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## Human pathogens abundant in the bacterial metagenome of cigarettes.

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### Abstract

**BACKGROUND:** Many studies have evaluated chemical, heavy metal, and other abiotic substances present in cigarettes and their roles in the development of lung cancer and other diseases, yet no studies have comprehensively evaluated bacterial diversity of cigarettes and the possible impacts of these microbes on respiratory illnesses in smokers and exposed nonsmokers.

**OBJECTIVES:** The goal of this study was to explore the bacterial metagenomes of commercially available cigarettes.

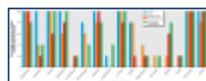
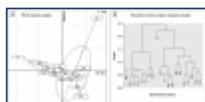
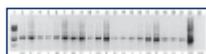
**METHODS:** A 16S rRNA-based taxonomic microarray and cloning and sequencing were used to evaluate total bacterial diversity of four brands of cigarettes. Normalized microarray data were compared using principal component analysis and hierarchical cluster analysis to evaluate potential differences in microbial diversity across cigarette brands.

**RESULTS:** Fifteen different classes of bacteria and a broad range of potentially pathogenic organisms were detected in all cigarette samples. Most notably, we detected *Acinetobacter*, *Bacillus*, *Burkholderia*, *Clostridium*, *Klebsiella*, *Pseudomonas aeruginosa*, and *Serratia* in  $\geq 90\%$  of all cigarette samples. Other pathogenic bacteria detected included *Campylobacter*, *Enterococcus*, *Proteus*, and *Staphylococcus*. No significant variability in bacterial diversity was observed across the four different cigarette brands.

**CONCLUSIONS:** Previous studies have shown that smoking is associated with colonization by pathogenic bacteria and an increased risk of lung infections. However, this is the first study to show that cigarettes themselves could be the direct source of exposure to a wide array of potentially pathogenic microbes among smokers and other people exposed to secondhand smoke. The overall public health implications of these findings are unclear at this time, and future studies are necessary to determine whether bacteria in cigarettes could play important roles in the development of both infectious and chronic respiratory diseases.

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