Alpenglow: Binghamton University Undergraduate Journal of Research and Creative Activity

Volume 4 | Issue 1 Article 6

April 2018

What's Living on Your Cellphone? Prevalence of Bacterial Contamination of Health Care Worker's Mobile Devices and Recommendations for Change as Related to Nursing Practice

Benjamin Kornblum
Binghamton University, bkornbl1@binghamton.edu

Abstract
Hospital acquired infections (HAIs) are steadily increasing around the world. HAIs are costly, distressing to patients, and largely preventable. In 2011, approximately 722,000 HAIs were contracted in acute care settings in the U.S., approximately 75,000 of these patients died (Magill et al., 2014). Best practice dictates regular cleansing of tools and surfaces used in the patient care environment. Around two-thirds of health care workers (HCW) suspect their mobile devices harbor organisms, yet approximately 90% never clean their phones. A growing body of literature demonstrates that HCWs mobile devices are contaminated with bacteria at rates between 41.2-97.8% (Tekerekoğlu et al., 2011; Ustun & Cihangiroglu, 2012). A large percentage of HCWs suspect their mobile devices are dirty and evidence supports that fact, yet very little is being done to correct this issue. The purpose of this paper is to describe the risks associated with mobile device use, make specific recommendations for cleansing and use practices that can be employed by both HCW and patients alike to decrease potential cross-contamination and HAIs, and how nurses could effectively take a lead in preventing future HAI's.

Introduction

According to the World Health Organization (WHO) for every 100 hospitalized patients seven will develop an HAI in developed countries, while 10 will develop HAIs in developing countries (World Health Organization, 2010). HAIs are the most frequent adverse health event globally, yet as many as 70% of these are preventable (World Health Organization, 2010; CDC, 2016). Aggressive campaigns educating the importance of hand hygiene, along with disinfection of tools used in patient care have been amongst the primary interventions which have led to decreased HAIs.

The global boom in smart phone technology has brought an arguably invaluable tool into the lives of HCWs everywhere. Smart phones allow for instantaneous communication of photos, medication orders, and disease information between providers and patients alike. Communication by means of mobile devices can help to reduce medical errors and increase the speed of diagnosis (Soto, Chu, Goldman, Rampil, & Ruskin, 2006). The net effect of mobile devices on healthcare has been positive. Mobile devices are used by approximately 90% of HCWs during the work day, of this population more than half use their phones 3-20 times daily (Srikanth et al., 2010). One

study found that 50-65% of HCWs admitted to using mobile devices during physical interactions with their patients (Manning, Davis, Meng, & Ballard, 2013). The available literature demonstrates that HCWs phones are contaminated by bacteria at rates between 41.2-97.8% (Tekerekoğlu et al., 2011; Ustun & Cihangiroglu, 2012). It is important to note that not all of these organisms are pathogenic though. Rates of contamination of HCW's mobile devices with pathogenic bacteria varied by study, but most ranged from 9-25% with a few outliers finding rates as high as 43.6% and 52% (Brady, Verran, Damani, & Gibb, 2009; Sadat-Ali et al. 2010; Ulger et al. 2009). The issue of mobile device contamination has far reaching implications extending well outside of the field of healthcare. A study found that 90.1% of patient and visitor cellphones were contaminated with one or multiple strains of bacteria (Tekerekoğlu et al., 2011). More surprisingly still the study conducted by Tekerekoğlu and colleagues found patients and their visitors mobile devices carried higher rates of pathogenic bacteria than those of HCWs "39.6% vs. 20.6%" respectively. This study demonstrates that everyone plays a part in maintaining clean environments. It is only through judicious practice and collective awareness that the potential threat from cell phones can be adequately addressed. This paper will summarize the available literature regarding contamination rates of HCWs mobile devices and their potential role as fomites in the transmission of pathogenic organisms. The issue of bacterial cross-contamination will be viewed through the lens of nursing staff. Recommendations will be made for how nurses and patients alike can help drive changes in mobile device cleansing practices. Through simple, routine cleaning practices the potential threat posed by these tools can be greatly reduced.

