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COMPARATIVE EVALUATION OF CAPTURE AND RELEASE OF PATHOGENIC BACTERIA BY FLOCKED SWABS

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Abstract

The ability of clinical swabs to collect and release pathogenic bacteria efficiently is necessary to obtain diagnostic sensitivity for the benefit of patient care. To improve the survival of fastidious bacteria, swabs are often coated with non-fiber material. In a comparative study, the water absorption and capture and release characteristics of coated and uncoated flocked swabs have been determined with suspensions of *Streptococcus pneumoniae, Hemophilius influenzae, Neisseria gonorrheae*, and *Peptostreptococcus anaerobius*. HydraFlock® and PurFlock® Ultra swabs of Puritan Medical Products (PMP) and uncoated nylon and coated Nylon (ESwab) swabs of Copan Diagnostics (CD) were compared.

Whole swabs or swab tip fibers were placed in water and their weight gain was determined to compute water absorption. Collection and release of pathogenic bacteria were studied by immersing swabs in bacterial suspensions and enumeration of bacteria released from swabs.

Water absorption of coated and uncoated swabs ranged from 13.2% to 21.6%, the highest and lowest being uncoated PurFlock® Ultra and ESwab, respectively. Swab tip material of uncoated PurFlock® Ultra swabs absorbed significantly less water than uncoated HydraFlock® and Nylon swabs. Compared to uncoated swabs of the same type, coated PurFlock® Ultra swab exhibited significantly higher recovery of *S. pneumoniae*, N. *gonorrheae*, and *P. anaerobius*. On the other hand, uncoated HydraFlock® swab gave higher recovery of *H. influenzae, N. gonorrheae*, and *S. pneumoniae* than coated swabs of the same type. No significant difference in recovery of test bacteria was evidenced between ESwab and Nylon swab.

Recovery of all bacteria by swab type revealed the lowest and the highest recovery by uncoated PurFlock® Ultra (54%) and uncoated HydraFlock® (93%) swabs, respectively. No significant difference in the recovery of bacteria was observed between Nylon (coated & uncoated), HydraFlock® (coated & uncoated), and coated PurFlock® Ultra swabs.

These results point to the fact that coating of swabs may not be beneficial for the recovery of all organisms and its utility depends on physiocochemical properties of swab tip material.

Materials and Methods

Swabs

Puritan Medical Products
- Coated HydraFlock®
- Uncoated HydraFlock®
- Coated PurFlock® Ultra
- Uncoated PurFlock® Ultra

Copan Diagnostics
- Nylon flocked
- E-swab

Absorbance studies

Water absorption of whole swab

Swab (N=5) was immersed in 1 ml of distilled water for 10 sec and percent water absorption was determined.

Water absorption of swab head material

Swab head material was removed from the swab shaft (N=5), transferred into a pre-weighed tube and 1 mL of distilled water was added. Tubes were shaken for 1 min at room temperature to remove unbound water, and percent water absorption was determined.

Culture studies

- The CLSI document M40-A (CLSI, 2003) served as a guide for culture studies.
- Bacterial cell suspension equivalent to 0.5 McFarland was prepared in 0.85% sterile saline and diluted to ~10^7 CFU/ml.
- To compare the capture and release efficacy, each test swab type (N=12) was immersed in the diluted bacterial suspension for 10 sec to allow absorption. The swabs were removed from the bacterial suspension, held in air for 45 sec, transferred to the dilution medium, and vortexed for 15 sec to release bacteria. Bacteria were quantified after necessary dilutions and cultured on appropriate media to obtain recovery.

Materials and Methods (continued)

Table 1. Summary of organisms, media, and culture conditions used in the study.

Organism	Culture Medium	Culture Conditions
Streptococcus pneuomoniae (ATCC 6305)	5% Sheep blood agar	37°± 1° C for 18-24 h, 5% CO_2
Hemophilus influenza (ATCC 10211) *Neisseria gonorrhoeae* (ATCC 43069)	Chocolate agar	37°± 1° C for 18-24 h, 5% CO_2
Peptostreptococcus anaerobius (ATCC 27337)	5% Sheep blood agar	37°± 1° C for 48 h, anaerobic

$$\text{Recovery (\%)} = \frac{\text{Dilution Factor x A}}{\text{Dilution Factor x B x C x D}} \times 100$$

A = Number of bacteria recovered (CFU/mL)
B = Number of viable organisms in the starting culture (CFU/mL)
C = Average water absorption capacity of the swab (mL)
D = Average dry weight of swab (g)

Data Analysis

- Statistical analysis of data collected was done by using JMP-7 (SAS Institute, Cary, NC).
- One-way Analysis of Variance (ANOVA) was used to test the equality of several means and to establish the test of significance. The *p*-values were computed and then the test of significance was applied ($\alpha = 0.05$).
- Tukey-Kramer Honestly Significance Different Test ($p \leq 0.05$) was used to determine which means are significantly different from one another.

Results

Table 2. Water absorption of whole swabs

	Coated HydraFlock®	Uncoated HydraFlock®	Coated PurFlock® Ultra	Uncoated PurFlock® Ultra	Nylon flocked	E-swab
Water absorption of swab	17.9%	18.8%	17.9%	21.6%*	14.2%	13.2%

*Swab with the highest absorption

Uncoated PurFlock® Ultra exhibited the highest ability to absorb water.

