Povidone-Iodine Vapor Kills MRSA

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Purpose
Background
Povidone-iodine antiseptics are often used to clean and de-germ skin prior to surgery.
- Povidone, a polymer, slowly releases iodine, which kills microbes.
- FDA regulations recently changed, requiring hospitals to use single-use bottles of povidone-iodine instead of larger, multi-use ones.
  - This is to prevent patient fluids from contaminating bottles.
  - O'Rourke and colleagues found S. aureus, a bacterium notorious for causing hospital-associated infections, on the rim of two multi-use povidone-iodine bottles in a Pennsylvania hospital.1

Problem
Single-use povidone-iodine bottles are expensive.
- Cost: 2-3 times as much per ounce as multi-use bottles
- This means hundreds of millions of dollars per year in extra healthcare costs.
Multi-use bottles should theoretically be safe.
- Povidone-iodine should be able to kill most vegetative bacteria that get inside.

Hypothesis
Bottles of povidone-iodine should disinfect themselves.
- Povidone-iodine releases iodine vapor, killing bacteria inside the bottle that are not in contact with the solution.
- This should hold true for S. aureus.
Multi-use bottles of povidone-iodine may be safe to use in a clinical setting.

Methods
Potato Experiment
Goal: Demonstrate that povidone-iodine gives off iodine vapor.
- Chunks of potato were made and hung inside of plastic bottles containing povidone-iodine.
- Potatoes contain starch, which reacts with iodine to turn a deep purple.
- After 24 hours, potato chunks turned purple, so iodine must have been present.

Potato Experiment
Goal: Demonstrate that povidone-iodine vapor kills methicillin-resistant S. aureus (MRSA) bacteria.
1. Small metal cylinders called penicylinders were soaked in MRSA and dried.
2. Penicylinders were hung inside of bottles containing povidone-iodine for 20, 40, and 80 minute periods.
3. Penicylinders were dropped into glass tubes containing saline and gently sonicated to release bacteria.
4. A serial dilution was performed, and the resulting liquid was spread onto plates. Plates were incubated, colonies were counted, and total kill was assessed.

Results
Potato Experiment
Povidone-iodine does give off iodine vapor as manifested by the purple color of the exposed potato pieces.
- Iodine is the only component of povidone-iodine vapor that is likely to kill microbes.

MRSA experiment
Povidone-iodine vapor killed MRSA, and the amount of kill increased over time.
- For each time increment and sample, log reduction was computed. 1 log reduction = 90% kill, 2 log reduction = 99% kill, and so on.
- Kill clearly increased with contact time, and 98% or better kill occurred after 80 minutes.

Conclusion
Povidone-iodine releases iodine vapor, which kills MRSA.
- After 80 minutes, nearly complete kill occurred. It may be possible to safely reuse povidone-iodine bottles.
  - Most major surgical procedures last longer than 80 minutes. So, if povidone-iodine is used at the beginning of a surgery, any MRSA contamination is likely gone by the time the next surgery begins.

Pursuing these findings further could lead to significant cost savings.
- Based on a rough estimate, around $300 million in healthcare costs could be saved by switching to multi-use povidone-iodine bottles.

Future Research Possibilities
This experiment should be repeated using Pseudomonas aeruginosa or another similar gram-negative bacterium.
- MRSA is gram-positive, but research suggests that gram-negative bacteria are more resistant to povidone-iodine.2
- Pseudomonas aeruginosa, a gram-negative bacterium, is notorious for resisting disinfection, making it particularly relevant.

Bibliography & Acknowledgements
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