Review of the Literature

Issues Related to Cleansing Practices for Mobile Phones

Mobile devices have been described by some infection prevention specialists and epidemiologists as a "Trojan Horse" for bacterial cross-contamination (Brady, Verran, Damani, & Gibb, 2009). This Trojan Horse property comes from the quiet, unassuming, yet powerfully pervasive role that mobile devices play in modern health care. Nearly every HCW has a mobile device in their pocket, and many of them are using their mobile devices during work. Yet no one is cleaning their phones after patient interactions as if they were a stethoscope or blood pressure cuff. Some might even argue that cleaning practices of mobile devices are not necessary. A study conducted by Sadat-Ali and colleagues (2010) seems to suggest that cleaning of mobile devices does in fact make a difference in contamination. This study evaluated 288 HCWs mobile devices, they found that 31 of these people (12.4%) cleaned their mobile devices on occasion with alcohol infused wipes. Of these 31 individuals, only 19.4% of them had bacterial contamination on their mobile devices. The other 219 HCW whose mobile devices were swabbed and plated, stated that they never cleaned their phones, this group had contamination rates of 41.2% (Sadat-Ali et al., 2010). The participants in this study were identified according to the units they worked on in the hospital. The authors categorized these employees as working in the emergency room (ER), operating room (OR), outpatient department (OPD), or in the "wards." Differences, in patient demographics, bacterial colonization rates and other related information was not discussed. This study seems to fairly clearly demonstrate that even casually cleaning your mobile devices can decrease rates of contamination.

A study conducted by Khan and colleagues yielded some confounding evidence regarding the efficacy of cleaning practices though. This study examined 106 portable electronic devices

(PEDs) being used by physicians at two large teaching hospitals. This study found that the group of individuals who self-reported cleaning their devices monthly to once a year (46%) had higher rates of bacterial contamination than those who never cleaned their PEDs (17.4%) (Khan et al., 2015). It would be expected that those who never cleaned their phones would have higher rates of pathogenic contamination yet they did not. It is important to note that the group of individuals in this study who self-reported daily to weekly cleaning routines (34.8%) had lower rates of pathogenic bacterial contamination than the other two groups though (Khan et al., 2015). One possible explanation for this result is the potential for dishonesty in the self-report process.

Albrecht and colleagues (2013) evaluated the efficacy of the use of ethanol wipes in decontaminating PEDs. In this study, 10 new PEDs were distributed at random to nursing staff in different clinical wards of a hospital. The nurses used these PEDs for a four week period. They were reminded to cleanse their devices daily by a pre-installed application and were instructed to follow a standardized protocol using alcohol based wipes. In between groups, the devices were sterilized and plated to insure no organisms were present. The comparison group made up of 10 medical informatics specialists, used the PEDs for a four week period as well, but they were forbidden to cleanse their PEDs during this time frame (Albrecht, Sedlacek, Groos, Suerbaum, & Vonberg, 2013). The researchers discovered 2.7 times more bacteria on the devices used by the comparison group as compared to the experimental group of nurses (Albrecht et al., 2013). The authors of this paper did not discuss the differences in contamination rates between the mobile devices amongst the nursing staff and how this may have related to the patient populations being cared for in their usual setting. This omission, was due to the fact that the study was observer blinded with respect to unit and personnel using the tablets (Albrecht et al., 2013). The work of

Albrecht et al. demonstrates that regular cleaning of devices used in patient care leads to significantly lower contamination levels.

Transmission of Bacteria by Mobile Phones in Acute Care Environments

Badr, Badr, and Ali (2012) found evidence supporting the fact that bacteria on mobile devices can be transmitted from the device onto the hands of the user. This study assessed a 32 person multi-disciplinary group at a hospital in Egypt. The participants cleaned their hands using an alcohol based sanitizer at which point their hands were cultured. After cleansing none of the participants hands yielded a positive culture. The participants were then asked to engage in a brief conversation on their mobile devices at which point their hands were sampled again, as were their mobile devices. After the phone conversations the rates of contamination of the HCWs hands increased from 0 to 93.7% (Badr, Badr, & Ali, 2012). This increase corresponded exactly to the contamination rates of the participants mobile devices. Furthermore, the bacteria cultured off of the participants hands were found to be genetically the same as those on their mobile devices (Badr, Badr, & Ali, 2012). The species of non-pathogenic bacteria isolated in this study were not listed by the authors. They did however enumerate which pathogenic species were isolated from both the hands and mobile devices of the participants. Coagulase negative *streptococcus, S. aureus* (including methicillin resistant strains), *B. anthracoid, K. pneumoniae, Serratia marsecens, and Proteu mirabilis* were the bacteria isolated (Badr, Badr, & Ali, 2012). The authors of this study observed that all participants carried their mobile devices to many different wards in the hospital, regularly taking calls during patient care without cleaning these devices. The authors do not discuss differences in the characteristics of patient populations cared for by the participants, or whether any effort was made to control for these differences. The work of Badr and colleagues clearly

