Nanoparticles For Specific Detection And Killing of Pathogenic Bacteria

Tech ID: 30000 / UC Case 2017-840-0

SUMMARY

UCLA researchers in the Department of Chemistry and Biochemistry and Department of Medicine have developed novel functionalized mesoporous silica nanoparticles that can specifically identify pathogenic bacteria and deliver on-target drug treatments.

BACKGROUND

Bacterial infection is a common illness that affects many Americans each year. The specific bacteria involved are often unknown, and even when they are, highly specific antibiotics are typically unavailable. Hence, treatment frequently involves the use of broad spectrum antibiotics. This not only contributes to the emergence of antibiotic resistance, but also adversely affects many nonpathogenic bacteria, e.g. in the intestine, that are beneficial to the host. Sometimes this adverse effect on what is known as the gut microbiome results in difficult to treat superinfections, *e.g.*, *Clostridium difficile colitis*. Therefore, there currently exists a need for a method for rapidly diagnosing specific pathogens so as to allow more specific treatment and for a more efficacious antibiotic delivery system to target specific pathogen populations so as to limit bacterial resistance and avoid negatively impacting the host microbiome.

Beyond the natural exposure of hosts to pathogenic bacteria, modern bioterrorism threatens harm to great numbers of individuals via intentionally exposing them to rapidly fatal organisms. It is important to specifically diagnose such pathogens so that appropriate antibiotics can be administered. Current mechanisms of detection are often either inaccurate, *e.g.,* unable to distinguish the highly pathogenic bacterium *Francisella tularensis* subsp. *tularensis* from nonpathogenic *Francisella* species, or slow, requiring hours to identify the pathogen specifically. Hence there is need for methods to rapidly identify and treat specific bioterrorism agents.

There are a number of delivery systems that are currently being explored for drug delivery. Specific characteristics of ideal delivery systems include: nonspecific interactions, target site access, controlled drug release, and drug suitability. One specific delivery system, mesoporous silica nanoparticles (MSNs), have all of these essential characteristics while offering: tunable particle size and morphology, and great design flexibility for chemical modifications allowing facile incorporation of drug moieties. These MSNs have even been shown to selectively release “caged” drug substances due to antibody functionalized surfaces interacting with a specific antigen species like a sulfonamide group. However, MSNs have never been shown to release a diagnostic indicator or an antibiotic payload as a result of a surface interaction between antibody and molecules directly secreted or released by pathogenic bacteria.

INNOVATION

Drs. Zink and Horwitz at UCLA have developed a novel functionalized mesoporous silica nanoparticle (MSN) that can recognize the O-antigen of lipopolysaccharide (LPS) through an FB11 antibody and release a cargo molecule that either can instantly reveal the presence of a specific pathogen, in this case *Francisella tularensis* subsp. *tularensis*, or kill the pathogen. To confirm specific identification of its target, the functionalized MSN has been shown to be effective in distinguishing *Francisella tularensis* subsp. *tularensis* from the very closely related bacterium *Francisella tularensis* subsp. *novocida* (also known as *Francisella novicida*). While shown for a bacterial species that is a known biological warfare tool, its premise could be used for identifying and/or eliminating not only bioterrorism agents but common bacterial pathogens that cause infections.

APPLICATIONS

- Specific targeting of bacterial biological warfare species leading to both diagnosis and treatment
- Specific targeting of common pathogenic bacterial species (diagnosis and treatment)

CONTACT

UCLA Technology Development Group
ncd@tdg.ucla.edu
tel: 310.794.0558.

INVENTORS

- Horwitz, Marcus A.

OTHER INFORMATION

KEYWORDS

specific diagnosis, pathogen-specific targeting, bacterial infection, illness, acquired resistance, silica nanoparticles, nanoparticle drug delivery, surface interaction pathogen recognition, antibody

CATEGORIZED AS

- **Biotechnology**
  - Other
- **Medical**
  - Delivery Systems
  - Disease: Infectious Diseases
- **Nanotechnology**
  - Materials

RELATED CASES

2017-840-0

- Targeted drug delivery based on a specific biomarker

ADVANTAGES

- Rapid diagnosis of target pathogens through interaction of bacterial marker (distinguish between species)
- High specificity of drug delivery to target through interaction of bacterial marker (distinguish between species)
- Minimalization of off target effects due to specific recognition of pathogen
- Less effects on other microbial populations thus avoiding superinfection and emergence of antibiotic resistance

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,045,555	06/29/2021	2017-840

RELATED MATERIALS

- Ruehle, B., Clemens, D. L., Lee, B.-Y., Horwitz, M. A. & Zink, J. I. A Pathogen-Specific Cargo Delivery Platform Based on Mesoporous Silica Nanoparticles. (2017). doi:10.1021/jacs.7b01278

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Safe and Potent Vaccines against Tularemia
- Novel Live Recombinant Booster Vaccine against Tuberculosis
- Safe Potent Single Platform Vaccine Against Tier 1 Select Agents and Other Pathogens

UCLA Technology Development Group
10889 Wilshire Blvd., Suite 920,Los Angeles,CA 90095
https://tdg.ucla.edu
Tel: 310.794.0558 | Fax: 310.794.0638 | ncd@tdg.ucla.edu