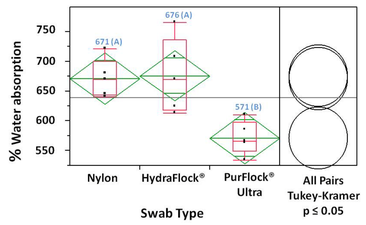


Figure 1. One-way ANOVA of water absorption capacity of uncoated swab fibers.
Actual means are shown above each box. Letter-coded report is shown in parenthesis. Levels not connected by the same letter are significantly different.

PurFlock® Ultra exhibited the lowest water absorption capacity in the group. (**Figure 1**). Water absorption capacity of a swab plays an important role to extract microorganisms from the collection site by capillary action.

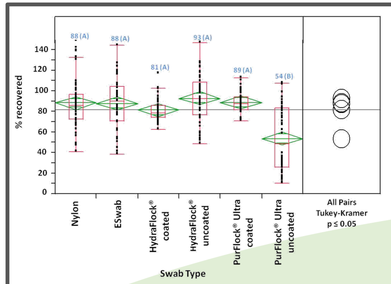
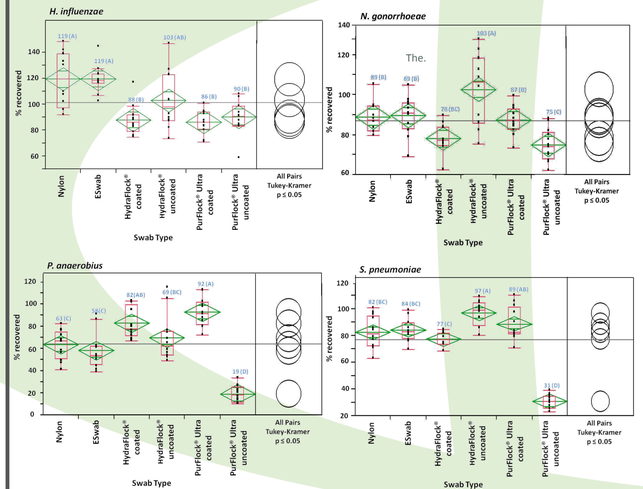


Figure 2. One-way ANOVA of recovery of all bacteria-by swap type.
Actual values are shown above each box. Letter-coded report is shown in parenthesis. Levels not connected by the same letter are significantly different.

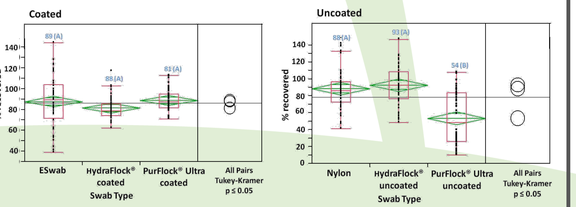
Uncoated HydraFlock® swab and uncoated PurFlock® Ultra gave the highest and lowest recovery of bacteria, respectively. Uncoated PurFlock® Ultra recovered significantly less bacteria than all other swab types.

Figure 3. One-way ANOVA of recovery of each bacterium by swab type.
Actual values are shown above each box. Letter-coded report is shown in parenthesis. Levels not connected by the same letter are significantly different.



Coated PurFlock® Ultra swab gave significantly higher recovery of *S. pneumoniae*, N. *gonorrheae*, and *P. anaerobius* compared to the uncoated PurFlock® Ultra swab. On the other hand, uncoated HydraFlock® swab gave higher recovery of *H. influenzae, N. gonorrheae*, and *S. pneumoniae* than coated swabs of the same type. No significant difference in recovery of test bacteria was evidenced between ESwab and Nylon swab.

Figure 4. One way ANOVA of recovery of all bacteria by swab coating.
Actual values are shown above each box. Letter-coded report is shown in parenthesis. Levels not connected by the same letter are significantly different.



No significant difference in recovery of bacteria between the different coated swabs. Uncoated PurFlock® Ultra recovered significantly less bacteria than the other uncoated swabs.

Conclusions

This study addresses the effect of coating of swab fibers on the collection and release of clinically important pathogens.

Which swabs preformed the best overall?

The highest recovery of all test bacteria and the highest water absorption by swab fibers was demonstrated by uncoated HydraFlock®. Higher water absorption potentially increases viability of fragile organisms on the swab head by preventing desiccation, thus resulting in higher diagnostic sensitivity. Water absorption of swab fibers is a function of chemical composition, microstructure, and surface polarity

Does swab fiber coating affect the capture and release of bacteria?

Coating of PurFlock® Ultra swab enhanced its performance to recover bacteria over uncoated swabs of the same type although no significant difference in recovery of any test bacteria found between Nylon swab and ESwab of Copan. Therefore, physicochemical properties of swab fibers in combination with coating may affect (increase or decrease) the capture and release of test bacteria.

How did the swabs rank for recovery of each test bacteria?
1 = highest amount of recovery while 5 = lowest amount of recovery

	Coated HydraFlock®	Uncoated HydraFlock®	Coated PurFlock® Ultra	Uncoated PurFlock® Ultra	Nylon flocked	ESwab
H. influenzae	5	3	6	4	2	1
N. gonorrhoeae	5	1	4	6	3	2
P. anaerobius	2	3	1	6	4	5
S. pneumoniae	5	1	2	6	4	3

References

CLSI (2003) Quality Control of Microbiological Transport Systems; Approved Standard, CLSI document M40-A (ISBN 1-56238-520-8), pp 1-33, CLSI, Wayne, PA.

Sall, J. *et al* (2007) JMP Statistics: A guide to statistics and data analysis using JMP, 4th Edn., SAS Publishing, Cary, NC.