Equally important, the risk of developing type 1 diabetes, an insulin-dependent autoimmune disease, has been associated with dysbiosis due to repeated use of broad-spectrum antibiotics (i.e. streptomycin, polymyxin E and ampicillin, or vancomycin) (Boursi et al. 2015; Candon et al. 2015) (Table 1.1).

1.4.1.2 Metabolic Diseases: Deregulated Metabolism

The onset of many metabolic diseases such as obesity has been linked to an early antibiotic exposure in mice and man (Ajslev et al. 2011; Cho et al. 2012). Additionally, antibiotic use seems to be a risk factor for advancing from obesity to a metabolic syndrome (cohort of cardiovascular disease, fatty liver disease, steatohepatitis, and type 2 diabetes) (Emanuela et al. 2012).

In a project led by Kroemer and Zitvogel, researchers discovered that antibiotics inhibited the clinical benefit of a novel immunotherapy (immune checkpoint inhibitors [ICI]) in patients with advanced cancer (Routy et al. 2018). In fact, the administration of ampicillin, colistin and streptomycin in mice and beta-lactam inhibitors, fluoroquinolones, or macrolides in humans suppressed ICI effect by reducing *Akkermansia muciniphila* abundance in the microbiome (Routy et al. 2018) (Table 1.1). This is in concordance with the recently recognized role of the microbiome in tumorigenesis and cancer progression (Roy and Trinchieri 2017).

1.4.1.3 Infectious Diseases: Increased Susceptibility to Pathogens

The lack of microbial competition in the gut lumen as a result of antibiotic-provoked dysbiosis can lead to overgrowth and colonization by opportunists or pathogens such as *Clostridium difficile*, *S. aureus*, or *Klebsiella pneumonia* (Song et al. 2008; Buffie et al. 2012). These pathogenic bacteria are usually the cause of antibiotic-associated diarrhea (AAD), a major concern in nosocomial infections. *C. difficile*, a spore-forming bacterium, is the leading healthcare-acquired infection, causing a recurrent chronic infection and often lethal pseudomembranous colitis (Buffie et al. 2012). Likewise, susceptibility to *Salmonella enterica* serovar Typhimurium increased in a mouse model after streptomycin and vancomycin use (Sekirov et al. 2008) (Table 1.1). After antibiotic treatment, other pathogenic and opportunistic bacteria, such as resistant *Enterococcus* strains, can disrupt the gut mucosa, leading to bloodstream infections or sepsis, particularly in immunocompromised patients and children (Ubeda et al. 2010; Mai et al. 2013).

Additionally, the lack of microbiome signaling (microbial-associated molecular patterns [MAMPS]) following broad-spectrum antibiotics prescription (including gentamycin) can also reduce the innate and adaptive immune responses to microorganisms, making the host more vulnerable to other infections, e.g. *Candida albicans* (Shankar et al. 2015) (Table 1.1).