

Everything old is new again...

Efficacité antimicrobienne et durabilité du cuivre et de ses alliages sur les surfaces fréquemment touchées

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Microbiologiste-Infectiologue
Vancouver



Conflict of Interests

Bureau of Speakers	Cepheid, Hologic, Bruker
Material and Reagents	Altona, Biomerieux, Copan, Cepheid, Hologic, BD
Site visit and Social events	Altona, Biomerieux, Copan, Cepheid, Hologic, BD
Copper Research	Teck Resources Limited (grant)

Learning objectives



01

The pitfalls of Infection Control

The need for engineered solutions

02

The history of Copper

And the mechanisms of action

03

Studying copper surfaces

Complexity of the approaches

04

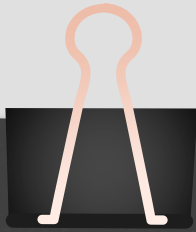
Advantages/Limitations of Copper Surfaces

In the hospital vs the Community

05

The future of Copper

New applications to prevent Infections



01

The pitfalls of IPAC

The need for engineered solutions



Prévention et Contrôle des infections liées aux soins de Santé

Les infections nosocomiales sont largement évitables par de bonnes pratiques.

La prévention des infections assure et améliore la sécurité des patients , leur famille et le personnel médical.

Nécessaire pour réduire le risque de prolifération de bactéries multi-résistantes aux antibiotiques

La base



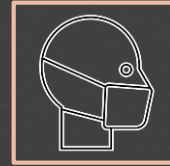
Hygiène des Mains

Eau + Savon
VS
SHA



Contrôle de l'environnement

QUAC
VS
Peroxyde d'hydrogène



EPP

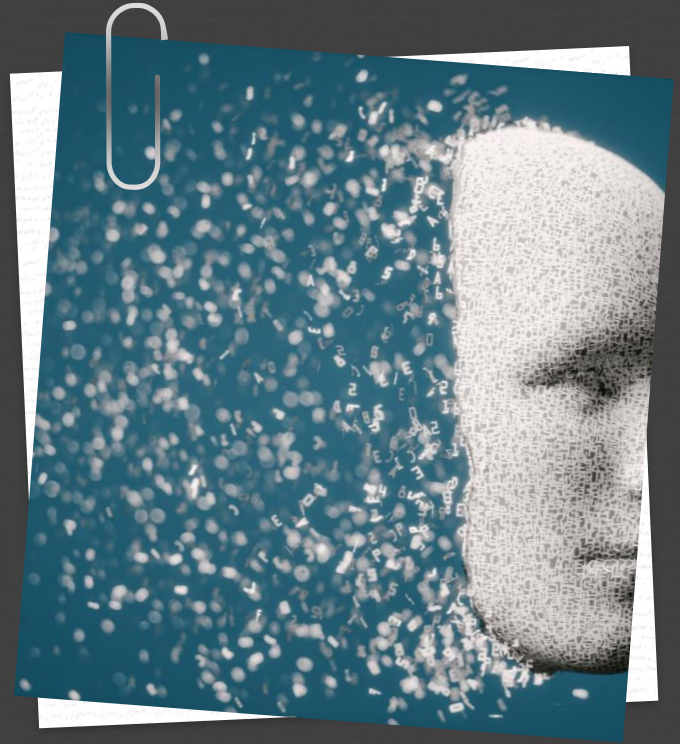
Masque chirurgical
VS
N95

Analyse des facteurs humains

Plusieurs de nos interventions sont dépendantes de l'intervention humaine

- Lavage des mains adéquats
- Nettoyer vs désinfecter
- Port adéquat de l'EPP

Le système de santé actuel présente plusieurs obstacles.

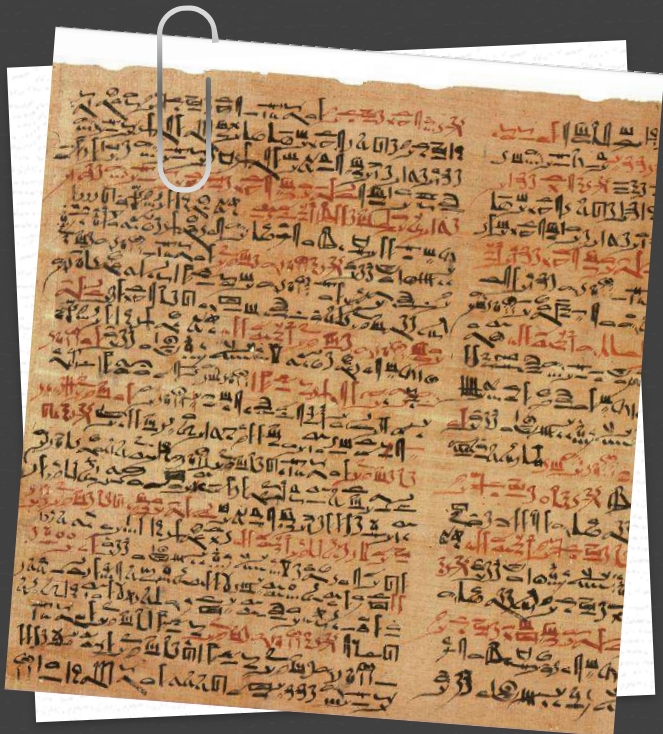




Le Cuivre à travers le temps

Une ancienne "innovation"

02



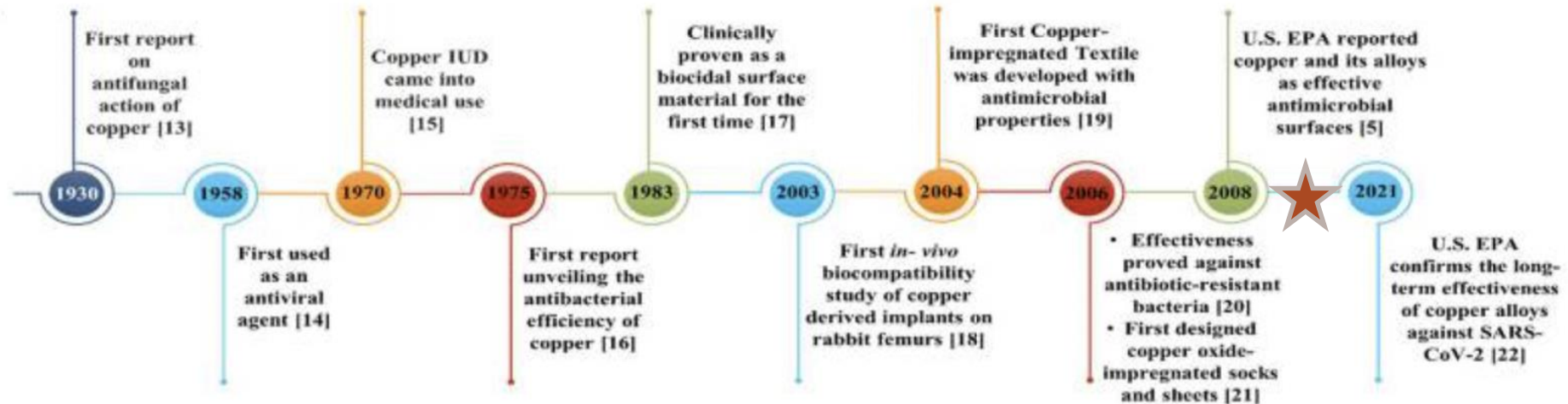
La petite Histoire

Évidence Médicale

- 2600-2200 AC
- La première description d'utilisation du cuivre pour prévenir les infections
- Soins de plaie et purification d'eau

