (4%)	
	3	0	(0%)	3 (6%)	
	4	2	(4%)	3 (6%)	
	Many - 5	38	(76%)	33 (66%)	0.614*
	Missing	3	(6%)	6 (12%)	
Reasons given for not cleaning cell phone upon NICU entry					
	I do	23	(46%)	27 (54%)	0.419*
	I don't want to	0	(0%)	0 (0%)	
	I don't know how	3	(6%)	1 (2%)	
	I don't have time	0	(0%)	2 (4%)	
	I don't have materials	2	(4%)	1 (2%)	
	I don't think it is important	1	(2%)	1 (2%)	
	None of the above	20	(40%)	16 (32%)	
	Missing	1	(2%)	2 (4%)	
Correct way to clean cell phone per participant written description					
	Correct	6	(12%)	10 (20%)	0.048
	Partially Correct	30	(60%)	29 (58%)	
	Wrong	10	(20%)	2 (4%)	
	Missing	4	(8%)	9 (18%)	

* Fisher Exact test for line item versus rest of items in the question

The NICU has a neonatology staff of two neonatologists, four full-time neonatal nurse practitioners (NNPs), and three part-time NNPs. The author is one of the full-time NNPs in this NICU and is Master's Degree prepared. The NICU staff has approximately 60 nurses dedicated to the unit, 20 hospital-wide respiratory therapists, four lactation consultants, one NICU dietitian, and one neonatal occupational therapist. The department provides clinical teaching for registered nurses, respiratory therapists, and neonatal nurse practitioner students.

In order to qualify for data collection, the participants must have a cell phone with them, be older than 18 years of age, be a parent of a NICU infant or a healthcare worker entering the NICU, and be willing to participate in the data collection. Participants entered the NICU between October 2018 and February 2019. Data was collected for 1-2 weeks, both pre and post-intervention. Exclusion criteria include visitors or families who urgently need to transfer their infant to a level 4 NICU, families who do not have a cell phone or families who do not wish to participate. The health care providers and visitors who take the survey must meet the inclusion criteria and be willing to participate.

Overall, this community follows most medical advice and is willing to make changes if they feel the changes will improve the lives of their family members. This contextual factor may impact this intervention's success and may not represent all NICU visitors in

Table 3 - Characteristics of Culture Swabs

	Pre-Intervention (n=15) n (%)	Post-Intervention (n=15) n (%)	*p*-value
Bacterial Growth Levels			
No growth	0 (0%)	5 (33%)	
Rare Bacteria	0 (0%)	0 (0%)	
Scant Bacteria	2 (13%)	2 (13%)	
Few Bacteria	4 (27%)	4 (27%)	0.065[1]
1+ Bacteria	8 (53%)	4 (27%)	
2+ Bacteria	1 (7%)	0 (0%)	
3+ Bacteria	0 (0%)	0 (0%)	
4+ Bacteria	0 (0%)	0 (0%)	
Bacterial Identification (NP, non-pathogenic)			
Coag Negative Staph (NP)	15/15 (100%)	9/15 (60%)	0.069
Strep Veridans (NP)	8/15 (53%)	8/15 (53%)	1.000
Group D Strep	1/15 (7%)	0/15 (0%)	1.000
Fungus	1/15 (7%)	0/15 (0%)	1.000
Lactobacillus (NP)	1/15 (7%)	0/15 (0%)	1.000
Bacillus Species	3/15 (20%)	0/15 (0%)	0.224
Haemophilus Species	2/15 (13%)	0/15 (0%)	0.480
Micrococcus Species	1/15 (7%)	0/15 (0%)	1.000
Staph Aureus	2/15 (13%	0/15 (0%)	0.480
Corynebacterium Species	1/15 (7%)	0/15 (0%)	1.000
Swabs with One or More Pathogens	7/15 (47%)	0/15 (0%)	0.028
Number of swabs with organisms	15/15 (100%)	05/15 (33%)	0.042

[1]Few or less vs. 1+ or more

other communities.

"Overall, this community follows most medical advice and is willing to make changes if they feel the changes will improve the lives of their family members. This contextual factor may impact this intervention's success and may not represent all NICU visitors in other communities."

