

# Vancomycin-resistant *Enterococcus* (VRE) Outbreak in a Pre- and Post-Cardiothoracic Transplant Population: Impact of Discontinuing Multidrug-resistant Organism (MDRO) Surveillance during the COVID-19 Pandemic

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# Disclosures

No relevant financial relationships to disclose.



## Learning Objectives

1. Structure an outbreak management plan for rapid and effective intervention.
2. Examine a possible unintended consequence of pandemic-prompted discontinuation of multidrug-resistant organism surveillance and isolation.
3. Demonstrate an understanding of the complex nature of the cardiothoracic transplant population.



# Presentation Outline

1. Background
2. Methods
3. Results
4. Discussion



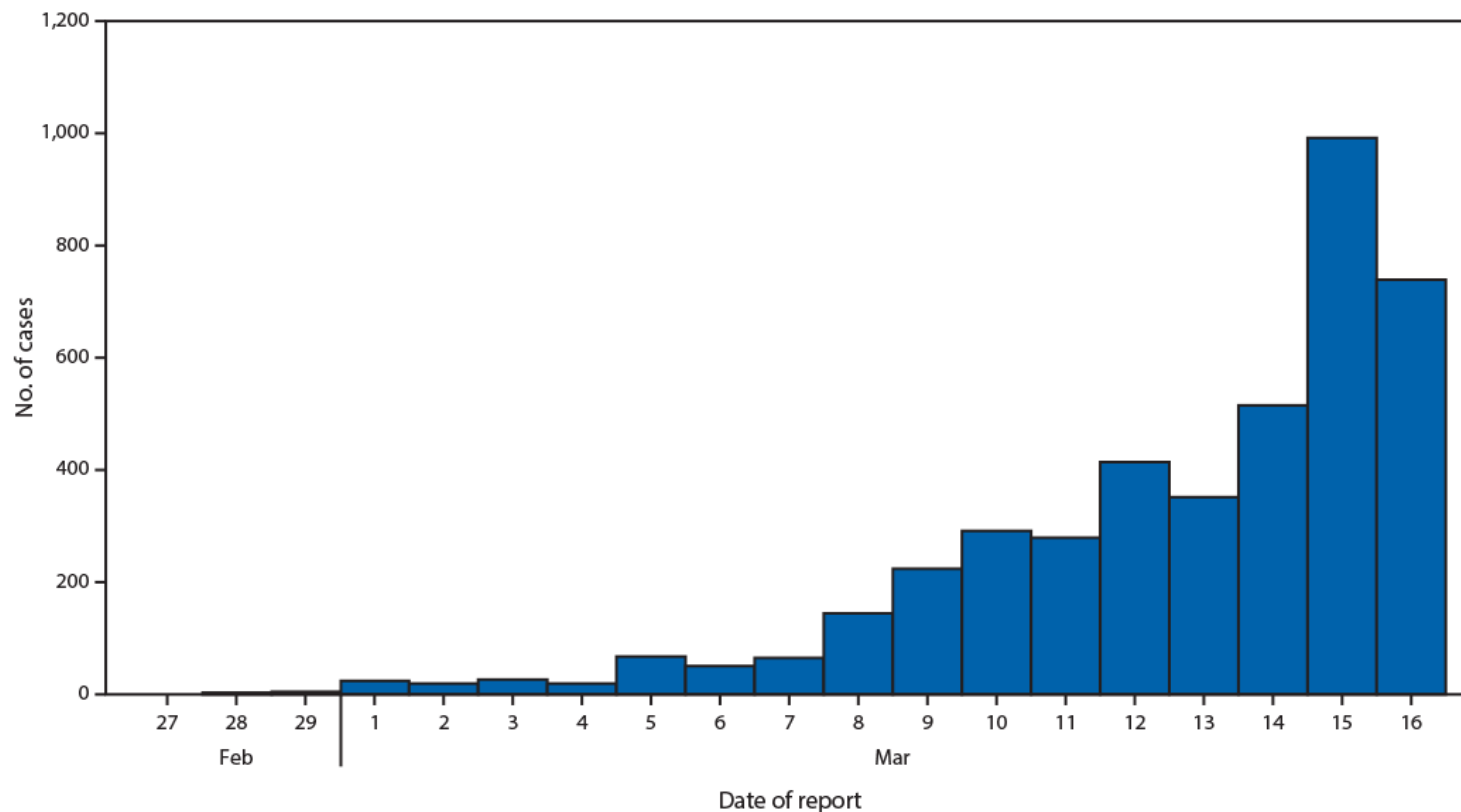
# Background





# Outset of the COVID-19 Pandemic

Many institutions suspended MDRO surveillance early in the COVID-19 pandemic due to anticipated personnel, personal protective equipment (PPE), and testing shortages (Stevens 2020).



Number of new coronavirus disease 2019 (COVID-19) cases reported daily\*, † (N = 4,226) — United States, February 12–March 16, 2020



# Early Institutional Response

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Institution: Northwestern Memorial Hospital (NMH), a large academic medical center in Chicago, Illinois.

Suspended surveillance and contact precautions for VRE for all but the following patient populations in March 2020:

1. Hematology/Oncology (Heme/Onc)
2. Stem Cell Transplant (SCT)
3. Abdominal Solid Organ Transplant (SOT)