Dates Contemporaines Importantes

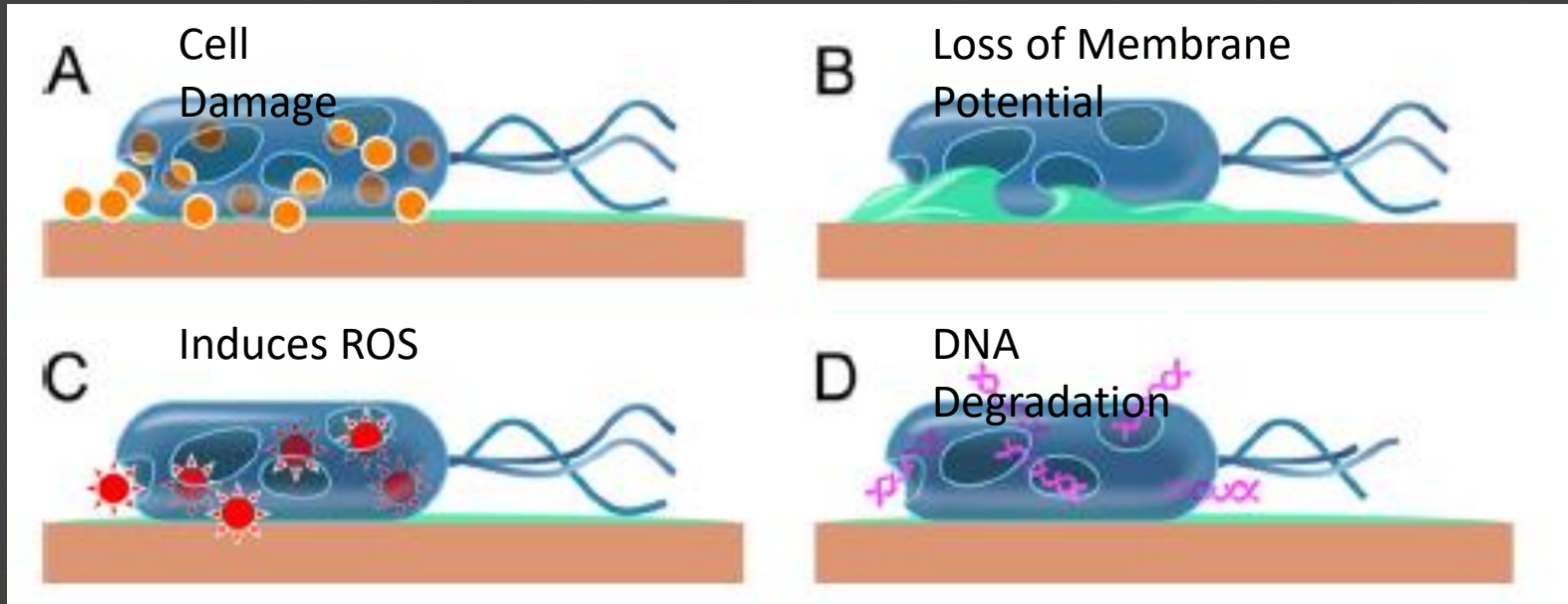
b)



Current Opinion in Biomedical Engineering

Mais comment ça marche?

Mécanisme d'Action





En pratique?



03

Studying Copper Surfaces

1ère
Étude

GEnBMT study

(Données non publiées)

Tracey Woznow BSc, BEd, Elizabeth Bryce MD, FRCPC, DSc (Hons),
Titus Wong MD, FRCPC, Aleksandra Stefanovic MD, FRCPC, Richard
Dixon, Matthew Croxson, Linda Hoang MD, FRCPC,
Raewyn Broady MBChB, FRCPA, FRCP

GENBMT STUDY

Re-Engineered Patient Rooms

Copper-nickel alloy applied to:

- A) Visitor chair armrest
- B) Patient bedrails
- C) Patient tables
- D) Toilet seat
- E) Sink



Étude GEnBMT



ATP

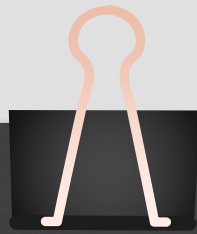
- Mesure d'ATP continuellement plus basse
- Réduction du RLU sur les surfaces de cuivre par 85.7%



UFC

- La Moyenne de UFC enregistrée est systématiquement plus basse sur les surfaces de cuivre.
- Une réduction de 90.1% en UFC est enregistrées sur les surfaces de cuivre.

Mars 2020



"The Pandemic Changed Everything"

-SOMEONE FAMOUS

**50-
90%**

Diminution d'utilisation des transports en commun

(Mondialement)

2^e
Étude

Phase 1: Translink

(Données non publiées)

Teresa Williams PhD, Tracey Woznow BSc, BEd, Billie Velapatino PhD,
Elizabeth Bryce MD, FRCPC, DSc (Hons), Richard Dixon, Marthe
Charles MD, MSc FRCPC.



TransLink
Tomorrow

VGH+
UBC hospital
foundation



CHAIR
Coalition for Healthcare
Acquired Infection Reduction



Copper
+ Health

/ **Teck**

Objectifs

Activité Antimicrobienne

UFC
ATP

Durabilité

Couleur
Épaisseur
Microstructure

Efficacité après Usage

En laboratoire:
CFU
EPA standard

En Bref

- 2 autobus
- 2 Skytrain
- 3 produits à base de cuivres utilisés





PRODUCTS

Copper Stick-on Wraps

(100% Cu)



PRODUCTS

Copper Alloy Spray-on

(80% Cu/20% Ni)

PRODUCTS

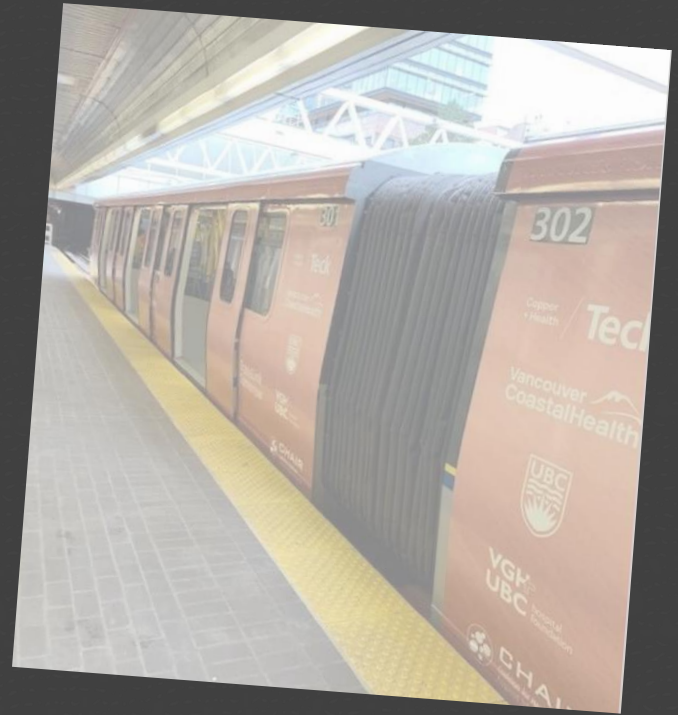
Copper Alloy Cover

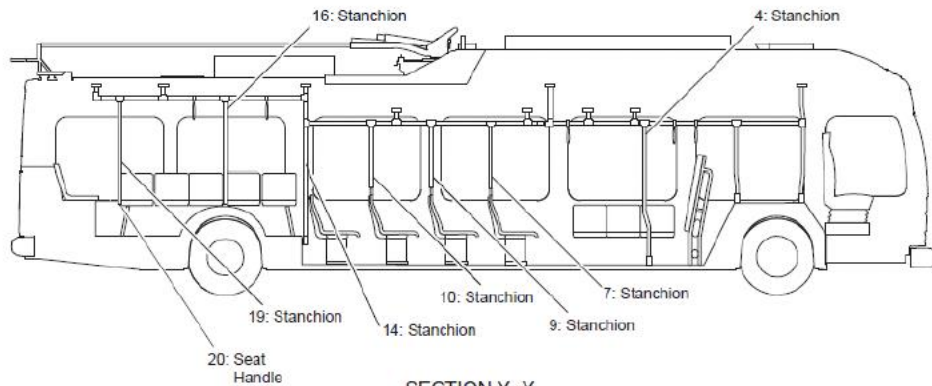
(Alloy of ~90% Cu with nickel, zinc, and resin)



Conception de l'étude

- Nettoyage et désinfection effectuées au début de l'étude (en profondeur)
- Bus: 2 fois par semaine QUAC
- Skytrain: 2 fois par semaine H₂O₂

