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# How antidepressants help bacteria resist antibiotics

**抗抑郁药如何帮助细菌抵抗抗生素**

**A laboratory study unravels ways non-antibiotic drugs can contribute to drug resistance.**

**一项实验室研究解开了非抗生素药能贡献药物抵抗的途径。**

**一项实验室研究揭示了非抗生素药物如何导致耐药性。**

The **emergence** of disease-causing **bacteria** (that are **resistant** to **antibiotics**) // is often **attributed** to the **overuse** of **antibiotics** in people and **livestock**. But researchers have ***homed*** in on another potential driver of **resistance**: **antidepressants**. ***By*** studying **bacteria** grown in the laboratory, a team ***has*** now **tracked** how **antidepressants** can **trigger** drug **resistance**.

句子成分：括号中的是**bacteria**的定语。斜杠前的所有，一起做主句的主语。

疾病导致细菌出现，抵抗抗生素通常被归咎于人群、家畜抗生素滥用。但是研究者找到了其他的潜在抵抗驱动者：抗抑郁药。正在实验室中研究细菌生长，一个团队正在跟踪-抗生素如何触发药物抵抗。

**对抗生素耐药的致病细菌的出现通常归因于人和牲畜过度使用抗生素。但研究人员已经锁定了耐药性的另一个潜在驱动因素：抗抑郁药。通过研究实验室中生长的细菌，一个研究小组现在已经追踪了抗抑郁药如何引发耐药性。**

“Even after a few days **exposure**, **bacteria** develop drug **resistance**, not only against one but **multiple** **antibiotics**,” says senior author Jianhua Guo, who works at the Australian Centre for Water and Environmental Biotechnology at the University of Queensland in Brisbane. This is both interesting and scary, he says.

“尽管一些天的暴露，细菌发展出耐药性，不仅仅对一种药物耐药，而是很多种。”cxxxx说，生物学家。“这既有趣又危险。”

**“即使在接触几天后，细菌也会产生耐药性，不仅针对一种抗生素，而且针对多种抗生素，”资深作者Jianhua Guo说，他在布里斯班昆士兰大学澳大利亚水与环境生物技术中心工作。他说，这既有趣又可怕。**

Globally, **antibiotic** **resistance** is a significant public-health **threat**. An estimated 1.2 million people died ***as*** a **direct** result of it in 2019, and that number is **predicted** to climb.

语法：as表原因

全球地，抗生素耐药是一个重要的公共健康威胁。一个预估，1200万人死因是直接和抗生素耐药有关，而且这个数量一直被预估上涨。

**在全球范围内，抗生素耐药性是一个重大的公共卫生威胁。据估计，1年有2万人直接死于此**[**2**](https://www.nature.com/articles/d41586-023-00186-y#ref-CR2)**，预计这个数字还会攀升。**

## Early clues 早期线索

Guo *became interested in* the possible **contributions** of non-**antibiotic** drugs to **antibiotic** **resistance** in 2014, after work by his lab found more **antibiotic**-**resistance** genes // **circulating** in **domestic** wastewater samples than in samples of wastewater from hospitals, where **antibiotic** use is higher.

郭对非抗生素药对抗生素耐药的重要贡献感兴趣，在2014年，在通过对比，在医院的废水中找到更多的抗生素耐药基因，医院用的抗生素多。

**郭在2014年对非抗生素药物对抗生素耐药性的可能贡献产生了兴趣，因为他的实验室发现，家庭废水样本中循环的抗生素抗性基因比医院废水样本中循环的抗生素耐药基因更多，因为医院的抗生素使用率更高。**

Guo’s group and other teams also **observed** that **antidepressants** — which are among the most widely **prescribed** medicines in the world — killed or **stunted** the growth of *certain* **bacteria**. They **provoke** “an SOS response”, Guo explains, **triggering** **cellular** **defence** **mechanisms** that, in turn, make the **bacteria** better able to survive **subsequent** **antibiotic** **treatment**.

郭和其他团队也察觉到了抑郁药—被广泛地使用在处方药中—杀灭或者防御增长期地某些细菌。它们引发了“紧急回应”。郭解释，促发细胞的防御机制，是使细菌更好地在之后的抗生素治疗中存活。

**郭的小组和其他团队还观察到，抗抑郁药 - 这是世界上最广泛的处方药之一 - 杀死或阻碍某些细菌的生长。郭解释说，它们引发“SOS反应”，触发细胞防御机制，从而使细菌更好地在随后的抗生素治疗中存活下来。**

In a 2018 paper, the group reported that *Escherichia coli* became **resistant** to multiple **antibiotics** after being **exposed** to **fluoxetine**, which is commonly sold as Prozac. The latest study examined 5 other **antidepressants** and 13 **antibiotics** from 6 classes of such drugs and **investigated** how **resistance** in *E. coli* developed.

在2018年的论文中，这个团队报道了xxxx成为了抵抗多种抗生素在暴露在氟西汀的环境中，氟西汀的商品名是xxx/被卖做xxx。最近的研究测试了来自这些药的6个组中的，5个其他抗抑郁药、13个抗生素，调查了xxx如何耐药。

**在2018年的一篇论文中，该小组报告说，*大肠杆菌*在暴露于氟西汀后对多种抗生素产生耐药性，通常作为百忧解出售。最新的研究检查了来自5类此类药物的13种其他抗抑郁药和6种抗生素，并调查了*大肠杆菌*耐药性的发展情况。**

In **bacteria** grown in **well-oxygenated** laboratory **conditions**, the **antidepressants** caused the cells to **generate** reactive oxygen species: **toxic molecules** that activated the **microbe**’s **defence mechanisms**. Most **prominently**, this activated the **bacteria**’s **efflux pump** systems, a **general expulsion** system that many **bacteria** use to eliminate various molecules, including **antibiotics**. This probably explains how the **bacteria** could **withstand** the **antibiotics** without having specific **resistance** genes.