# Importance of VRE



## VANCOMYCIN-RESISTANT ENTEROCOCCUS (VRE)

**THREAT LEVEL**  
**SERIOUS** ○○○○○

This bacteria is a serious concern and requires prompt and sustained action to ensure the problem does not grow.

	<b>20,000</b> DRUG-RESISTANT ENTEROCOCCUS INFECTIONS		<b>1,300</b> DEATHS FROM DRUG-RESISTANT ENTEROCOCCUS INFECTIONS
<b>66,000</b>		ENTEROCOCCUS INFECTIONS PER YEAR	
SOME <i>ENTEROCOCCUS</i> STRAINS ARE RESISTANT TO VANCOMYCIN <b>LEAVING FEW OR NO TREATMENT OPTIONS</b>			





# Importance of VRE

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## Risk Factors

- Prolonged antibiotic exposure
- Inpatient hospitalization
- Surgical procedures
- Invasive medical devices
- Immunocompromised status

## Modes of Transmission

- Contact with contaminated surfaces
- Contact with contaminated equipment
- Person to person spread via contaminated hands

**High VRE prevalence and history of VRE outbreaks at NMH**



# Reinstating VRE Surveillance

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Reinstated surveillance and contact precautions for VRE in the following patient populations in September 2020:

1. Medical Intensive Care Unit (MICU)
2. **Cardiothoracic Transplant Intensive Care Unit (CTICU)**
3. **Cardiothoracic Transplant Stepdown Unit (CTSDU)**



# Cardiothoracic Transplant Units

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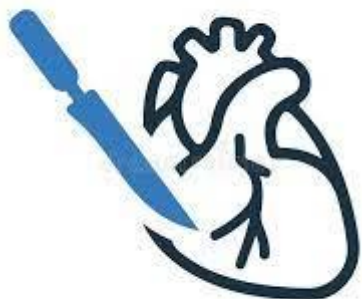
Units: CTICU and CTSDU.

VRE outbreaks were not previously detected in this population at our institution.

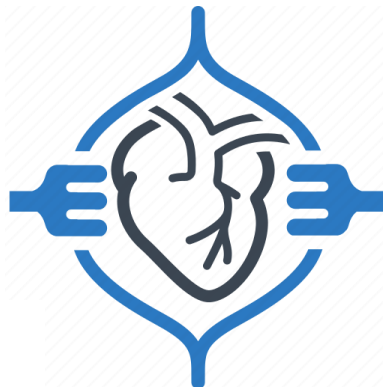
VRE outbreaks in the cardiothoracic transplant population are not prominently featured in the literature.