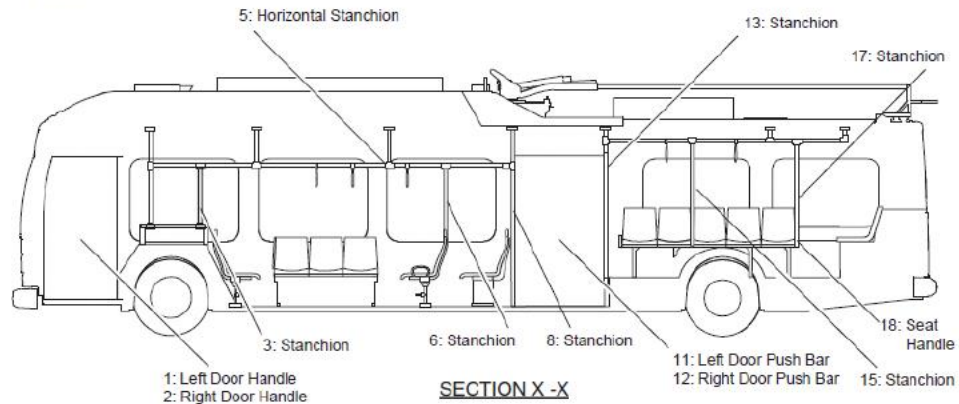




SECTION Y - Y

Product	Bus# 2124 Locations				Bus #2156 Locations			
Control	1	3	13	18	2	8	16	20
Copper Stick-on Wrap	8	12	16	19	3	5	7	17
Copper Alloy Cover	7	10	14	17	9	13	15	19
Copper Alloy Spray-on	4	6	9	11	4	6	12	14
Organosilane	2	5	15	20	1	10	11	18

BUS



SECTION X - X

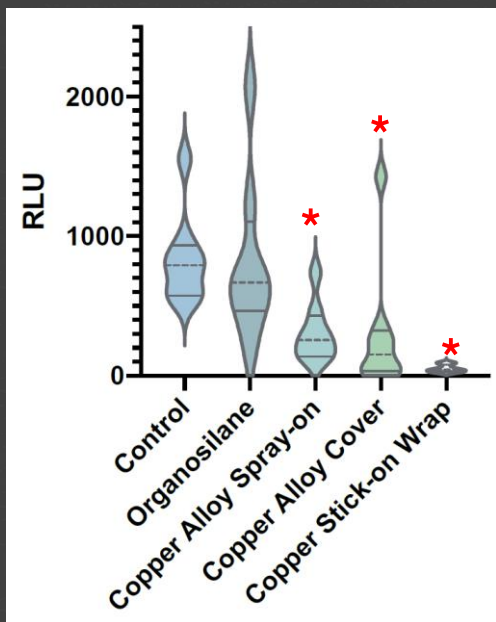
Conception de l'étude

- Mesure d'ATP
- Prélèvement d'échantillon microbiologique (UFC)

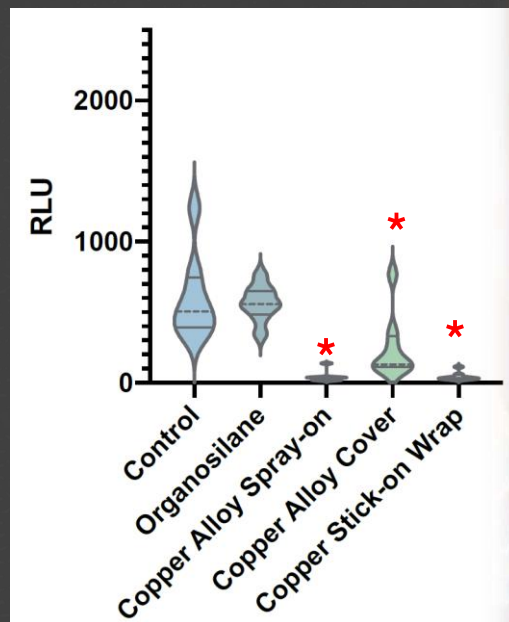


Résultats: Mesure d'ATP

BUS

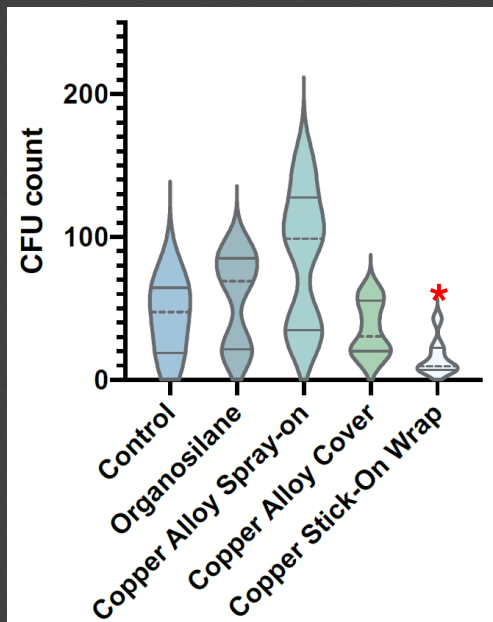


Skytrain

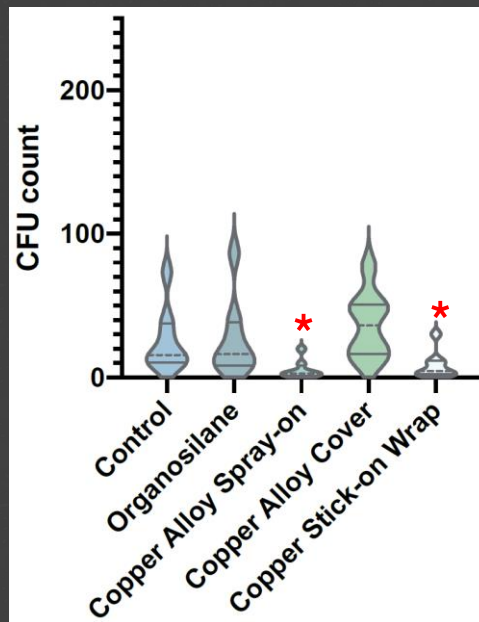


Résultats: Mesure d'UFC

BUS



Skytrain



AC 33



301,AC,9



US EPA- 2016

- An effective product is expected to achieve a 3log₁₀ reduction (ie above a 99.9% reduction) in viable bacteria, compared to a stainless steel control, for each microbe within a 1 hr contact period.

Résultats en laboratoire

Pseudomonas aeruginosa

SURFACE	UNEXPOSED		SKYTRAIN		BUS	
	% Red.	Log ₁₀ Diff	% Red.	Log ₁₀ Diff	% Red.	Log ₁₀ Diff
Organosilane	-4.3	-0				
Copper Alloy Spray-on	>99.9	4	>99.9	4	>99.9	3.4
Copper Alloy Cover	>99.9	3.1	>99.9	3.7	99.9	3
Copper Stick-on Wrap	>99.9	3.9	>99.9	4	>99.9	4

Staphylococcus aureus

SURFACE	UNEXPOSED		SKYTRAIN		BUS	
	% Red.	Log ₁₀ Diff	% Red.	Log ₁₀ Diff	% Red.	Log ₁₀ Diff
Organosilane	69.8	0.5				
Copper Alloy Spray-on	99.8	2.7	>99.9	3.4	84.6	0.8
Copper Alloy Cover	47	0.3	99.5	2.3	98.6	1.9
Copper Stick-on Wrap	99.9	2.8	99.6	2.4	89.2	1

Conclusions

Après 5 semaines
d'utilisation à bord

- Plus de 1140 échantillons ont été prélevés et analysés.
- L'efficacité des surfaces de cuivre et autres alliages a été démontrée non seulement en transit mais également après 5 semaines d'utilisation (en laboratoire)
- Les surfaces de cuivres ont maintenu leur caractéristiques physiques et antimicrobiennes après 5 semaines d'utilisation.