Intervention(s) :

The project had four objectives to improve the frequency of routine cleaning of cell phones among neonatal providers and families at a neonatal intensive care unit. The first was to assess the current frequency of cleaning of cell phones among health care providers and families at a local NICU. The second objective was to identify current evidence-based guidelines for frequency and modes of cleaning cell phones. The third objective was to develop and deliver education material addressing the knowledge deficits and barriers identified in the survey for staff and families. The fourth and final objective was to evaluate the frequency of cell phone cleaning after education.

This intervention assessed cell phone cleaning and cell phone cleaning attitudes and skills of visitors and workers at the NICU. There was data collection before and after an educational intervention given to both health care providers and families. Data was collected for approximately 1-2 weeks, pre-and post-intervention. The data collection assessed knowledge and attitudes via survey and evaluated bacterial load on cell phones with swabs.

The author developed a survey to determine the current frequency of cell phone cleaning and attitudes toward cleaning and cleaning knowledge of those entering the NICU. The survey was given to health care workers, families, and visitors entering the NICU. Before setting up a cleaning station and any educational interven-

tions, the pre-intervention survey was given to teach visitors and health care providers the best way to clean their cell phones. The follow-up survey asked the same questions and was given three weeks after the cleaning station set-up and educational intervention.

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The second data collection section was a swab of cell phones for bacterial load after entering the NICU at patient bedsides. Swabs were collected from the cell phones at the patient's bedside after entry to the NICU, labeled with the date, time, and NICU bed space or NICU bed space 26, if taken from a hospital employee's phone. Swabs were all collected by the investigator and then walked to the laboratory for plating and incubation. Microbiology then assessed swabbed plates for bacterial load and reported findings to the investigator.The educational intervention developed was a PowerPoint presentation with a real-time demonstration of cell phone cleaning. The author developed the educational intervention. The content addressed deficiencies in knowledge and attitudes identified by the survey and information obtained through a literature review about the latest evidence-based practice in cleaning inanimate objects. It was reviewed by the medical director and the author's DNP project chair. The first educational intervention was started in small groups for each shift of the NICU on Jan 21, 2019. The intervention was then placed on the NICU mandatory computer education site with a due date of Feb 7, 2019. It included a demonstration of the cleaning technique and the new cleaning station installed when the first educational intervention was given. The second educational intervention was again a PowerPoint presentation discussing the importance of cell phone cleaning, with a video demonstrating proper cell phone cleaning. This dual educational intervention was played on a monitor above the scrub sink for everyone to watch as they scrubbed into the NICU but had not been implemented by the end of the study.

Study of the Intervention(s):

The approach chosen to determine the impact of the intervention was change statistics. Survey data were compared before the educational intervention and three weeks after the intervention. Bacterial colonization was also assessed before and three weeks after the educational intervention.

The educational intervention participants were counted, and the hospital's education department recorded their education completion. The time spent on the educational intervention was also tracked. The author and content experts felt that the information collected could better relate to a culture change toward cell phone cleaning in the NICU by waiting three weeks after the educational intervention.

There was no comparison group in this project. The two groups analyzed were those who entered before and after the educational intervention.

Before this project was initiated, the author checked with the NICU director, hospital administration, and the quality improvement director to ensure that no similar projects were happening in the hospital that may have impacted this project's outcomes.

Measures:

The survey chosen was not a published reliable tool, as the process and evaluation of cell phone cleaning are new to the NICU. The author developed the study with the input of advisors and experts, including their content experts, chair, and mentor. It was then checked for readability and measurability with a small test group of nurse practitioners completing their doctoral degrees. A statistical mentor also suggested improvements in the tool to assess the information more accurately.

A content expert on the project assisted the author with the statistical measures. The hospital administration was approached and agreed to fund this project. The hospital also approved the time needed to present the project and training to the hospital workers. In addition, the hospital donated the lab supplies and microbiology analysis. Administrative support for the project contributed to the study's success. The author routinely assessed the missing survey data and double-checked data entered into the spreadsheet to analyze the completeness of the survey data.

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Analysis:

Analysis was done pre and post-educational intervention on survey data and cell phone swab data. Demographic and outcome variables were described using frequency distributions and appropriate summary statistics for central tendency and variability. A Fisher Exact Test (using an online calculator) was used to measure the change between pre-intervention frequency of cell phone cleaning and post-intervention frequency of cell phone cleaning and for categorical values. The Mann-Whitney U test was used for Likert scale variables. The author had statistical advice and analysis oversite from a statistical expert at the University of Utah, College of Nursing. Descriptive statistics were performed using Excel. A content analysis was conducted on the open-ended survey questions. The words were read word for word and then

coded. Next, the coded data were categorized, organized, and summarized.