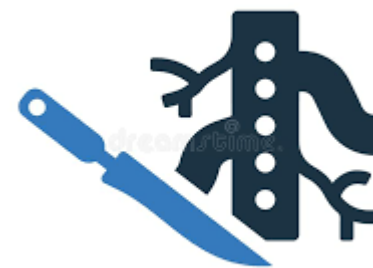
# Patient Population in CTICU and CTSDU



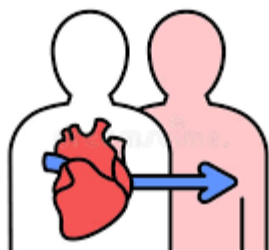
Cardiac Surgery



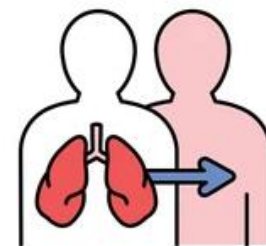
Thoracic Surgery



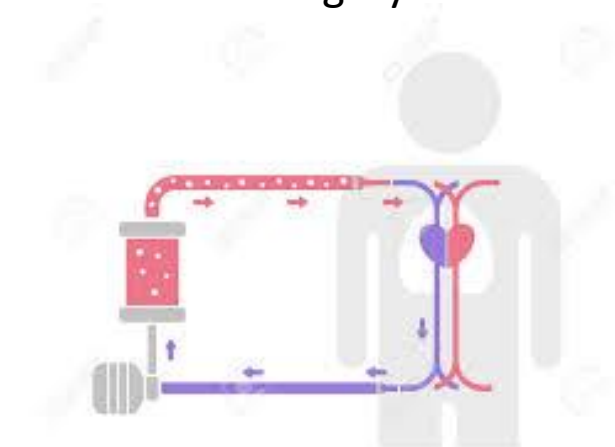
Vascular Surgery



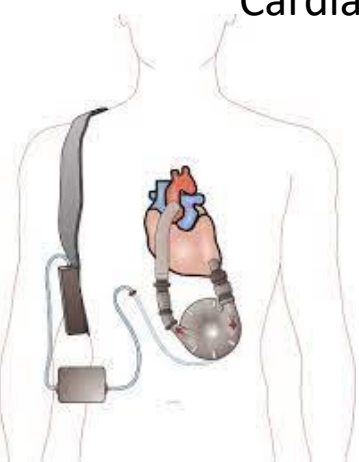
Heart Transplant



Lung Transplant



Extracorporeal Membrane Oxygenation (ECMO)