demonstrates the potential danger of using a mobile device then touching a patient, or their surroundings without first cleaning your hands.

These four studies were conducted in different parts of the world, amongst multidisciplinary teams, in varied hospital environments. In each of these studies HCWs phones were found to be contaminated by bacteria. Each one of these studies further demonstrated that mobile device and hand hygiene when coupled together were effective at drastically decreasing the risks posed by cross-contamination.

Organisms such as Methicillin-resistant *Staphylococcus aureus* (MRSA) and *Acinetobacter baumannii*, are of clinical importance for a number of reasons. Both MRSA and *A. baumannii* are common causative agents of HAIs (Klein, Smith, & Laxminarayan, 2007; Park et al., 2013). Both of these bacteria share another common feature; they are capable of remaining alive on surfaces for months (Kramer, Schwebke, & Kampf, 2006). MRSA has demonstrated survival times in excess of 90 days on polyethylene, and up to 52 days on polyester fabrics (Neely & Maley, 2000). *A. baumannii* shows the highest rates of recovery of colony forming units on rubber, and polyvinylchloride (PVC) with certain strains demonstrating the ability to survive for up to four months (Wendt, Dietze, Dietz, & Rüden, 1997). Both PVC and polyethylene plastic are common components of modern mobile technologies (Ito et al., 2013). The possibility of both MRSA and *A. baumannii* surviving for such long periods of time on the surfaces which mobile devices are constructed out of is particularly concerning. MRSA and *A. baumannii's* hardiness are not unique to them, not all nosocomial pathogens share this ability to survive for long periods. However, this ability of

pathogens to survive for long periods makes monitoring for and containing these bacterium all the more important. MRSA is the leading cause of lower respiratory tract infections, surgical site infections, and is the second most common causative agent in hospital acquired bacteremia (Klein, Smith, & Laxminarayan, 2007). It is estimated that deaths related to MRSA average 6,000 annually (Klein, Smith, & Laxminarayan, 2007). *A. baumannii* accounts for 32% of gram negative HAIs (Park et al., 2013). In the study conducted by Park and colleague 92% of the cases of *A. baumannii* were contracted in the hospital setting. For patients who get *A. baumannii* related bacteremia the mortality rate is between 29-46.9% (Park et al., 2013).

Borer and colleagues studied the cross-contamination potential of *A. baumannii* between HCWs hands, mobile devices, and onto patients in a hospital in Israel. This study randomly screened 124 HCW including both doctors and nurses at random. Samples were collected from both their hands and their mobile devices at the same time. The sampling occurred over a two month time frame. To determine if cross-contamination had occurred, blood samples were collected from patients during this same time as were skin swabs from the axilla and groin (Borer et al. 2005). After culturing the bacteria the researchers analyzed their genetic make-up using gel electrophoresis techniques. The researchers recovered the same *Acinetobacter species* including multi-drug resistant (MDR) strains from the hands of health care workers, mobile devices, and skin of patients (Borer et al. 2005). It is important to note that the isolates of *Acinetobacter spp.* isolated from the patient's blood was not found to be related to those on the HCWs hands or phones. This study seems to have demonstrated the ability for bacteria to be transferred from hand, to cell phone, to patient and vice-versa. Borer and colleagues did not discuss differences in the patient populations cared for by the study participants. They did not attempt to control for any possible differences in characteristics such as bacterial contamination, which may have been

attributable to characteristics unique to those patient populations. Pulling from the available research, this was the only study found that analyzed the genetic similarity of what was on patient's skin and in their blood to what was on HCWs mobile devices and hands. The findings of Borer and colleagues make clear the need to treat mobile devices with caution and clean them just as one would another other tool used in care of patients.