Ethical Considerations:

While done in the NICU, this quality improvement study exclusively involved adult subjects and their cell phones. Therefore, none of the data or information was obtained from a protected group. Consent was obtained with voluntary involvement in the project. There was no incentive or deterrent to participation in this project. This study was determined to be non-human subject research by the University of Utah Institutional Review Board and the Timpanogos Hospital Institutional Review Board. No conflicts of interest were discovered or disclosed by any project team members.

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Results:

Intervention Steps and Process Measures and Outcomes:

Demographic data are presented (Table 1). There were an equal number of completed pre and post-surveys (n=50). There was no statistical difference between the respondents who were family or visitors (36-38%) or healthcare workers (62-64%) between the pre and post-surveys. Survey data are shown (Table 2). There was also no difference between the pre and post-surveys in the percentages of respondents who had never cleaned their cell phones (10% vs. 2%). There was a statistical improvement in the number of respondents who had changed their cleaning habits since coming to the NICU, the number who had been taught/told to clean their cell phones, and the number trained to clean their cell phones after the educational intervention.

The number of respondents who typically cleaned their cell phones daily did not significantly change pre and post-intervention. Also unchanged was the number of respondents who tended to their cell phones every time they entered the NICU and the number of respondents who could correctly answer the best way to clean their cell phones. There was also no significant change in the rank-sum score on the Likert scale for the perception of bacterial load.

Secondary analysis showed that most health care workers already had the habit of cleaning their cell phones upon entry to the NICU both before and after the intervention (71% and 72%, respectively, NS). However, a statistical improvement was noted for families and visitors in the percentage who had cleaned their cell phones on entry to the NICU compared to pre and post-intervention (37% vs. 83%, p=.0069).

Swab data can be viewed (Table 3). Fifteen swabs were obtained pre-intervention, and 15 swabs were obtained post-intervention. There was a statistical difference between pre-intervention swabs, showing 100% bacterial colonization, and post-intervention swabs, which had 67% bacterial colonization after a 72-hour incubation period. There were also statistical differences found between pre-intervention swabs with ten different organisms and a total of 35 isolates compared to 2 other organisms and 17 isolates for post-intervention swabs. The level of bacterial load between pre-intervention swabs and post-intervention swabs with greater than a few organisms showed a statistically significant decrease (p=.065) at a cutoff of 0.1 but not at an alpha of 0.05. Bacteria-specific isolates are noted (Table 3) on pre-and post-intervention swabs. Post-intervention swabs had no pathogens recovered.

Contextual Elements:

The investigator initially planned to give the educational intervention in a NICU staff meeting. However, the staff meeting date was changed to a date and time that the investigator could not attend. Steps were then made for the medical director to give the educational intervention at the staff meeting. However, the discussion of a requested case study lasted for the session. New arrangements had to be made for the delivery of the educational intervention. Because the educational intervention could not be given in a single day to all staff, teaching only during nursing shifts delayed the post-survey and swab analysis by approximately two weeks. The investigator presented the educational intervention in person to about 30% of the staff until the PowerPoint, which included a video, was provided as a mandatory online education module for staff for NICU staff.

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Unit census and level of parental involvement were different during the pre-intervention and post-intervention periods. During the pre-intervention surveys, the NICU had fewer patients but a more significant number of families with longer lengths of stay. Surveys were of interest to both health care workers and families. During the post-intervention surveys, the NICU had increased census but shorter lengths of stay. Both health care workers and families seemed to be more likely to say that they would consider completing the survey the next time they were in. However, in both periods, families and health care workers expressed interest in the results, and several requested that the swab result be made available. This request was denied as swabs were anonymously labeled, and no structure was in place to discuss swab findings one-to-one. Health care workers had been present with the pre-intervention swabs and often attempted to determine which day post-intervention swabs would be obtained. The investigator had to privately coordinate this with microbiology and ensure that both departments did not know which day swabs would be obtained. Swabs were all obtained in the same manner by the investigator,

plated, and analyzed by the microbiology department lead.

Details about missing data:

Because surveys were anonymous, data could not be requested if the content was missing. If data were written that coincided with categories, but the answer was not circled, it was coded to the corresponding category. If the investigator could not interpret the written response or did not match any of the answers, then the answer for that question was left blank. Questions left blank were not used in the analysis, but the remaining survey questions were still used for the completed questions.

