

gene. Nowadays, this resistance is frequent in industrialized countries (Cristina et al. 2016) and also in developing countries like Southern Asia (Das et al. 2016). Additional carbapenemases have now been reported as *bla*_{NDM}, *bla*_{OXA-48}, *bla*_{VIM}, and *bla*_{IMP-1} (Cristina et al. 2016; Onori et al. 2015). The resistance can be sourced from different ways as we explained before, including the production of β -lactamases *ampC* type and *K. pneumoniae* carbapenemase (KPC) type (Abdallah et al. 2015; Ruppé et al. 2015).

According to WHO (2016), carbapenem antibiotics are ineffective in more than half of people treated for *K. pneumoniae* infections in some European countries. Human mortality rates caused by CRKP are high in case of infections, 26–44%, and very high related with bacteremia, 70% (Amit et al. 2015; Hoxha et al. 2016). According to Cristina et al. (2016), the infection rates have been dramatically increasing worldwide over the past 10 years.

Furthermore, 187 cases of KPC infections were detected in Brazil in 2010 and 18 deaths were registered (Dos Santos et al. 2015). In a single Italian hospital, Onori et al. (2015) analyzed the diversity of *K. pneumoniae* strains and observed 16 CRKP isolates that were added to a database of 319 genomes. A study done in a university hospital in Milan (Italy) by Ridolfo et al. (2016) showed that CRKP was isolated during hospital stays in 46 of the patients (73%). In the same way, Poulou et al. (2012) reported 73 CRKP infections associated with ICU (43.8%) and medical wards (41.1%) in a university hospital in Greece. Most of the cases (90.4%) were from general medical and surgery wards, and the remaining 9.6% were from the ICU. Furthermore, a study done by Laurent et al. (2008) showed that 9 in 30 patients in a Belgium hospital developed an infection caused by KPC.

Recent studies reported that the infections caused by MDR *E. coli* will increase and it is expected to cause three million deaths each year by 2050 (Potter et al. 2016; Tang et al. 2016). Infections caused by MDR *K. pneumoniae* represent a global public health concern and a major therapeutic challenge for present and future generations.

11.5.2 Extended-Spectrum β -Lactamase

The prevalence of ESBL-producing bacteria is increasing in humans, animals, and their surrounding environment and is of global concern (Day et al. 2016; Seni et al. 2016). But it is important to note that the number of cases reported in ESBL are higher than CRE, particularly in animals.

The spread of resistance to many β -lactam antibiotics has been associated with one important mechanism called HGT, potentially carrying AMR genes of β -lactamases on plasmids (Lynch et al. 2013; Shaikh et al. 2015). ESBL-producing bacteria are now commonly isolated both in industrialized and in developing countries (Figure 11.3).