3^e
Étude

Phase 2: Translink et TTC

Teresa C. Williams, Edouard Asselin, Tony Mazzulli, Tracey Woznow, Hadi Hamzeh, Davood Nahkaie, Dean Waisman, Biljana Stojkova, Richard Dixon, Elizabeth Bryce & Marthe Charles (Scientific Report 2024)



**Mount Sinai
Hospital**

Conception de l'étude

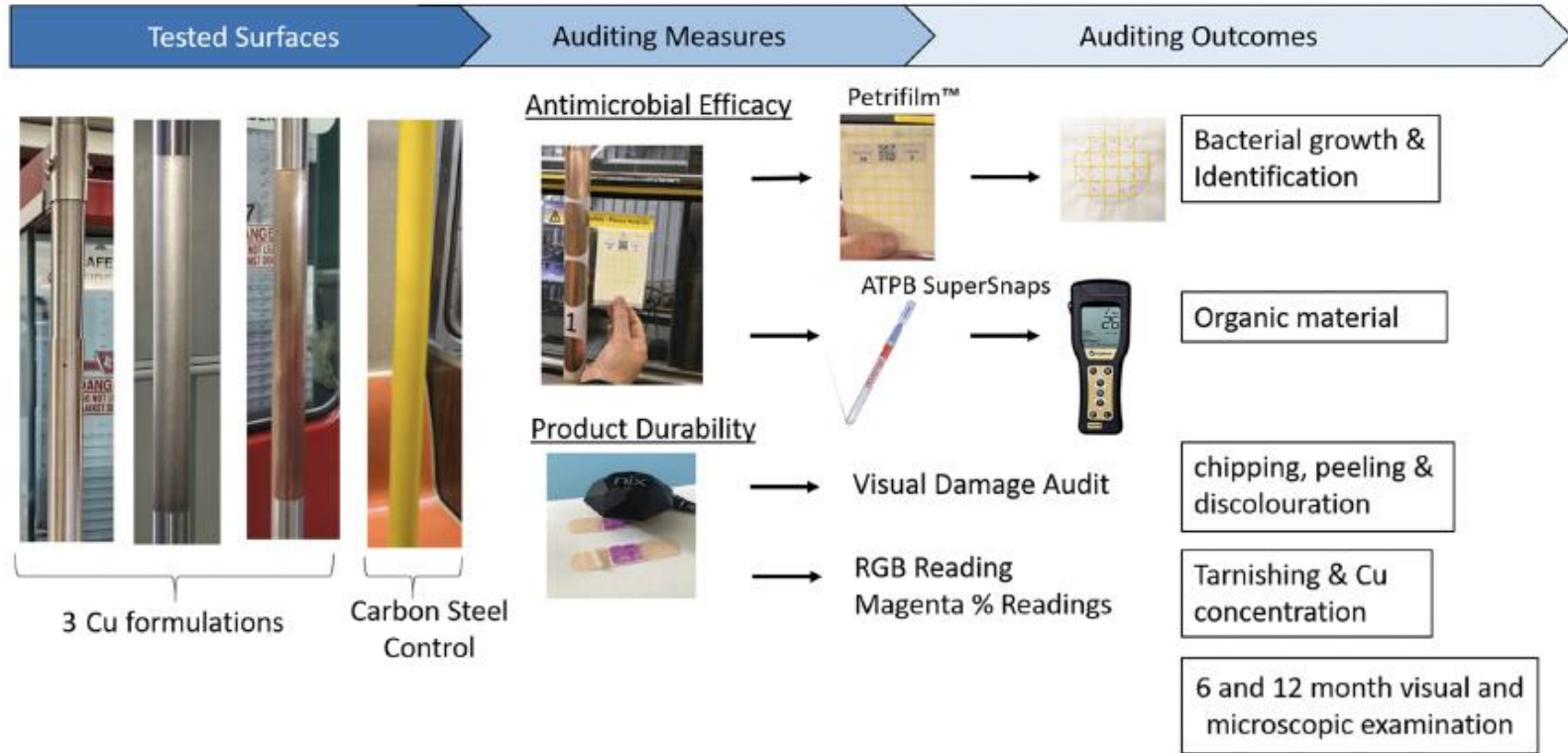
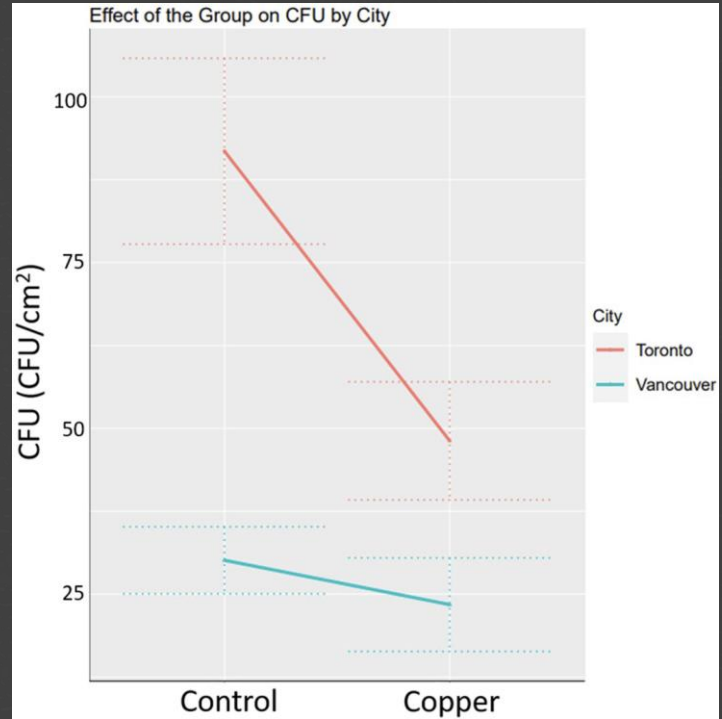
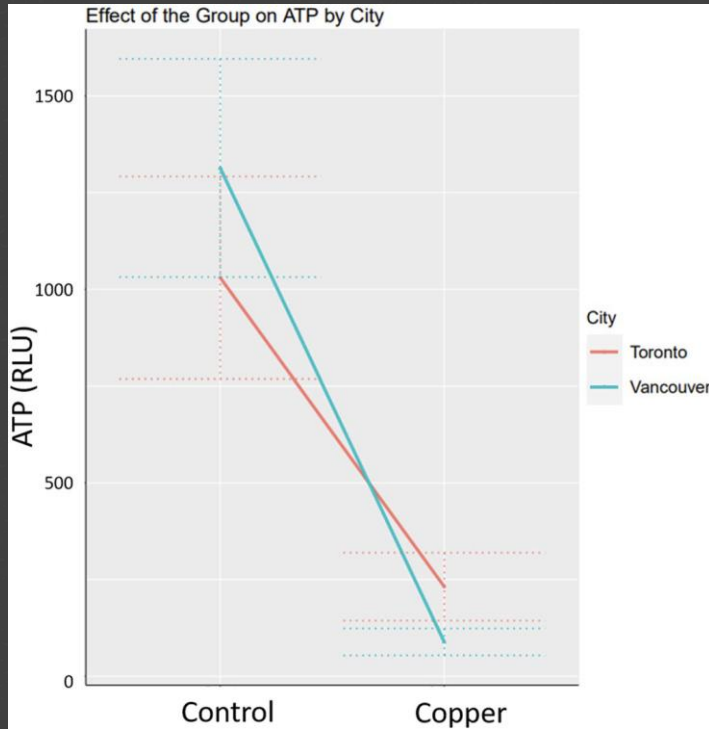


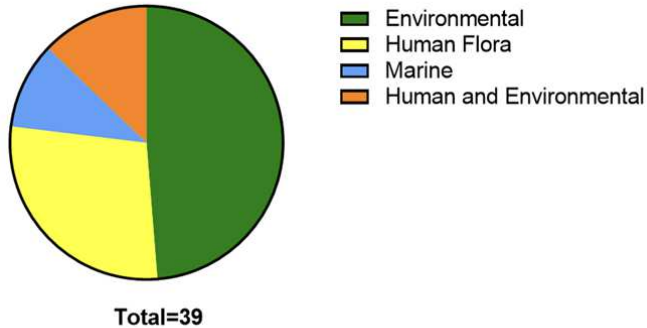
Figure 1. Overview of surfaces, auditing measures, and auditing outcomes for the 12-month in-use trial on public transit vehicles.