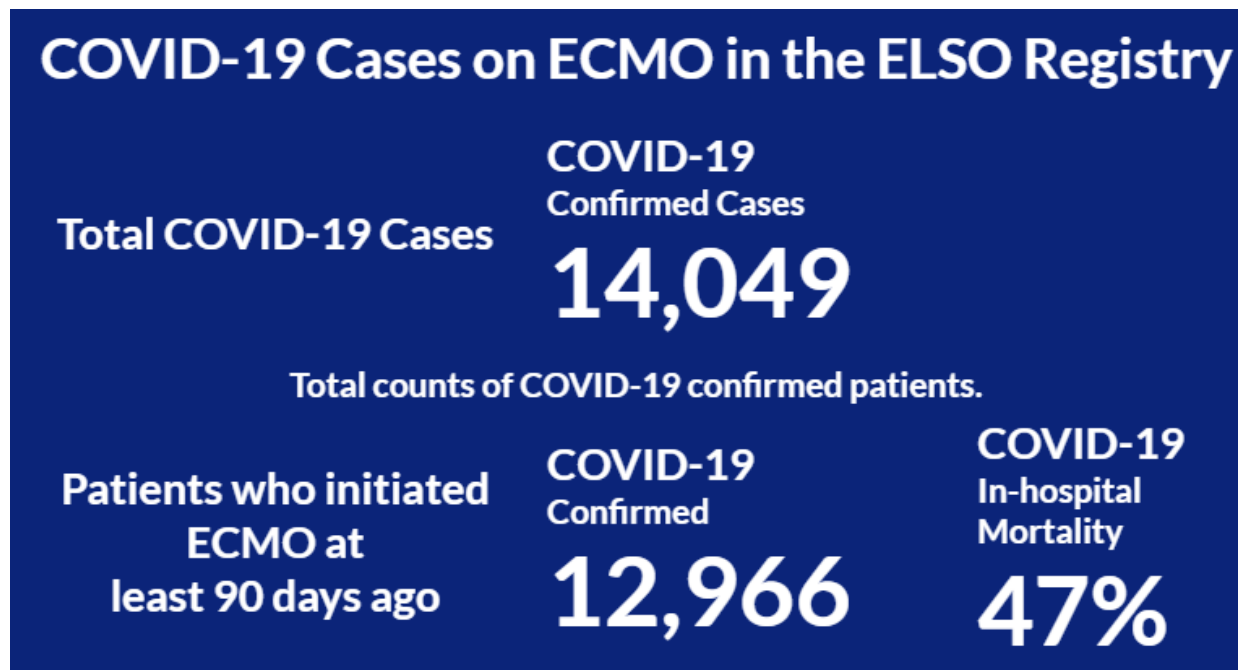
Ventricular Assist Device (VAD)



# Change in Patient Population due to COVID-19

Patients with severe COVID-19 lung injury had extended stays for ventilator and ECMO support.

Resulted in longer length of stay (LOS) for certain patients relative to that pre-pandemic.



Data updated as of May 8, 2022



# VRE Outbreak in CTICU and CTSDU

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Once VRE surveillance was reinstated, a VRE *faecium* outbreak was quickly detected involving both the CTICU and CTSDU.

## Study describes:

1. Outbreak epidemiology.
2. Infection control measures implemented to mitigate outbreak.
3. Lessons learned from pandemic-prompted discontinuation of MDRO surveillance in the cardiothoracic transplant population.

# Methods





# The Institution

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## Northwestern Memorial Hospital

➤ 943-bed academic medical center in Chicago, Illinois.

Northwestern University  
Institutional Review Board (IRB)  
reviewed and deemed study  
exempt from IRB review.







# VRE Surveillance

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## Prior to COVID-19 Pandemic

- Following areas conducted VRE surveillance rectal swabs upon admission and weekly: Heme/Onc, SCT, Abdominal SOT, CTSDU, and all adult ICUs.

## March 2020

- VRE surveillance suspended in all areas but Heme/Onc, SCT, and Abdominal SOT.

## September 2020

- VRE surveillance reinstated in MICU, CTICU, and CTSDU.



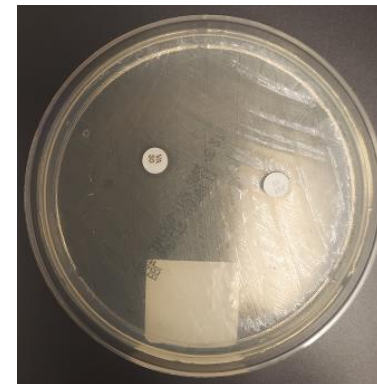
# VRE Culturing



Spectra VRE Media



Vitek MS System



Kirby-Bauer Disc Diffusion



Vitek 2 System



# Pulsed-field Gel Electrophoresis (PFGE) Typing

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1. Genomic preparations were digested and run on Chef Mapper System for 18.5h, with switch times of 1.0 and 12.0 seconds.
2. Sma1 restriction enzyme was used to digest genomic DNA.
3. Genetic similarities of intra-patient isolates determined by visual inspections of DNA banding patterns (Tenover 1995).
  - $\leq 3$  differing bands: closely related
  - 4-6 differing bands: possibly related
  - $> 6$  differing bands: genetically distinct



