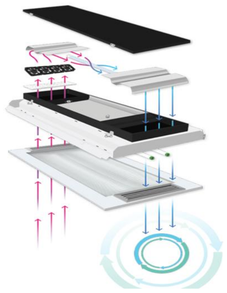

Ultraviolet Light Disinfection

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NRS 410: Research and Evidence Based Practice

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Background

- Healthcare-associated infections (HAIs) are complications of healthcare and are linked with high morbidity and mortality. Each year, about 1 in 25 U.S. hospital patients is diagnosed with at least one infection related to hospital care alone. (CDC, 2017)
- New research is being conducted to reduce the amount of HAI's by using various types of disinfection techniques, including the utilization of ultraviolet radiation in addition to standard cleaning procedures. (Chai, 2018)
- Antimicrobial resistant organisms in hospital rooms, increase the risk of infection. Ultraviolet light is one method being explored to combat these organisms. (Bryce, 2018)
- Implementation of UV radiation technology in various hospitals has documented a sustained reduction in surface microbial contamination, reduced cross contamination, and a reduced spread of multi-drug resistant bacterial infections. (Casini, B. 2019)

Purpose

- When looking at surfaces in hospital patient rooms, does the use of ultraviolet light decrease the amount of colony forming units (CFU) when compared to standard cleaning methods?

Methods

- Inclusion Criteria:
  - Written between 2015-2020.
  - Had one nurse as an author or was published in a nursing journal.
  - Study was located in the United States or a comparable health care system.
  - Quasi-Experimental Studies, Systematic Reviews
- Exclusion Criteria:
  - Articles were written in a language other than English.
  - Studies lacked a nursing author or were not published in a journal.
  - Studies were published before 2015.
- Search Process:
  - Sources: CINAHL.
  - Key words: ultraviolet light therapy, ultraviolet light, ultraviolet light radiation, uv-c, px-uv, hospital acquired infections and nosocomial infection.
  - 4 articles met all criteria to be included in the study.

References

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Chai, J., Donnelly, T., Wong, T., & Bryce, E. (2018). Environmental sampling of hospital surfaces: Assessing methodological quality. *Canadian Journal of Infection Control*, *33*(3),138–145. http://web.b.ebscohost.com.proxy.elmhurst.edu/ehost/detail/detail?vid=6&sid=8a7457a3-2bc6-446f-9da0-2295dffc47c0%40sessionmgr101&bdata=JnNpdGU9ZWhvc3QtbGl2ZSZzY29wZT1zaXRl#AN=132996006&db=rzh

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Kane, D. W., Finley, C., & Brown, D. (2018). UV-C light and infection rate in a long term care ventilator unit. *Canadian Journal of Infection Control*, *33*(1), 44–48. http://web.a.ebscohost.com.proxy.elmhurst.edu/ehost/detail/detail?vid=3&sid=12727e36-e647-4ae0-82d2-05932c9b2741%40sessionmgr4008&bdata=JnNpdGU9ZWhvc3QtbGl2ZSZzY29wZT1zaXRl#AN=129292277&db=rzh

Ethington, T., Newsome, S., Waugh, J., & Lee, L. D. (2018). Cleaning the air with ultraviolet germicidal irradiation lessened contact infections in a long-term acute care hospital. *American Journal of Infection Control*, *46*(5), 482–486. https://doi-org.proxy.elmhurst.edu/10.1016/j.ajic.2017.11.008

Results

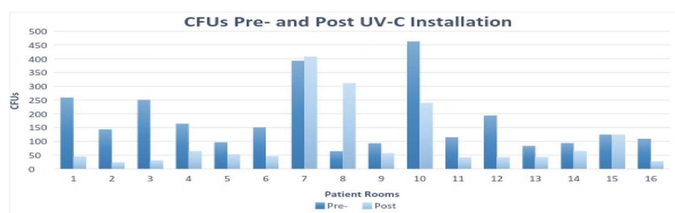
Table 1. Median, lower, and higher values of the bacterial load detected in each hospital setting.