Résultats: Échantillonnage

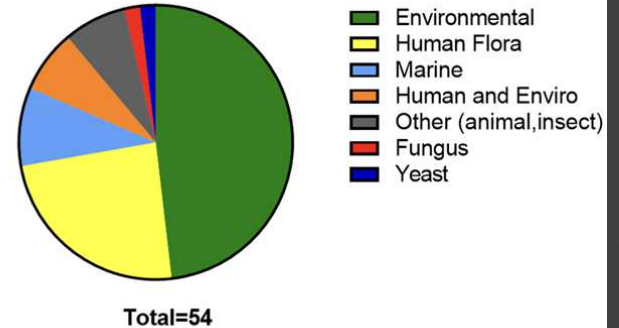


Résultats: Microbiologie

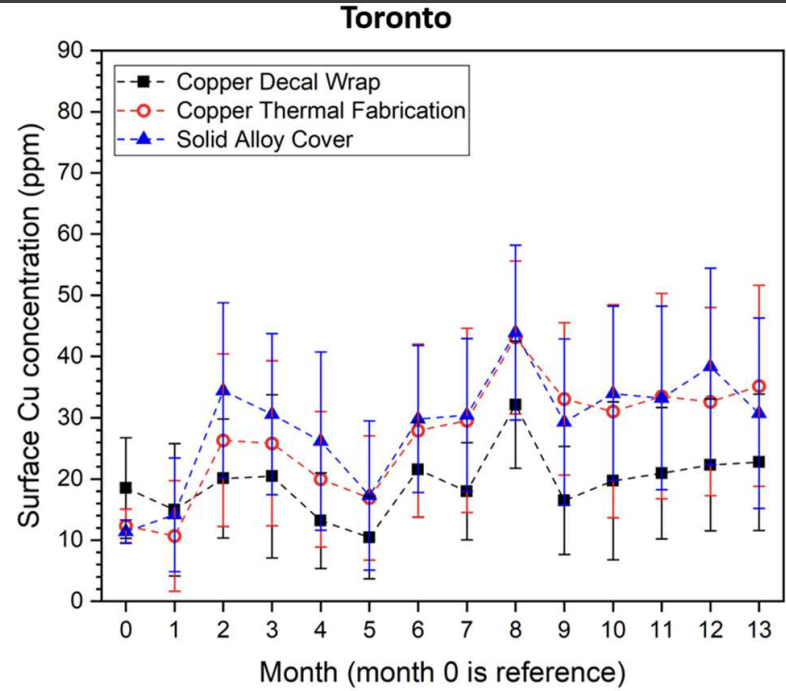
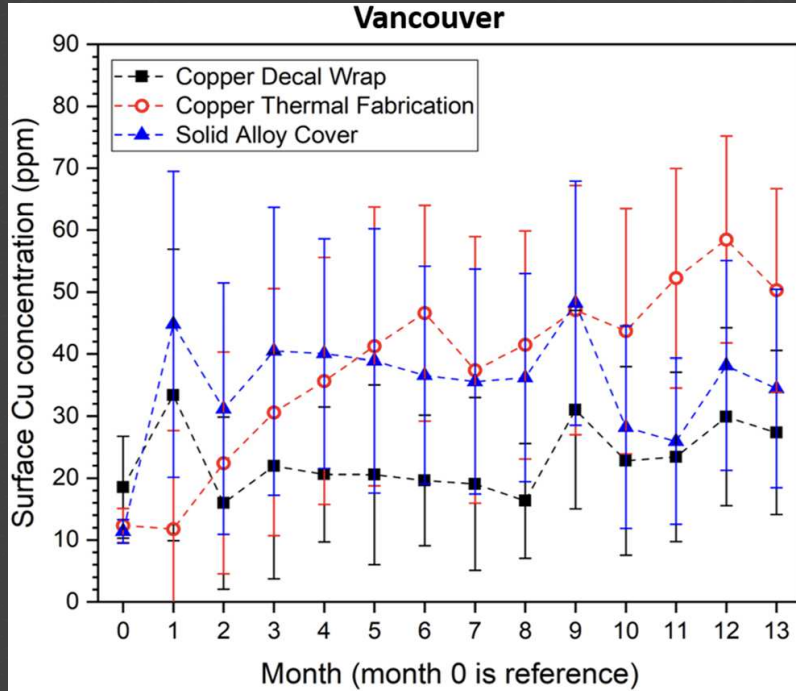
A Bacterial Classifications identified from Toronto



B Bacterial Classifications identified from Vancouver



Résultats: Physico-Chimique



Conclusions

Après 12 mois
d'usage à bord:

- La mesure d'ATP est réduite de 87% en moyenne pour le cuivre et ses alliages et de 43% en moyenne pour les UFC lorsque comparé au control.
- La variation en composition de cuivre n'a pas significativement changé d'un mois à un autre, et l'épaisseur du produit n'a pas changé en un an.
- Les microorganismes retrouvés à la surface des produits du cuivre font partis de la flore commensale ou environnementale.

4^e
Étude

Simulation d'utilisation

Marthe K. Charles, Teresa C. Williams, Davood Nakhaie, Tracey Woznow, Billie Velapatino, Ana C. Lorenzo-Leal, Horacio Bach, Elizabeth A. Bryce & Edouard Asselin (Biometals, 2023)

Conception de l'étude

Application of Disinfectants



Stainless steel Cu Decal Integral Cu Cu Spray



Quat. Ammonia AHP Artificial Sweat Untreated

Wiped 200X
10s wipe, 30 min dry

Infection of Coupons



SA OR PA OR MNV-1 OR 229E

Inoculate



Bacteria

Collected in Lethen broth at
SA: 1 & 2 hours
PA: 30 & 60 min

Virus

Collect in 10% MEM
at 1 & 2 hours

Viral Analysis



Serial dilute in 1% MEM

Inoculate
MRC-5 / RAW 264.7 cells



Score wells for CPE
- 229E → 5 dpi
- MNV-1 → 7 dpi

*dpi = days post infection

Bacterial Analysis



Sonicate for 5 minutes

Serial dilute in
Lethen broth

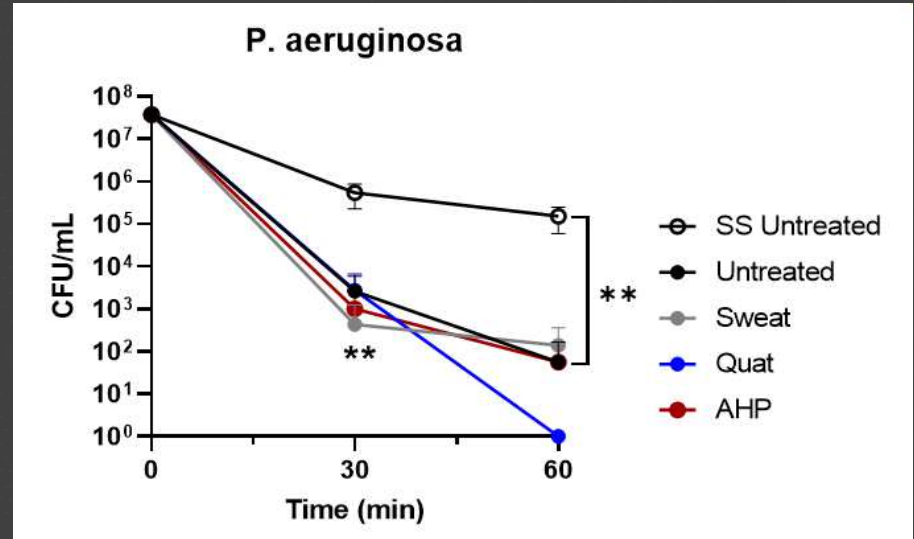


incubate
48 hrs

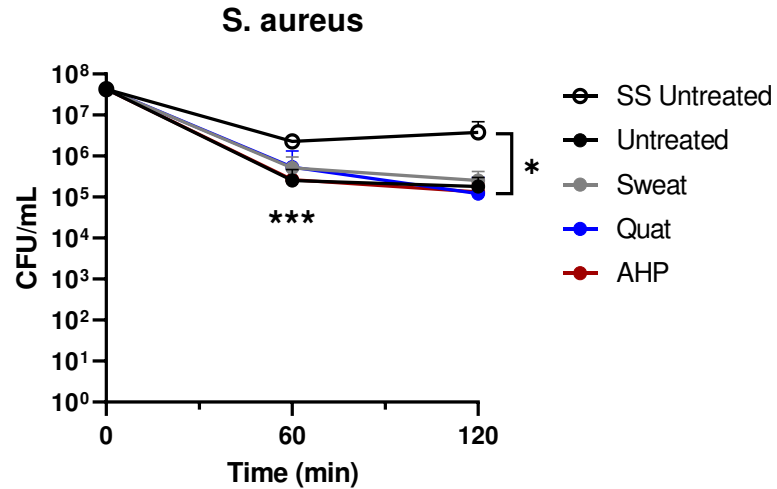
Count

P. aeruginosa

12-months of simulated cleaning with disinfectants or sweat did not affect the antimicrobial efficacy of Cu against PA compared to the untreated control