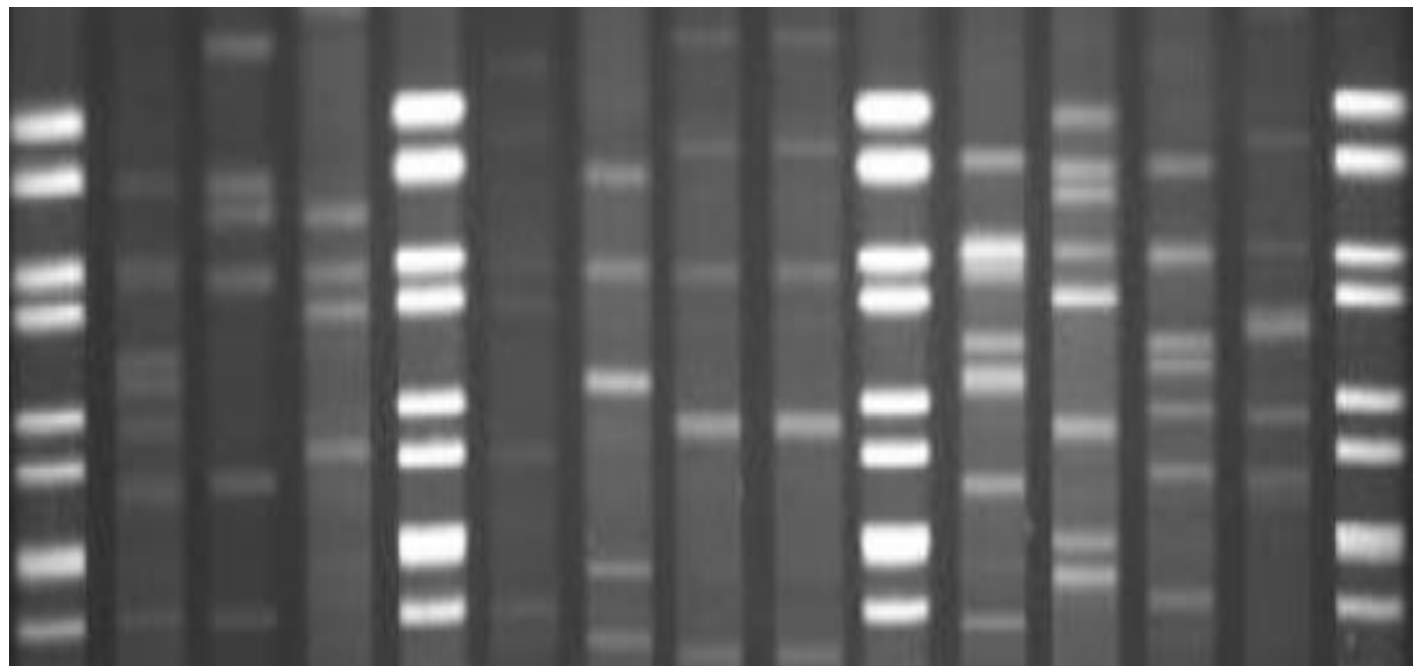
# Pulsed-field Gel Electrophoresis (PFGE) Typing

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VRE isolates identified within three days of specimen collection.

PFGE typing performed on all positive isolates.

Strain typing results within one to two weeks of culturing.





# VRE Management

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Every patient is screened for VRE upon admission.

If VRE culture is positive:

- Initiate contact precautions requiring gown and gloves to be worn.

If VRE culture is negative:

- Best Practice Advisory (BPA) populates in electronic medical record (EMR) to prompt order for weekly screen.



# VRE Outbreak Definitions

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## VRE Colonization

- A positive culture from a rectal specimen.

## VRE Infection

- A positive culture from any non-rectal specimen.

## Outbreak

- $\geq 3$  patients with VRE isolated from clinical/surveillance samples whose epidemiology indicated shared time, space, and/or healthcare providers and whose PFGE strain types were related (Tenover 1995).



