Keypad mobile phones are associated with a significant increased risk of microbial contamination compared to touch screen phones

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Abstract

The use of mobile phones in the clinical environment by healthcare workers has become widespread. Despite evidence that these devices can harbour pathogenic micro-organisms there is little guidance on how to reduce contamination. Recently touch screen phones with a single flat surface have been introduced. We hypothesise that bacterial contamination of phones used in hospitals will be lower on touch screen devices compared to keypad devices. Sixty seven mobile phones belonging to health care workers were sampled. The median colony count for touch screen phones and keypad devices was 0.09 colony forming units (cfu)/cm² (interquartile range (IQR) 0.05–0.14) and 0.77 cfu/cm² (IQR range 0.45–3.52) respectively. Colony counts were significantly higher on the keypad phones (Fisher’s exact test \( p < 0.001 \)). Multivariate analysis showed the type of phone (keypad vs. touch screen) was associated with increased colony counts (F-statistic 14.13: \( p < 0.001 \)). Overall, nine (13%) phones grew either meticillin resistant Staphylococcus aureus (MRSA) and vancomycin resistant enterococci (VRE) have been recovered from as many as 10% of mobile phones (Goldblatt et al, 2007; Jeske et al, 2007; Brady et al, 2009). Contaminated handheld devices have the potential to be reservoirs for cross contamination of patients and other staff. The majority of healthcare professionals use the same mobile phone inside and outside the workplace, and this risks contamination to other departments, hospitals and the community. There has been extensive guidance on how to reduce bacterial contaminants on hands and clothes and standards are regularly monitored in UK hospitals. There is relatively little guidance, however, on how to reduce contamination on mobile phones.
In 2011 market research by the independent regulator and competi-
tion authority for the UK communications industries (Ofcom, 2011),
indicated that more than a quarter of adults use a smartphone, with
increasing numbers of users among younger age groups. Many of
these devices have a touch screen with a solitary smooth surface as
opposed to a key pad with separate buttons and numerous crevices.
We postulated that bacterial contamination of phones used in the
healthcare setting will be lower on touchscreen devices compared
with keypad devices.

Methods
During a six month period in 2011 healthcare professionals carrying
mobile phones within a clinical environment in our hospital were
approached randomly. To be included in the study, mobile phones
had to be used to communicate clinical information; ‘on-call’ baton
hospital phones that were passed from clinician to clinician were
included. Healthcare workers had to be approached within the hospi-
tal. A single clinician could only have one phone sampled; and a
single phone could not be sampled more than once. Consecutive cli-
icians were approached in the hospital. A similar number of keypad
and touchscreen phones were sampled.

Conventional agar contact methodology was used to detect the
presence of bacteria on the mobile phones. Direct contact methods
are more sensitive than swabbing techniques (Obee et al., 2007) and
both sides of a numbered nutrient agar dipslide (Dimanico Ltd,
Henlow, Bedfordshire, UK) were pressed firmly on the front surface of
the phone. Using the dipslide uniform pressure was applied to the
most handled parts of the phone (keypad, virtual keyboard, menu
button, earpiece). All phones were sampled by one of three trained
investigators. Each mobile phone was photographed and the clini-
cians were asked to fill out anonymous corresponding numbered
questionnaires to record their grade, specialty, concomitant use of a
pager and predominant working environment within the hospital.
The microbiologist was blinded to the type of phone sampled.

All slides were incubated aerobically at 37°C for 48 hours. The
incorporation of 2.3,5-triphenyltetrazolium (TTC ‘red spot dye’)
within the agar aided the visualisation and enumeration of bacterial
colonies. The aerobic colony count (ACC) as colony forming units
(cfu/cm²) was calculated by dividing the number of colonies isolated
from each mobile phone by the area sampled (22 cm²). Confirmatory
tests were conducted on all presumptive pathogens. Presumptive
enterococci were Gram-stained and tested for asaccharolytic activity
(bile-esculin test). Once confirmed, the disc diffusion method
was used to determine the susceptibility of each isolate to vancomy-
cin (5 µg/disc; Oxoid Ltd, Basingstoke, UK). Presumptive S. aureus
colonies were tested for DNase activity and resistance to cefoxitin
(10 µg/disc; a surrogate marker of metillin resistance). In both cases,
zone sizes were interpreted according to British Society for
Antimicrobial Chemotherapy guidelines (Andrews, 2009). Samples
were considered unsuitable for analysis if there was an error in sam-
ping technique or if slides were contaminated with a bacteria display-
ing swarming motility (e.g. Proteus spp) making the enumeration of
colonies difficult.

Although not clearly linked to infection rates, a common threshold
for the standard of hospital cleanliness at a hand touch site is an aero-
bic colony count less than 2.5 cfu/cm² (Dancer, 2004). Accordingly,
an aerobic colony count > 2.5 cfu/cm² or the presence of potential
pathogens were considered hygiene failures.

Statistical methods
The primary endpoint of the study was to investigate if there was
a relationship between the number of bacteria recovered (cfu) and
the type of mobile phone interface screen. This was performed using
Fisher’s exact test. Multivariate analysis was performed to identify
significant independent factors. Other factors taken into consider-
ation included date the sample was taken, job description of phone
holder (training doctor vs. consultant (attending) doctor, depart-
ment of phone holder (medicine, surgery and anaesthetics). The
multivariate analysis also considered if the phone holder carried an
additional pager.

A secondary analysis was to determine the type of organism iso-
lated and whether the type of phone was associated with the growth
of antibiotic resistant organisms. A two sample test of proportion
was used to assess these results.