S. aureus

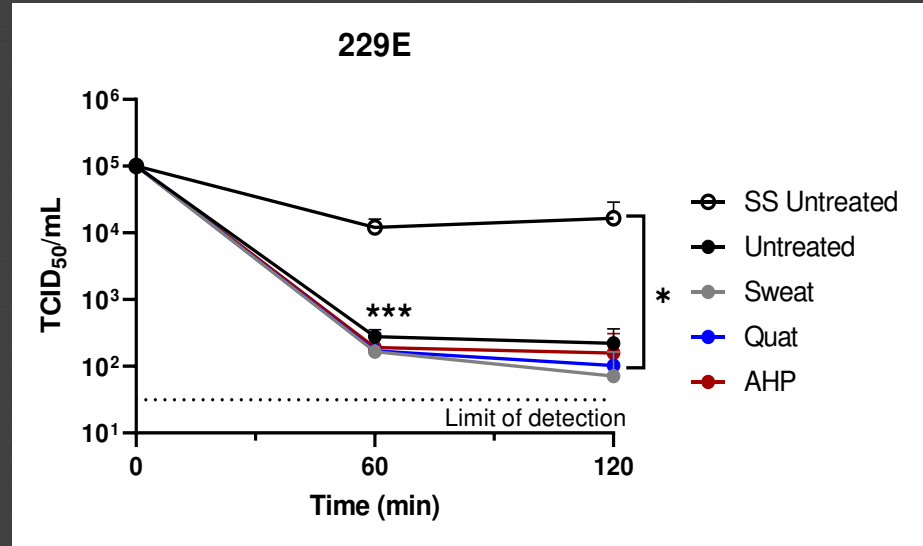


12-months of simulated cleaning with disinfectants or sweat did not affect the antimicrobial efficacy of Cu against SA compared to the untreated control



Coronavirus (229E)

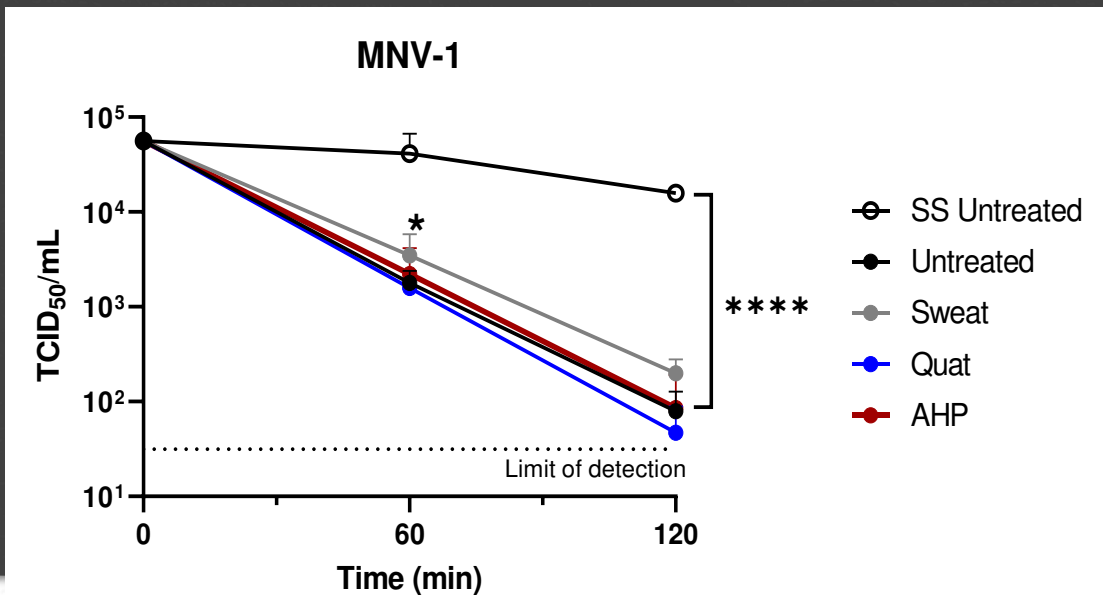
Cu exhibited excellent antiviral capabilities. No reduction in antiviral efficacy was observed after 12-months simulated use with disinfectants and sweat compared to untreated control





Norovirus (MNV-1)

Cu exhibited excellent antiviral capabilities. No reduction in antiviral efficacy was observed after 12-months simulated use with disinfectants and sweat compared to untreated control



Conclusions

Après une
simulation
d'usage de plus
de 200
nettoyage:

- Le cuivre préserve une efficacité contre le *Pseudomonas aeruginosa* et le *S. aureus*
- Le cuivre a démontré une efficacité excellente contre les substituts du Norovirus et du Coronavirus.
- Le nettoyage et la sueur ne semble pas affecté les propriétés antimicrobiennes du cuivre.



04

Advantages/Limitations of Copper Surfaces

The complexity of the task

Avantages



Activité
continue



Retrofit



Durabilité



Réduction de la
biomasse dans
l'environnement



Formulation
sécuritaire

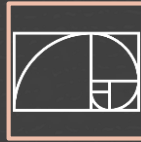


Large Spectre
d'Activité

Désavantages



Coûts



Apparence



Choix de
désinfectant



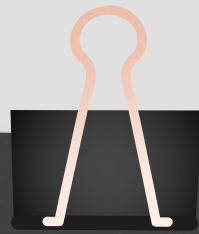
Vandalisme



Pression
Minière?



Résistance
Bactérienne?



05

The Future of Copper

New applications for Prevention of Infections

Cuivre dans le Future



Campagne de recyclage du cuivre en discussion dans l'industrie minière.

Recyclage



Recherche en technologie de surface sur les supermatériaux.

Nanotechnologie



L'impact de la généralisation de l'utilisation du cuivre devra être étudié.

Plus de recherche

Message à Retenir!

- Le cuivre est un antibactérien solide homologué par PMRA- ARLA depuis 2014.
- **NE REMPLACE PAS LE NETTOYAGE ET LA DÉSINFECTION!**
- Plusieurs études démontrent que le cuivre a des propriétés antivirales également.
- Les alliages de cuivre disponible commercialement et homologués par ARLA ont supportés 1 an d'utilisation en transport en commun.

Remerciements





Merci !

Vous avez des questions?