Similarly, Ulger and colleagues' (2009) study looked at HCWs in the intensive care unit (ICU) and operating room (OR). 200 staff members were screened in this study. The sample included doctors, nurses, and other health care staff. The dominant hand of each participant was sampled and plated as were their mobile devices, these samples were collected simultaneously. The contamination rate of the mobile devices was 94.5% which is in step with the literature (Ulger et al., 2009). 52% of the HCWs mobile devices yielded MRSA, this is an alarmingly high rate of contamination for such a problematic nosocomial pathogen (Ulger et al., 2009). The researchers further demonstrated that the bacterial isolates found on the HCWs hands and phones were similar. This suggested that bacteria were being introduced from the HCWs hands onto their phones. Other literature suggests that there is no reason to suspect that this process does not work in the reverse order (Borer et al., 2005; Badr et al., 2012). The study participants were interviewed about their mobile device cleaning habits, and it was found that only 10.5% of them cleaned their phones with any regularity (Ulger et al., 2009). It is possible that the level of patient acuity, and intimate interaction between HCWs and their patients required in these settings, coupled with poor cleaning practices, may have all played a part in such a high rate of drug resistant bacteria being present in this study. The authors of this study did not address differences in the patient populations seen in an OR as compared to an ICU and how this may have affected contamination rates.

Chang and colleagues took a similar approach to that of the group led by Ulger. Chang and colleagues collected samples from HCW nares, dominant hand, and mobile devices. These researchers hoped to determine if the same bacteria which resided on the HCWs nares and hands were found on their mobile devices. Ninety-four percent of the staff members had the same bacteria on their nares or hands as on their mobile devices (Chang et al., 2017). The rates of contamination by nosocomial pathogens was lower in this study at 27.3% (Chang et al., 2017). This study's authors also did not discuss or control for possible differences in patient characteristics observed between hospital units. Meadow, Alrtichter, and Green (2014) also analyzed the similarity between bacteria isolated from peoples' hands as compared to those on their mobile devices. These researchers found that 22% of the bacteria found on a persons hands were also located on their phones (Meadow, Altrichter, & Green, 2014). This study was not looking at people working in the healthcare field, but rather was conducted at microbiological conference.

Work by Beckstrom and colleagues looked at the transfer of bacteria from mobile devices to the hands of parents in a neonatal intensive care unit (NICU). This study recruited 50 parents in a NICU in Washington. The parents were asked to wash their hands and arms to the elbows for 30 seconds according to the unit policy. After washing their hands, the parents were asked to use their mobile devices to take a photo, mock a brief phone call, and send a short text. The tasks performed by the participants were supposed to mimic common real world uses of mobile devices. Upon completion of the prescribed tasks, the parent's hands were sampled for microbiological life, as were their mobile devices. The researchers then had the participants use an antimicrobial gel to clean their hands but gave no instructions for how to properly utilize the soap free cleaner (Beckstrom, Cleman, Cassis-Ghavami, & Kamitsuka, 2013). 90% of the participants were found to have the same bacteria on their mobile devices, and hands after handling the devices (Beckstrom

et al., 2013). There was an overall decrease in bacterial load for the participants after use of the antimicrobial gel, but only 22% saw a complete elimination of ogranisms (Beckstrom et al., 2013). *In vitro* studies suggest that the overall reduction in bacteria should have been higher after use of the gel (Beckstrom et al., 2013). Although, there are many explanations for these results, the authors felt the most likely one was the parents not knowing how to properly apply the gel to their hands. Neonates have immature immune systems in the best of circumstances. Neonates ill enough to be in the NICU represent a highly susceptible population. The findings of this study suggest that quality improvement measures should be taken to change the policies surrounding mobile devices in the NICU setting. Changes for this setting could include forcing both HCW and parents to clean both their phones and hands, and could be as extreme as all together banning the use of mobile devices in the NICU.