Setting	Timing of Sampling	*n* (Samles)	Median	Lower	Higher	IQR
Patient rooms	Before C&D	25	43	0	180	93
	After SOP	25	2	0	50	7
	After SOP + Pulsed-UVC	25	0	0	3	1
ICU	Before C&D	10	23	1	50	45
	After SOP	10	1	0	14	2
	After SOP + Pulsed-UVC	10	0	0	1	0
OT low turnover	Before C&D	60	1	0	100	4
	After SOP	80	1	0	100	6
	After SOP + Pulsed-UVC	30	0	0	1	0
OT high turnover	Before C&D	40	7	0	38	25
	After SOP	10	0	0	3	1
	After Pulsed-UVC	20	0	0	4	0

Note: ICU—Intensive Care Unit; OT—Operative Theatre; C&D—Cleaning and Disinfection; SOP—Standard Operative Procedure; IQR—Interquartile Range.

(Casini, 2019, p. 5)

- Quasi Experiment, Single study
- ($p < 0.05$)
- Total non-compliant samples after application of the standard operating protocol (SOP) were 9/115 (8%) against 0/85 (0%) after Pulsed-UVC treatment
- Total positive samples, after the SOP, were found to be 72/115 (63%), whereas 15/85 (18%) after treatment with Pulsed-UVC.



(Ethington, 2018)

- Quasi experimental, single study,
- Location: before and after UV-C installation in the special care unit (SCU) of a long-term acute care hospital.
- Population: All SCU patients that were admitted during span of study.
- Experiment: Shielded UV-C units were installed in 16 patient rooms/ hallways, and the biohazard room. Microbiologic impactor air sampling was completed in August 2015. Air sampling was repeated 81 days later.
- Common healthcare–associated infections (*Clostridium difficile* [8 cases annually vs 1 case, $P = .01$] and catheter-associated urinary tract infection [20 cases annually vs 9 cases, $P = .012$]) were reduced significantly as were overall infections, in number of cases (average 8.8 per month vs 3.5, $P < .001$), and infection rate (average monthly rate 20.3 vs 8.6, $P = .001$), despite no reported changes to the amount or type of cleaning done, infection control protocols, or reporting procedures.
- Other infections, traditionally considered contact transmissible (central line–associated bloodstream infection and methicillin-resistant *Staphylococcus aureus*), also declined noticeably.
- Ethington concluded that the installation of UV-C contributed to decreasing the amount of HAIs contracted in SCUs. After UV-C installation, airborne bacteria in patient rooms were reduced an average of 42%.

(Jeldon, 2016) (*p<0.0001 - with a 0.05 level of significance)

- Quasi-Experiment, Single study
- Decontamination of MRSA & VRE on hard surfaces, (Porcelain, stainless steel, chrome, and a bed rail section), in hospital rooms
- (N:6)
- Independent variable: UV-C Light, Dependent variable: Quantity of MRSA and VRE CFU's
- MRSA: reduced from 4.6 log10 to 1.7 log, VRE: reduced 3.9 log10 to 1.7 log10

TABLE 1: Infection rate as number of infections per 1000 patient days

	UV-C Group				Control Group			
Month/ Year	Patient Days	Average Census	Infection (N)	Infection Rate	Patient Days	Average Census	Infection (N)	Infection Rate
Sept 15	540	18	9	16.7	510	17	13	25.5
Oct 15	660	22	11	16.7	589	19	11	18.7
Nov 15	600	20	10	16.7	551	19	14	25
Dec 15	480	16	6	12.5	372	12	5	13.7
Jan 16	527	17	3	5.7	580	20	8	13.8
Feb 16	620	20	4	6.5	620	20	5	8.1
TOTALS	3427	113	43	74.8	3222	107	56	104.8
AVERAGE	571.2	18.8	6.67	12.5	537	17.2	10	17.5