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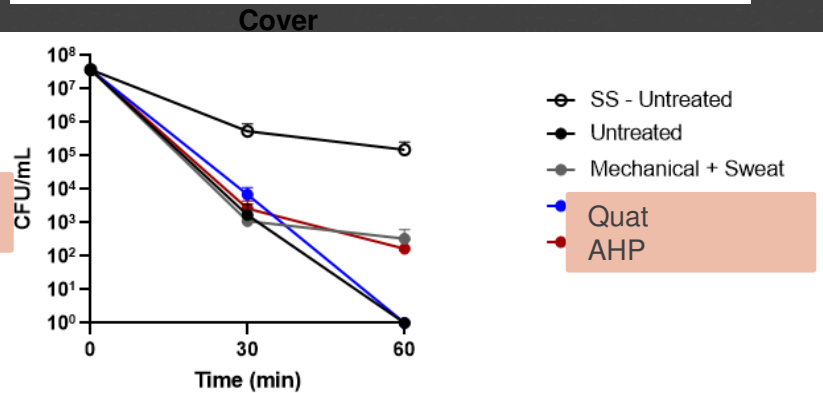
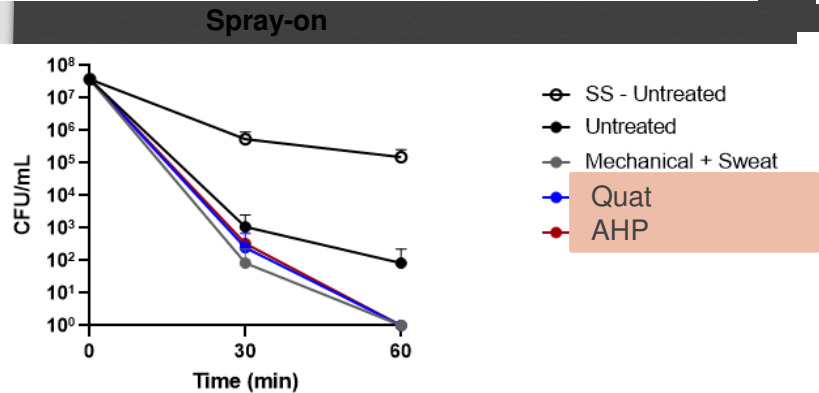
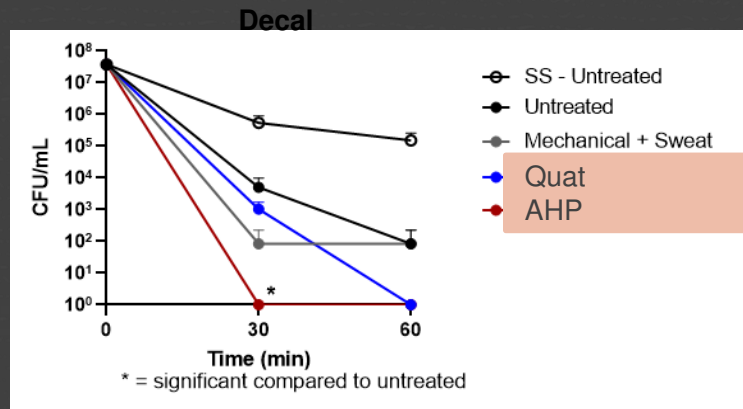
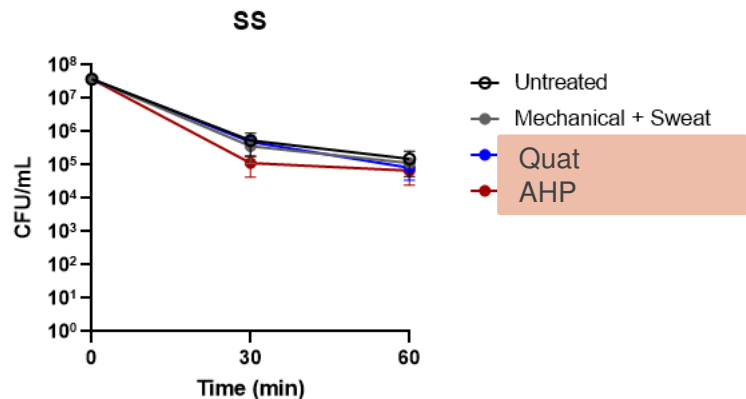
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References

- Mashrur SM, Wang K, Lavoie B, Habib KN. What can bring transit ridership back: An econometric study on the potential of usage incentives and operational policies in the Greater Toronto Area. *Transp Res Part F Traffic Psychol Behav.* 2023 May;95:18-35. doi: 10.1016/j.trf.2023.03.014. Epub 2023 Mar 31. PMID: 37035633; PMCID: PMC10069306.
- Bisht N, Dwivedi N, Kumar P, Venkatesh M, Yadav AK, Mishra D, Solanki P, Verma NK, Lakshminarayanan R, Ramakrishna S, Mondal DP, Srivastava AK, Dhand C. Recent advances in copper and copper-derived materials for antimicrobial resistance and infection control. *Curr Opin Biomed Eng.* 2022 Dec;24:100408. doi: 10.1016/j.cobme.2022.100408. Epub 2022 Aug 23. PMID: 36033159; PMCID: PMC9395285.
- Williams, T.C., Asselin, E., Mazzulli, T. *et al.* One-year trial evaluating the durability and antimicrobial efficacy of copper in public transportation systems. *Sci Rep* **14**, 6765 (2024). <https://doi.org/10.1038/s41598-024-56225-9>
- Charles, M.K., Williams, T.C., Nakhaie, D. *et al.* In vitro assessment of antibacterial and antiviral activity of three copper products after 200 rounds of simulated use. *Biometals* (2023). <https://doi.org/10.1007/s10534-023-00572-z>

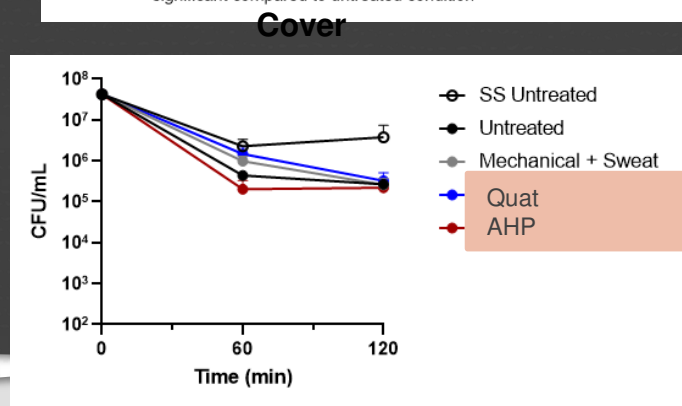
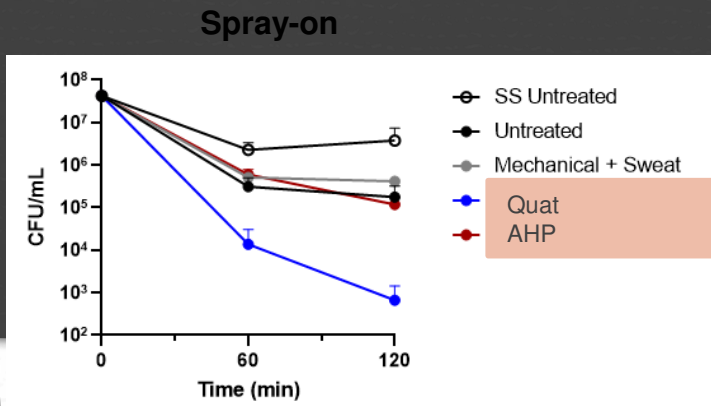
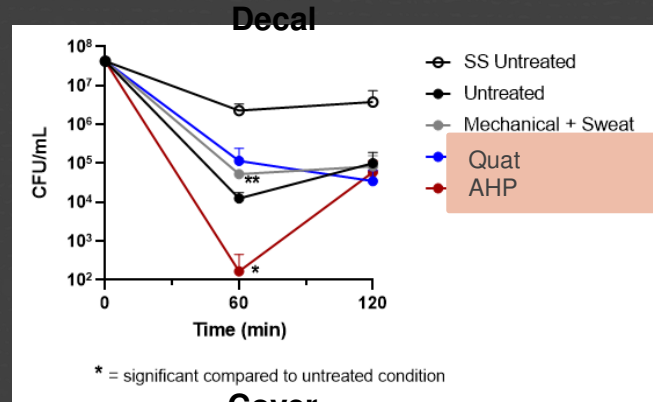
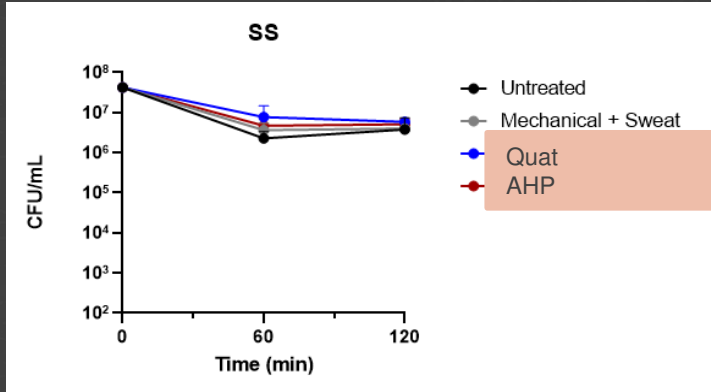
Pseudomonas aeruginosa (PA)

12-months cleaning with disinfectants/sweat was not detrimental to antimicrobial ability compared to untreated coupons