Transmission of Bacteria by Mobile Phones Between Acute Settings and the Community

The Trojan Horse property of mobile devices does not just have an impact at the workplace. The mobile device follows an HCW home, potentially bringing the problems of the hospital into the community. Ustun and Cihangiroglu (2012) conducted a study in a hospital in Turkey in which 183 mobile devices were collected and cultured from a diverse group of HCWs. While participants phones were being plated, researchers asked them whether they ever cleaned their phones, and if people other than themselves used the phones outside of the hospital. This study found that 97.8% of the phones harbored bacteria with 9.5% testing positive for MRSA and 11.2% testing positive for extended-spectrum beta-lactamase (ESBL) *Escherichia. coli* (Ustun & Cihangiroglu, 2012). The researchers found that there was a statistically significant difference in the rates at which ESBL *E. coli* was recovered from the mobile devices of ICU employees as compared to staff working in other areas of the hospital (20.5% vs 8.1%) (Ustun & Cihangiroglu, 2012). The study's

authors postulated that this difference in contamination with ESBL *E. coli* may be attributable to the "routine 'patient body care'" provided on ICU floors (Ustun & Cihangiroglu, 2012). Of the 183 staff sampled and interviewed, 96.7% self-reported that they had never cleaned their mobile devices. This finding is consistent with the literature. This study revealed that HCWs mobile devices are commonly used by other individuals outside of the work place. The study participants indicated that family members are the most common people to use their mobile devices, with their children being cited as regular users of many of the HCWs mobile devices. The risk of transmission from a HCWs mobile device to a high risk population such as the very young, or the very old is high. Work done by MacKenzie and colleagues (2007) demonstrated a strong relationship between the monthly percentage of MRSA in a hospital in Scotland and the percentage of MRSA infections in the surrounding community the following month (MacKenzie et al., 2007). As these studies help to demonstrate, a contaminated mobile device is not just a risk to a hospitalized patient, it is a health risk for the community as a whole.

The risk of cross-transmission and infection from mobile devices is not restricted to HCW alone. Research done by Tekerekoğlu and colleagues demonstrated that the rates of contamination of the mobile devices of patients and their visitors was higher than those of HCW. The rate of contamination amongst HCW in this study was 85.6% as compared to 90.1% of the mobile devices of patients and visitors (Tekerekoğlu et al. 2011). The researchers further found that the patients and their visitor's phones harbored significantly higher rates of pathogenic bacteria than their HCW counterparts (39.6% vs 20.6%) (Tekerekoğlu et al., 2011). Research done by Brady and colleagues demonstrated similar rates of bacterial contamination to those found by Tekerekoğlu and colleagues, with 83.4% of the patient's phones culturing positive in their study (Brady et al., 2011). Along with analyzing microbiological profiles of patient's mobile devices, this study also

involved nasal swabbing to analyze for organisms as well as a questionnaire to determine patient's attitudes about mobile device use in the hospital. The study found that 93.8% of the participants supported use of mobile devices by HCW and 60.8% stated that having bans placed on mobile device use would negatively affect their hospitalization (Brady et al., 2011). Of the participants who harbored nasal MRSA in the study, 25% of them had the organism on their phone as well. This finding suggests that patients colonized with MRSA may pass the organism onto their phones and potentially from there onto their hands or the hands of others. 50.9% of the participants in the study stated that they never clean their phones, 49% of the subjects stated that they would be happy to let a stranger use their phone if asked (Brady et al., 2011). The implications of this study are profound, these findings further highlight the real risks posed by mobile devices as a conduit for disease transmission. The fact that patients are willing to allow others to use their mobile devices in the hospital environment further complicates matters. The possibility that patients in isolation rooms may be allowing their friends and visitors to use their phones in the hallways and common areas of the hospital is a very real one. Restricting mobile device use does not seem to be a realistic or practical solution. This leaves education and recommendations for cleaning practices of both hands and mobile devices as the most reasonable means of addressing this issue. Nurses are perfectly poised as trusted health care leaders to design and implement programs to educate HCWs and patients alike about safe cleaning habits for mobile devices.