(Kane, 2018, p. 3) (*p<.05)

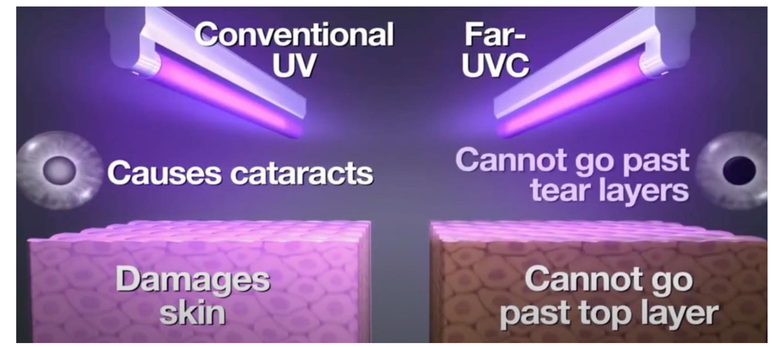
- Quasi Experiment, Single study
- Infection rate was significantly less in patient rooms with shielded UV-C units:
  - with shielded UV-C units where the rate was 12.5%
  - control group's rate of 17.5%
- Infection rate for each group was calculated as the number of infections per 1000 patient days in that wing (Kane, 2018, p. 5)
- Sample size: 81 patients over a 6 month period.
- Not truly randomized because patients were put into rooms based on availability therefore making it not a true randomized experiment.
- The infection rates were also monitored before the study which were 15.5 percent. Showing that the UV-C units help reduce infection rates.

(Chai, 2018)

- Systematic review, 122 studies from PubMed and MEDLINE regarding the environmental sampling of bacteria on high touch surfaces in hospital rooms
- 98 were selected as relevant sources
- Keywords included: recovery method, environmental sampling, bacteria, spores, and non-porous surface
- Conclusion: need for a standardization of sample collection methods

Discussion

- Level of Research: Level one (systematic review)
- The overall infection rate was significantly less in patient rooms with shielded UV-C units. UV-C works against microorganisms by damaging the cells so they cannot reproduce.
- Shielded UV-C light units had a positive effect on infection rates in our study for organisms that cause infection via airborne transmission. This suggests the possibility that cleaning the air can help reduce surface contamination.
- The data produced by these studies indicate that the use of UV technology is beneficial in eliminating bacteria in hospital rooms at a greater rate than standard cleaning procedures alone. Therefore, exposing patients to fewer potentially harmful organisms and reducing hospital acquired infections.



Conclusions

- **Strengths:** This is an innovative technology that is shown to eliminate HAI causing bacteria by the data in these studies. The results are clearly stated and laid out within the studies. Hospitals should strongly consider adding these non-staff dependent infection control methods to their infection prevention policies. Within one the studies, the disinfection rate of the UV light was tested alone and combined with standard cleaning procedures. This allows researchers to clearly compare the results between the new UV light disinfection and standard cleaning procedures.
- **Limitations:** This topic does have its limitations due to this new advanced technology. It limits the number of studies that have been performed thus far. Additionally, after a review of many studies, there is a lack of uniformity in the methods used to collect specimens for the research.
- **Implications:** These studies have the potential implication that ultraviolet lights, when combined with standard room cleaning procedures, have the ability to reduce resistant CFUs found in hospital rooms. Therefore, the evidence implies that it would reduce the rate of nosocomial infections. Hospitals investing in these UV light devices would have high upfront costs; however, this would save money in the long term by reducing HAI rates, and increase both patient and staff safety.
- **Recommendations for future studies:** At this time, more studies need to be conducted in order to explore the viability of using ultraviolet light to disinfect hospital rooms. Moving forward, a standardized method of collecting samples needs to be implemented due to the variety of hospital rooms used in different studies. A standardized method would provide more control for the studies against externalities. Based in the current research, we recommend that all hospitals begin implementing UV-C lights into their standard operating procedures for room sterilization.