CHAPTER TWO
2. LITERATURE REVIEW

2.1. The mobile phone

A mobile phone (also known as a cellular phone, cell phone or a hand phone) is a device that can make and receive telephone calls over a radio link whilst moving around a wide geographic area. It does so by connecting to a cellular network provided by a mobile phone operator, allowing access to the public telephone network. By contrast, a cordless telephone is used only within the short range of a single, private base (Suganya and Sumathy, 2012).

2.2. History of mobile phone

Prior to 1973, mobile telephony was limited to phones installed in cars and other vehicles. The first hand-held cell phone was demonstrated by John F. Mitchell and Martin Cooper of Motorola in 1973. The first hand-held cell phones were large, bulky and used in automobiles. They also consumed too much power to be used without the vehicle's engine running. Mitchell successfully pushed Motorola to develop wireless communication products that would be small enough to use anywhere and participated in the design of the cellular phone. The first cell phones started by using a 1G (Analog cellular networks) which was demonstrated by Motorola in 1973. The first commercial automated cellular network was launched in Japan by NTT (Nippon Telegraph and Telephone) in 1979. In 1981, this was followed by the simultaneous launch of the Nordic Mobile Telephone (NMT)

system in Denmark, Finland, Norway and Sweden. They advanced to 2G (Digital cellular networks) in Finland by Radiolinja on the GSM standard, and in 2001, the 3G (Mobile broadband data) network advanced in Japan by NTT DoCoMo on the WCDMA standard which gave cell phones the ability to support multi-media such as internet access, text messaging and sharing videos and photos. Initially the first cell phones started as 1G networks, while today, cell phones run using a 4G (Native IP networks) are WiMAX standard (offered in the U.S. by Sprint) and the LTE standard, first offered in Scandinavia by TeliaSonera (Farley, 2005).

2.3. Gram-negative bacteria

Gram-nagative bacteria are typically non-pathogenic in the immunocompetent host. This is especially true of *Enterobacteriaceae* and the non fermentative Gram-negative bacilli. However, in the debilitated host Gram-negative bacteria can become significant pathogens (Martine and Pharm, 2004).

Gram-negative bacteria are potential disease-causing agents. They could have come in contact with the cell phones through soil, clothing, food and/or hands of the users. The roles of these organisms in both nosocomial and community-acquired infections have been well documented. The frequent handling of the mobile makes it easy for cross contamination (Kawo and Musa, 2013).

These microorganisms have been variously reported as responsible for respiratory and skin infections, enteritis, meningitis, stomach disorders and sinusitis (Kawo *et al.,* 2012).

2.4. Community acquired infections

2.4.1. Definition

Community-acquired infections are infections acquired anywhere other than in a healthcare facility, in settings such as schools, exercise facilities, or any place where there is contact with other people or with surfaces that have been contaminated e.g. mobile phones. Most of these infections are due to *S. aureus*, Methicillin resistant *Staphylococcus aureus* (*MRSA*) and *C. difficile* (Clark, 2007).

2.4.2. Role of mobile phone contamination in community acquired infections

Several studies were done in different countries around the world by many scientists and microbiologists to see if there was mobile phones contamination and if these mobile phones contamination had a role in community acquired infections. In Nigeria, screened 50 mobile phones belonging to food vendors for microbial contamination. The rate of bacterial contamination was 100%, the organisms isolated were *Staphylococcus aureus* (50%), *Streptococcus faecium* (34%), *Bacillus cereus* (30%), *Escherichia coli* (26%) (Amushan *et al.,* 2012).

In India, obtained surface random samples from 100 mobile phones of students in Quaid-E-Millath Government College for women from the age group of 18 to 25

years. Bacterial growth observed in 50% of the samples. The bacterial contamination was dominated by 34% of Gram positive bacteria and 16% by Gram negative bacteria. *S. aureus* was present in 14%, *Enterococcus* sp was present in 18%, *Micrococcus* sp and aerobic spores contributed to 2% of the samples. E. coli and coliform bacteria was found in 16 of the bacterial isolates (Jagadeesan *et al.,* 2013).

Another study done in Nigeria, screened 25 mobiles from students and 25 from commercial centers at Bayero University Kano. Bacterial contamination of personal mobile phone was 80.0% and public mobile phone was 100%. The isolated bacteria from public phones and personal mobile phones were similar. Personal and public cell phones showed an association of microorganisms as a result of constant handling. The organisms consistently isolated were *S. aureus* (84%) and *Streptococcus* spp (16%) in public mobile phones and *S. aureus* (76%) and *Streptococcus* spp (48%) from personal mobile phones (Yusha *et al.,* 2010).

In Slovenia, 35 mobile phones owned by students of health sciences in University of Ljubljana were sampled by Ovca *et al.,* (2012). Microorganisms were detected in 30 of tested samples. Isolated bacteria were members of the *Enterobacteriaceae* family and genus *Staphylococcus*. Also *Enterococcus* spp and *Bacillus* spp were isolated.