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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*.

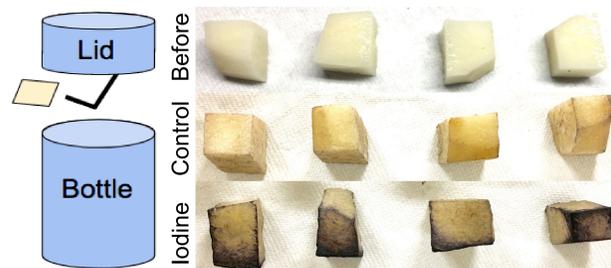
Multi-use bottles of povidone-iodine may be safe to use in a clinical setting.

Methods

Potato Experiment

Goal: Demonstrate that povidone-iodine gives off iodine vapor.

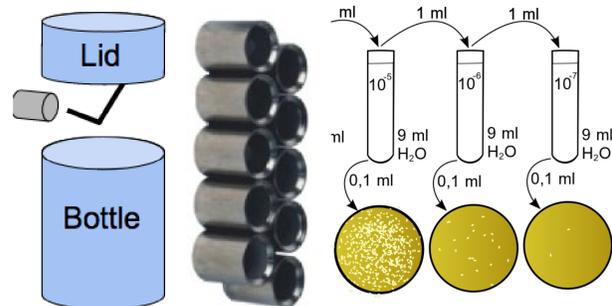
- Chunks of potato were made and hung inside of plastic bottles containing povidone-iodine.
- Potatoes contain starch, which reacts with iodine to turn a deep purple.
- After 24 hours, potato chunks turned purple, so iodine must have been present.



MRSA 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.

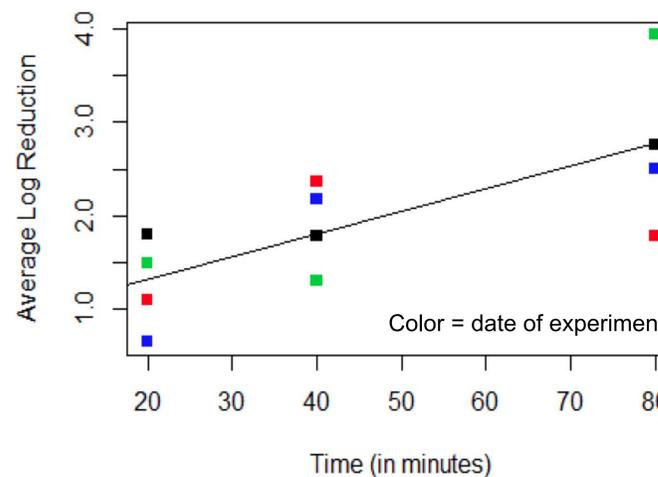
- Iodine is the only component of povidone-iodine vapor that is likely to kill microbes.

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.

Log Reduction vs. Time



- Kill clearly increased with contact time, and 98% or better kill occurred after 80 minutes.

Statistical analysis using ANOVA was performed to determine whether time affected kill in a statistically significant manner.

- Result: Time did affect kill, and the result was significant.
- Date of experiment was not statistically significant, and date-time interaction was also not significant.

| | ° of Freedom | F Value | Probability > F |
|--------------------|--------------|---------|-----------------|
| Time | 3 | 15.59 | <0.0001 |
| Date of Experiment | 3 | 0.39 | 0.7606 |
| Experiment * Time | 9 | 1.1 | 0.3645 |

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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