Minimizing Transmission of Pathogens by Mobile Phones Through Nursing Leadership

In 2010 the Insitiute of Medicine (IOM) published a report called *The Future of Nursing: Leading Change, Advancing Health.* In this evidence based report, the IOM recommends that "Nurses should be full partners, with physicians and other healthcare professionals, in redesigning

healthcare in the United States (IOM, 2010, p. 4).” The report goes on to to say that “Being a full partner involves taking responsibility for identifying problems… devising and implementing improvement plans… and making necessary adjustments to realize established goals (IOM, 2010).” It is every healthcare system’s goal and by extension should be the goal of every nurse to improve patient outcomes and reduce negative health events. HAIs are a huge burden on the healthcare system as they are pervasive, ever changing, and lead to largely preventable morbidity and mortality. The available evidence clearly demonstrates that contamination of HCW and patient’s mobile devices is an issue of real concern. Mobile devices hold the potential to act as a fomite both in the healthcare setting and in the community. The literature demonstrates that simple judicious cleaning habits used for the mobile device as well as the hands can effectively reduce the threat posed by mobile devices. As frontline care providers and educators of co-workers and patient’s alike, nurses can serve as the engine in driving for evidence-based practice (EBP) change surrounding mobile device and hand cleaning practices. Nurses spend more time with patients than any other healthcare providers (Delucia, Ott, & Palmieri, 2009). The increased time spent with patients, coupled with the fact that nurses are the most trusted profession, uniquely positions the nurse to serve as powerful educator for their patients. The increased time that a nurse spends with patients also increases the probability of transmission of bacteria from a nurses hands or tools onto their patient. The evidence clearly indicates what the path forward must look like. Nurses have a unique opportunity in this case to help implement practice changes that can help to keep patients free of HAI and focus the healthcare fields attention more directly onto the risk posed by the powerful tools in their pockets and the pockets of their patients.

The cost of the modern “smart” mobile device and a desire not to damage them must be balanced with the need to effectively rid such devices of pathogenic organisms. The lack of clear

manufacturers' instructions for what compounds are acceptable to clean a mobile device makes the matter of recommending safe and effective cleaning instructions somewhat problematic. Most mobile device forums for Android® and Apple® products do seem to indicate the use of alcohol based wipes is safe for these devices, however, care must be used not to get liquid into the port for the power cord, headphones or speakers if possible. Manning and colleagues (2013) authored a paper which developed an "iPBundle" which is a group of common sense hygiene practices to be employed before and after use of mobile devices that would be useful in nursing practice. There were four practices recommended in the iPBundle. One practice included covering mobile devices with a waterproof/water resistant barrier. This could be as simple as a single use plastic bag, or something more durable like a military grade case. Decontamination of devices both before and after use in the patient environment; use of automatic reminders on devices nudging the user to clean their devices at regular intervals during the work day; and hand hygiene before and after use of mobile devices were also recommended (Manning, Davis, Meng, & Ballard, 2013). Most of the literature supports use of either alcohol based wipes, or 0.5% chlorhexidine-70% isopropyl alcohol wipes which was demonstrated to be the most effective in eliminating most bacteria by Beer and colleagues (2006).

It is important to note that certain pathogenic organisms notably *C. difficile* and *M. tuberculosis* form highly hardy spores which cannot be easily cleaned from surfaces and tools. Work done by Kiedrowski and colleagues looking at the efficacy of various cleaning compounds at removing *C. difficile* from tablets found that only bleach wipes removed 100% of the organisms from these devices (Kiedrowski et al. 2013). Due to the difficulty of removing pathogens such as *C. difficile* and *M. tuberculosis* coupled with the caustic nature of bleach, it is not recommended for HCWs to bring mobile devices into the rooms of patients who are known or suspected of being

infected. If a mobile device must be brought into these patient rooms, use of a disposable plastic covering is recommended.

The literature does not demonstrate that a mobile device has been directly implicated in a patient becoming infected by a pathogen, it does however present a large body of evidence which supports there being a risk of such an event occurring. It is clear that through education of both HCWs and the general public that the risks posed by mobile device contamination can be mitigated. Mobile devices must be treated as any other healthcare tool would be, with regular cleansing of both the device and the hands occurring after each use. The changes necessary to eliminate mobile devices as a major risk factor in infection transmission, are simple, cheap, and do not put patients or HCW at risk, nor do they place an undue burden on the workload of the HCW. Nurses must step into their roles as full partners and leaders in the healthcare field and become champions for an EBP change surrounding cell phone hygiene.