Results
Between January and May 2011, 71 mobile phones were sampled.
Thirty six phones were keypad and 35 phones were touch-screen, 17
of which were iPhones. All of these phones were used in the clinical
environment on a daily basis. Four samples were deemed unsuitable
for analysis, giving 67 results (three were smeared samples and one
had an overgrowth of Proteus). They originated from the department
of medicine (n=17), department of surgery (n=39) and department of
anaesthetics (n=11). These included 41 from senior clinicians and 26
from training doctors and nurses. Overall, 23 of these clinicians also
carried pagers at work – 44 did not carry a pager. Ten of the phones
sampled were ‘on-call’ baton hospital phones that were passed from
clinician to clinician.

The overall median cfu for the 67 phones was 0.23 cfu/cm² (inter-
quartile range (IQR) 0–2.14). The median cfu count for touchscreen
phones and keypad phones was 0.09 cfu/cm² (IQR 0.05–0.14) and
0.77 cfu/cm² (IQR range 0.45–3.52) respectively. Colony counts were
significantly higher on the keypad phones (Fisher’s exact test p<0.001)
(Figure 1). Multivariate analysis showed only the type of phone
(keypad vs. touch screen) was associated with increased cfu growth
(above median) (F-statistic 14.13: p<0.001). Overall, nine (13%) phones
grew either MRSA or VRE. Eight (24%) keypad phones were
contaminated with these organisms compared with one touch screen
phone (3%) (Two sample test of proportion p=0.01). None of the 17
iPhones sampled were contaminated at levels >1 cfu/cm² and none
were contaminated with potential pathogens. Five of these iPhones
were enclosed in a protective case; 12 had their oleophbic screens
exposed directly to fingertips.

All the ‘on-call’ baton phones were keypad and had a median cfu
count of 1.27 cfu/cm² (IQR range 0.32–1.29); four (40%) of these
phones were contaminated with MRSA or VRE.

In order to confirm our findings we repeated the exercise in
another hospital. This hospital had a lower baseline MRSA rate in
comparison to our institution (patients admitted with MRSA coloni-
sation over the observed period – 3.9% in primary institution, 1.5%
in parallel institution.)

In the parallel institution the median cfu/cm² for 126 touchscreen
phones was 0.23 cfu/cm² (IQR 0.09–0.63) vs. 0.86 cfu/cm² (IQR 0.77–1.35). 0.4 cfu/cm². Five (4%) of the touch-
screen phones were contaminated with MRSA; none of the keypad
phones were contaminated with drug-resistant pathogens. Colony
counts were significantly higher on the keypad phones (Fisher’s exact
test p<0.001).

Discussion
Hospital acquired infection remains an important problem and
there has been much work on minimising vectors that carry
pathogenic bacteria within the setting. Hand washing significa-
antly reduces the spread of infection (Mortimer et al., 1966) and
hospital ties have been shown to carry the same bacteria that
colonise wound infections (Steinlechner et al., 2002). These
aspects are components of the ‘bare-below the elbows’ policy
that has become healthcare standard. Equally, many hospital and
healthcare authorities use fixed communication devices that can be sanitised, e.g. computer keyboards. Conversely, the use of mobile communication devices is relatively unregulated in respect to their potential for cross-infection.

Our study has shown that touchscreen mobile phones have lower bacterial colonisation when compared with keypad mobile phones. Keypad mobile phones were more likely to be contaminated at higher counts of bacteria and the majority of drug resistant bacteria were isolated from keypad phones. We propose that a keypad contact surface which is irregular and uneven can harbour bacteria and that the smooth surface of the touch screen has less potential for this. A comparative analogy with the computer keyboard has shown reduced colonisation rates where a smooth 2-D flat surface is used compared with a traditional 3-D keyboard (Wilson et al., 2008). There is evidence that cleaning mobile phones with an alcohol wipe can reduce contamination rates (Sumritivanicha et al., 2011). It is conceivable that a touchscreen phone with a flat surface will be easier to decontaminate using simple recommended measures. However repeated use of alcohol may damage plastic.

Worryingly the keypad is the area in contact with the fingertips and intermittent handling of mobile phones during and between consultations is a means for co-transmission and does conceivably reduce the effectiveness of hand washing; a recent study genotyping bacteria isolates on the user’s hand (Khivsara et al., 2006). The incidence of bacteria known to cause nosocomial infection on healthcare workers’ mobile phones. The incidence of bacteria known to cause nosocomial infection on healthcare workers’ mobile phones. (Soto et al., 2006). There is evidence that cleaning mobile phones with an alcohol wipe can reduce contamination rates (Sumritivanicha et al., 2011). It is conceivable that a touchscreen phone with a flat surface will be easier to decontaminate using simple recommended measures. However repeated use of alcohol may damage plastic.

Figure 1. Box plot comparing colony forming units (cfu) values in touch screen and keypad phones

Conclusion

Hospital acquired infections account for a significant burden of morbidity and mortality and reducing infections represents a significant saving both to the individual patient and financially to the whole healthcare system.

Mobile phones are likely to remain a part of the communications arsenal of modern healthcare practice. They can, however, act as a mobile reservoir for infection. We need to minimise the risk posed by these devices. Our study shows that when compared with keypad mobile phones, touchscreen mobile phones are considerably less contaminated, and have lower prevalence of multi-drug resistant bacteria.

Investing in touch screen phones for use in the hospital setting may be a cost-effective and safe way of reducing the infection risk associated with this now essential workplace tool.

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Conflict of interests

None declared.

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