Discussion:

Summary:

This project aimed to improve the frequency of routine cleaning of cell phones among those who enter the NICU. This key measure was achieved for families and visitors but not health care workers. Health care workers appeared not to have been affected by the educational intervention. There was no difference in the number of participants who cleaned their cell phones daily or those who cleaned them every time they entered the NICU. However, it was a measure of success that all participants did change their cell phone cleaning habits and acknowledged they had been taught how to clean their cell phones. The eradication of pathogens and decreased bacterial load shown by cell phone swab cultures confirmed that an appropriate and effective cleaning procedure had been identified.

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Interpretation:

The lack of daily cell phone cleaning and participants' inability to verbalize the correct cleaning process post-intervention may be related to several factors. The high rate of staff cleaning their cell phones when entering made statistical improvement difficult. Most nursery staff do not work every day, and many visitors do not visit every day so the investigator may have picked an unattainable measure for analysis. The video playing above the scrub sink to solidify the education had not been implemented during the post-intervention analysis, which may have been a factor in the lack of retention of the educational information.

Kirkby & Biggs implemented a cleaning procedure with antibacterial wipes in a NICU in 2014 and found that they could drop cell phone contamination from 100% to 72% in a convenience sample of 18 cell phones. (19) These phones were swabbed, then cleaned then swabbed again. Unfortunately, they did not collect data about the bacteria noted on cell phones or if any isolates were pathogenic. They also collected their data before entry to the NICU instead of at the NICU bedside. They then implemented an education program and mandatory cell phone cleaning. Four months later, a series of random audits found 100% compliance with this new cleaning procedure. This pilot program helped guide the current project's choice of the cleaning procedure, and the investigator was disappointed that the current program could not meet the 100% compliance reached by Kirkby and Biggs. (19)

Tekerokoglu et al. obtained 200 swabs of health care workers, patients, and visitors' cell phones brought into the hospital. (16) They found that approximately 20-40% held pathogenic bacteria, with patient/visitor cell phones having a higher rate of pathogens than the phones of health care workers. They recommended implementing a cell phone cleaning procedure and considering new techniques, including UV light. This helped guide the cleaning procedure chosen and the current project's analysis of bacteria and pathogens on swabs.

The cleaning procedure and educational intervention were low cost and had little time impact on the NICU unit personnel. Previously, the unit supplied antibacterial wipes and clear sleeves in which cell phones could be placed. They continued to provide the antibacterial wipes and purchased the UV lightboxes for cleaning. The UV lights are not medical grade and are low enough cost to obtain unit discretionary funds.

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Limitations :

This was a small quality improvement project in a single unit. The survey may not have adequately evaluated why the expected change to more frequent cell phone cleaning did not occur. A larger sample size of swabs may have achieved a statistically significant decrease in bacterial load at 0.05. A mandatory cell phone cleaning area may have achieved 100% compliance with cleaning upon entry to the NICU.

It may be that in a larger unit with an increased number of swabs, an evaluation of pathogen eradication from cell phones using UV light and antibacterial wipes would be feasible.

Conclusions :

These results show that we were able to develop an effective cell phone cleaning procedure for the NICU but could not impact the frequency of cell phone cleaning in a hoped-for manner. It appeared to sustain awareness of the need for cell phone cleaning in the NICU, but the educational intervention did not improve cell phone cleaning frequency. Improving cell phone cleaning in the subset of visitors and families upon entry was significant. While

not statistically significant, the reduction in bacterial load may be clinically significant. The decrease in pathogens on cell phones is both clinically and statistically significant.

This cleaning procedure could easily be implemented in other hospital areas where patients are deemed immunocompromised. If this cell phone cleaning procedure were implemented in a larger unit or a collaborative group, a link between nosocomial infection and pathogens on cell phones might be found.

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Sandy Ewell MBA BSN
Chief Nursing Officer
Timpanogos Regional Hospital
Orem, Utah

Corresponding Author

Kari Wood, DNP
Neonatal Nurse Practitioner,
Timpanogos Regional Hospital,
Orem, Utah
939 N 900 W, Orem, UT, 84057, USA
Email: kari.wood@comcast.net
Phone: (801) 376-6336 (cell, text)

Dale Gerstmann, MD
3NICU Medical Director,
Timpanogos Regional Hospital,
Orem, Utah

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