Conclusion

The literature clearly demonstrates that mobile devices pose a real threat as fomites for pathogen transmission in the hospital and community alike. Although the literature does not demonstrate that a mobile device has been the cause for patient infection, that does not preclude the possibility. The simple fact that HCWs and patients' cellphones are being used during hospitalization and pose a real public health risk is reason enough to take action. Nurses must step into their role as leaders and full partners in the healthcare field by being proactive in their interventions, rather than reactive. Interested nurses should begin by raising awareness at their places of work and educating patients and co-workers on how they can be a part of the solution, not the problem. This education should focus on why cleaning mobile devices is important, and

how best to carry out the process of disinfection. Nurses should role model the behavior that they want to see from their patients' by regularly disinfecting their personal mobile devices and those provided by their facility. Nurse leaders interested in seeing facility wide change, should approach both their quality management (QM) officer and the infection control specialist at their facility. QM and infection control are well suited to help the nurse to understand what the QM model used by the facility is. By working within a given facilities quality management framework the nurse leader helps to ensure that the proposed change will be well received by the employees, managers, and administration.

References

Albrecht, U. V., Von Jan, U., Sedlacek, L., Groos, S., Suerbaum, S., & Vonberg, R. P. (2013). Standardized, App-based disinfection of iPads in a clinical and nonclinical setting: comparative analysis. *Journal of Medical Internet Research*, *15*(8), 1-11.

Badr, R. I., Badr, H., & Ali, N. M. (2012). Mobile phones and nosocomial infections. *International Journal of Infection Control*, *8*(2), 1-5.

Beckstrom, A. C., Cleman, P. E., Cassis-Ghavami, F. L., & Kamitsuka, M. D. (2013). Surveillance study of bacterial contamination of the parent's cell phone in the NICU and the effectiveness of an anti-microbial gel in reducing transmission to the hands. *Journal of Perinatology*, *33*, 960-963.

Beer, D., Vandermeer, B., Brosnikoff, C., Shokoples, S., Rennie, R., & Forgie, S. (2006). Bacterial contamination of health care workers' pagers and the efficacy of various disinfecting agents. *The Pediatric Infectious Disease Journal*, *25*, 1074-1075.

Borer, A., Gilad, J., Smolyakov, R., Eskira, S., Peled, N., Porat, N....Schlaeffer, F. (2005). Cell phones and acinetobacter transmission. *Emerging Infectious Diseases*, *11*, 1160-1161. https://dx.doi.org/10.3201/eid1107.050221.

Brady, R. R., Hunt, A. C., Visvanathan, A., Rodrigues, M. A., Graham, C., Rae, C., ... & Gibb, A. P. (2011). Mobile phone technology and hospitalized patients: A cross-sectional surveillance study of bacterial colonization, and patient opinions and behaviours. *Clinical Microbiology and Infection*, *17*, 830-835.

Brady, R. R.W., Verran, J., Damani, N. N., & Gibb, A. P. (2009). Review of mobile communication devices as potential reservoirs of nosocomial pathogens. *Journal of Hospital Infection*, *71*, 295-300.

Centers for Disease Control. (2016, October 25) *Healthcare-associated infections*. Retrieved October 30, 2017, from https://www.cdc.gov/hai/surveillance/index.html

Chang, C. H., Chen, S. Y., Lu, J. J., Chang, C. J., Chang, Y., & Hsieh, P. H. (2017). Nasal colonization and bacterial contamination of mobile phones carried by medical staff in the operating room. *PloS one*, *12*(5), e0175811.

DeLucia, P. R., Ott, T. E., & Palmieri, P. A. (2009). Performance in nursing. *Reviews of Human Factors and Ergonomics*, *5*(1), 1-40.

Institute of Medicine [IOM]. *Future of nursing: Leading change, advancing health*. Retrieved November 17, 2017 from, https://www.nap.edu/read/12956/chapter/2#4

Ito, M., Khanchang, S., Saito, A., Murase, N., Hamaya, N., & Hiroyoshi, N. (2013) Recycling treatment of cell phones including PCBs by advanced jigging.

Khan, A., Rao, A., Reyes-Sacin, C., Hayakawa, K., Szpunar, S., Riederer, K., & Levine, D. (2015). Use of portable electronic devices in a hospital setting and their potential for bacterial colonization. *American Journal of Infection Control*, *43*, 286-288.