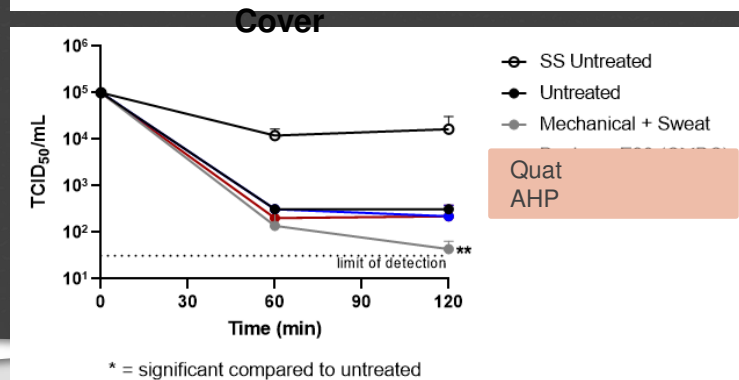
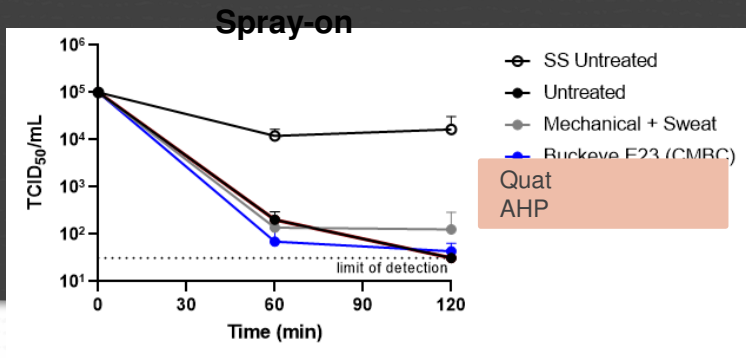
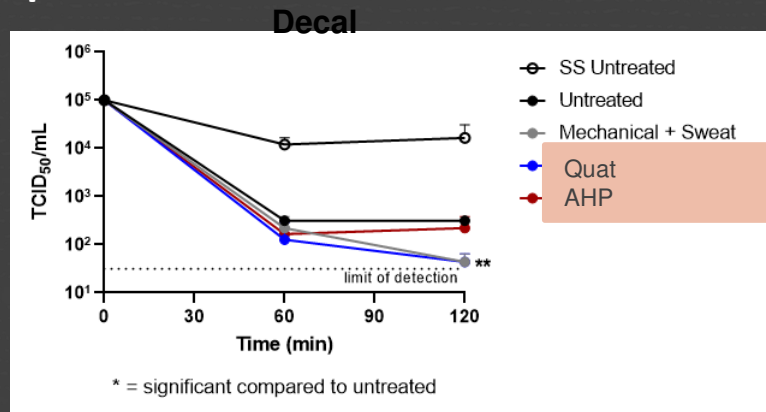
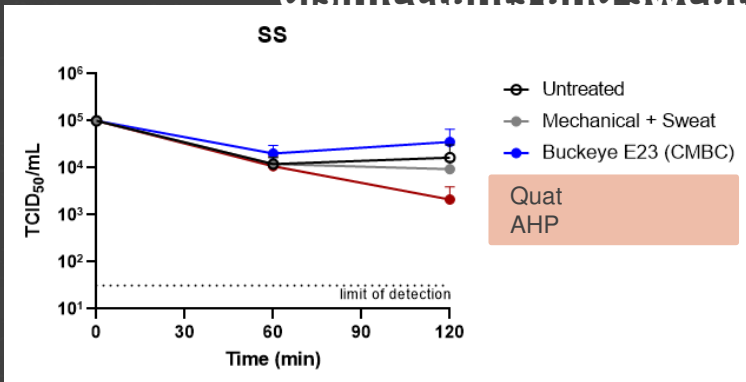
Staphylococcus aureus (SA)

12-months cleaning with disinfectants was not detrimental to antimicrobial ability compared to untreated control. Sweat in the absence of cleaning was detrimental to Coptek



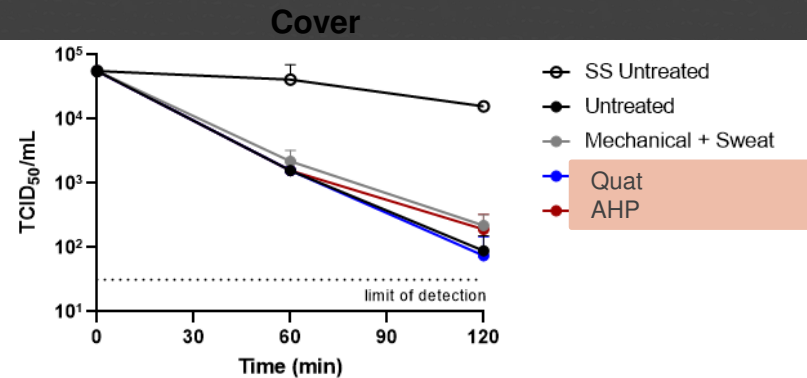
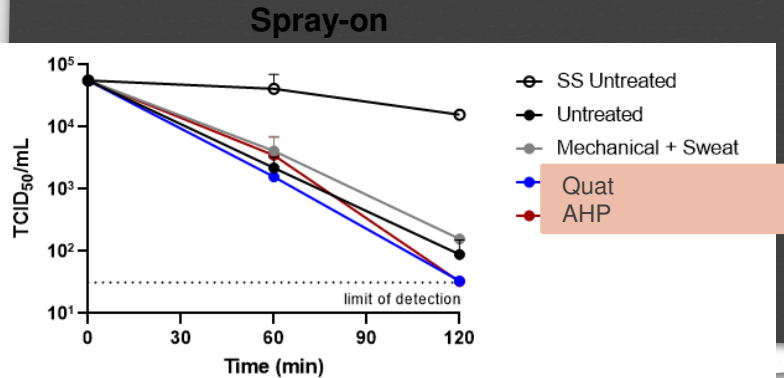
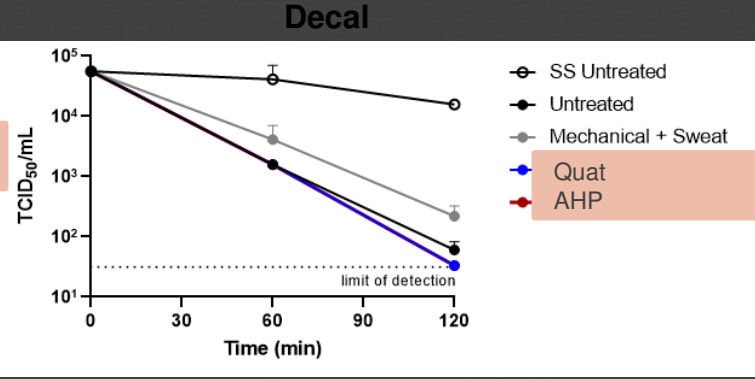
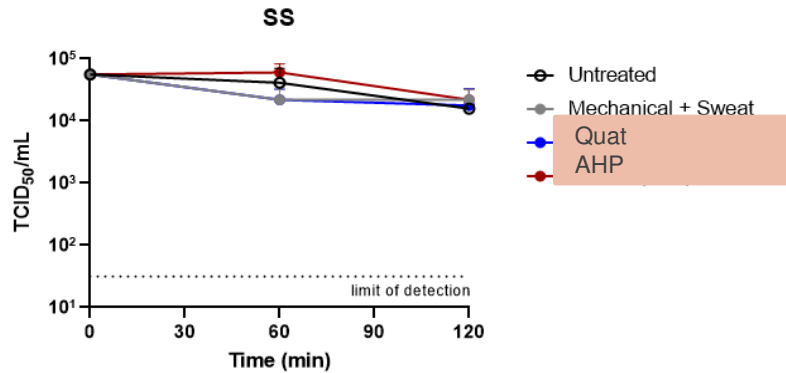
Coronavirus (229E)

No reduction in antiviral ability after 12-months simulated use with disinfectants and sweat compared to untreated control



Norovirus (MNV-1)

No reduction in antiviral ability after 12-months simulated use with disinfectants and sweat compared to untreated control



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