在有氧实验室中生长的细菌，抗抑郁药导致细胞产生氧气反馈物种（需氧物种）：毒物分子能够使微生物的防御机制活跃。非常显著地，这活跃了细菌的排除泵体系，一个普遍排出体系使很多细菌用来评估各种各样的分子，包括抗生素。这可能解释了细菌如何抵抗抗生素，在没有特殊的抵抗基因的时候。

**在含氧良好的实验室条件下生长的细菌中，抗抑郁药使细胞产生活性氧：激活微生物防御机制的有毒分子。最突出的是，这激活了细菌的外排泵系统，这是一种通用的排出系统，许多细菌用它来消除各种分子，包括抗生素。这可能解释了细菌如何在没有特定抗性基因的情况下承受抗生素。**

But **exposure** of *E. coli* to **antidepressants** also led to an increase in the **microbe**’s **mutation** rate, and the **subsequent** selection of various **resistance** genes. However, in **bacteria** grown in **anaerobic** **conditions**, levels of reactive oxygen species were much lower and **antibiotic** **resistance** developed much more slowly.

但是xxx的暴露同时导致了变异的机率增大，和随后的抵抗基因的选择。然而，在细菌生长的艳阳的环境中，活性氧自由基的标准比厌氧抵抗产生的缓慢。

**但大肠杆菌暴露于抗抑郁药也导致微生物突变率增加，以及随后各种抗性基因的选择。然而，在厌氧条件下生长的细菌中，活性氧水平要低得多，抗生素耐药性的发展要慢得多。**

Moreover, at least one antidepressant, **sertraline,** promoted the transfer of genes between **bacteria**l cells, a **process** that can **speed up** the **spread** of **resistance** through a population. Such transfer can occur between different types of **bacterium**, allowing **resistance** to **hop** between species — including from **harmless** **bacteria** to **pathogenic** ones.

更重要的是，至少一种抑郁药，舍曲林，促使细菌细胞中的基因转化，这个过程能加速耐药性在人群中的传播。这些转变能发生在不同种的细菌中，允许耐药性短距离跨物种跳跃——包括来自无害细菌到病原菌的物种。

**此外，至少一种抗抑郁药舍曲林促进了细菌细胞之间的基因转移，这一过程可以加速耐药性在人群中的传播。这种转移可能发生在不同类型的细菌之间，允许物种之间抵抗啤酒花 - 包括从无害细菌到致病细菌。**

## Growing recognition

Kiran Patil, who studies microbiome–chemical interactions at the University of Cambridge, UK, says that in the past five years there has been a growing appreciation that many non-**antibiotic** medicines that target human cells can also affect **bacteria** and **contribute** to **antibiotic** **resistance**. “The strength of the study is the mechanistic details,” says Patil.

Lisa Maier, who is based at the University of Tübingen in Germany and studies interactions between drugs and the microbiome, says that to understand how **antidepressants** can drive **antibiotic** **resistance**, researchers need to determine what molecules the drugs are targeting in the **bacteria** and to assess the effects of the medications on a wider variety of clinically relevant **bacteria**l species. In 2018, Maier and her colleagues surveyed 835 medicines that did not target microbes and found that 24% inhibited the growth of at least one strain of human gut **bacteria**[4](https://www.nature.com/articles/d41586-023-00186-y#ref-CR4).

Patil and Maier say it is important to gather evidence to assess the real-world impact of **antidepressants** on **resistance**, such as whether **antidepressants** are driving the accumulation of **antibiotic**-**resistant** **bacteria**, particularly disease-causing ones, in people, animals or the environment.

Although significant amounts of **antidepressants** have been found in wastewater, reported levels tend to fall below the concentrations at which Guo’s group saw significant effects in *E. coli*. But concentrations of some of the **antidepressants** that had strong effects in this study are expected to be reached in the large intestines of people taking the drugs.

## Follow-up studies

Maier says that several studies now link **antidepressants** and other non-**antibiotic** pharmaceuticals to changes in **bacteria**, and that preliminary studies have given the “first hints” regarding how such drugs can affect the microbiomes of people taking them.

But in healthy humans, *E. coli* is found mainly in the large intestine, where conditions are anaerobic, meaning that the process described in the paper might not occur at the same rate in people, says Maier. Future studies should use **bacteria**l growing conditions that model sites at which **antidepressants** might be acting, says Patil.

Guo says his lab is now looking at the microbiomes of mice given **antidepressants**. Early, unpublished data suggest that the drugs can change the animals’ gut microbiota and promote gene transfer.

But Guo and Maier caution people against stopping taking **antidepressants** on the basis of this research. “If you have depression, that needs to be treated in the best possible way. Then, **bacteria** second,” says Maier.

Researchers and pharmaceutical companies need to quantify the **contribution** of non-**antibiotic** pharmaceuticals to **antibiotic** **resistance**, says Guo. “Non-**antibiotic** pharmaceuticals are a big concern that we shouldn’t overlook,” he says.