Kiedrowski, L. M., Perisetti, A., Loock, M. H., Khaitsa, M. L., & Guerrero, D. M. (2013). Disinfection of iPad to reduce contamination with clostridium difficile and methicillin-resistant staphylococcus aureus. *American Journal of Infection Control*, *41*, 1136-1137.

Klein, E., Smith, D. L., & Laxminarayan, R. (2007). Hospitalizations and deaths caused by methicillin-resistant staphylococcus aureus, United States, 1999–2005. *Emerging Infectious Diseases*, *13*, 1840-1846.

Kramer, A., Schwebke, I., & Kampf, G. (2006). How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. *BMC Infectious Diseases*, *6*, 130. http://doi.org/10.1186/1471-2334-6-130

Magill, S. S., Edwards, J. R., Bamberg, W., Beldavs, Z. G., Dumyati, G., Kainer, M. A., ... & Ray, S. M. (2014). Multistate point-prevalence survey of health care–associated infections. *New England Journal of Medicine*, *370*, 1198-1208.

Manning, M. L., Davis, J., Sparnon, E., & Ballard, R. M. (2013). iPads, droids, and bugs: Infection prevention for mobile handheld devices at the point of care. *American Journal of Infection Control*, *41*, 1073-1076.

MacKenzie, F. M., Lopez-Lozano, J. M., Monnet, D. L., Stuart, D., Beyaert, A., Wilson, R., & Gould, I. M. (2007). Temporal relationship between prevalence of methicillin-resistant staphylococcus aureus (MRSA) in one hospital and prevalence of MRSA in the surrounding community: A time-series analysis. *Journal of Hospital Infection*, *67*, 225-231.

Meadow, J. F., Altrichter, A. E., & Green, J. L. (2014). Mobile phones carry the personal microbiome of their owners. *PeerJ*, *2*, e447.

Neely, A. N., & Maley, M. P. (2000). Survival of enterococci and staphylococci on hospital fabrics and plastic. *Journal of clinical microbiology*, *38*, 724-726.

Park, S. Y., Choo, J. W., Kwon, S. H., Yu, S. N., Lee, E. J., Kim, T. H., ... & Jeon, M. H. (2013). Risk factors for mortality in patients with acinetobacter baumannii bacteremia. *Infection & Chemotherapy*, *45*, 325-330.

Sadat-Ali, M., Al-Omran, A. K., Azam, Q., Bukari, H., Al-Zahrani, A. J., Al-Turki, R. A., & Al-Omran, A. S. (2010). Bacterial flora on cell phones of health care providers in a teaching institution. *American Journal of Infection Control*, *38*, 404-405.

Soto, R. G., Chu, L. F., Goldman, J. M., Rampil, I. J., & Ruskin, K. J. (2006). Communication in critical care environments: Mobile telephones improve patient care. *Anesthesia & Analgesia, 102,* 535-541.

Srikanth, P., Rajaram, E., Sudharsanam, S., Lakshmanan, A., Mariappan, U. S. S., & Jagannathan, K. (2010). Mobile phones: Emerging threat for infection control. *Journal of Infection Prevention, 11*(3), 87-90.

Tekerekoğlu, M. S., Duman, Y., Serindağ, A., Cuğlan, S. S., Kaysadu, H., Tunc, E., & Yakupogullari, Y. (2011). Do mobile phones of patients, companions and visitors carry multidrug-resistant hospital pathogens? *American Journal of Infection Control, 39,* 379-381.

Ulger, F., Esen, S., Dilek, A., Yanik, K., Gunaydin, M., & Leblebicioglu, H. (2009). Are we aware how contaminated our mobile phones with nosocomial pathogens?.*Annals of Clinical Microbiology and Antimicrobials, 8,* 295-300.

Ustun, C., & Cihangiroglu, M. (2012). Health care workers' mobile phones: A potential cause of microbial cross-contamination between hospitals and community. *Journal of Occupational and Environmental Hygiene, 9,* 538-542.

Wendt, C., Dietze, B., Dietz, E., & Rüden, H. (1997). Survival of Acinetobacter baumannii on dry surfaces. *Journal of clinical microbiology, 35,* 1394-1397.

World Health Organization. (2010). *Healthcare-associated infection fact sheet*. Retrieved September 11, 2017, from http://www.who.int/gpsc/cpimtry_work/gpsc_ccisc_fact_sheet_en.pdf?ua=1