# VRE Outbreak Definitions

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## Index Case

- First patient with a particular PFGE type.
- Patient who did not share time and space with first patient with same strain type but shared time and space with a subsequently positive patient.

## Outbreak Strain Type

- $\geq 3$  transmissions attributed to same strain type.

## Outbreak Resolution

- 4 consecutive weeks without a VRE transmission from both CTICU and CTSDU.



# Outbreak Investigation

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## Clinical characteristics:

- Demographics
- LOS prior to VRE detection
- History of COVID-19 disease
- Admitting service
- Invasive surgical procedures
- VRE colonization vs. infection
- Adverse outcomes from infection

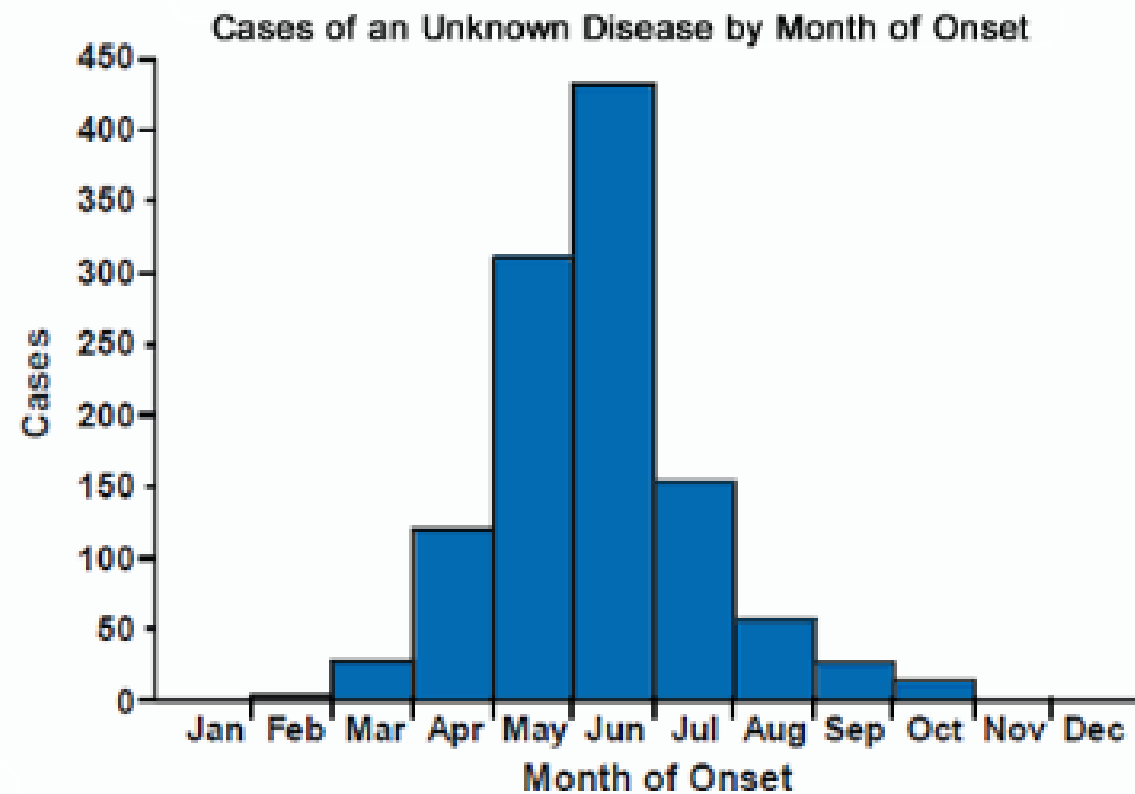
## Multidisciplinary Process Improvement Team (MPIT):

- Infection Prevention (IP)
- CTICU and CTSDU clinical leadership
- Environmental Services (EVS)
- Microbiology Laboratory





# Results





# VRE Surveillance Compliance

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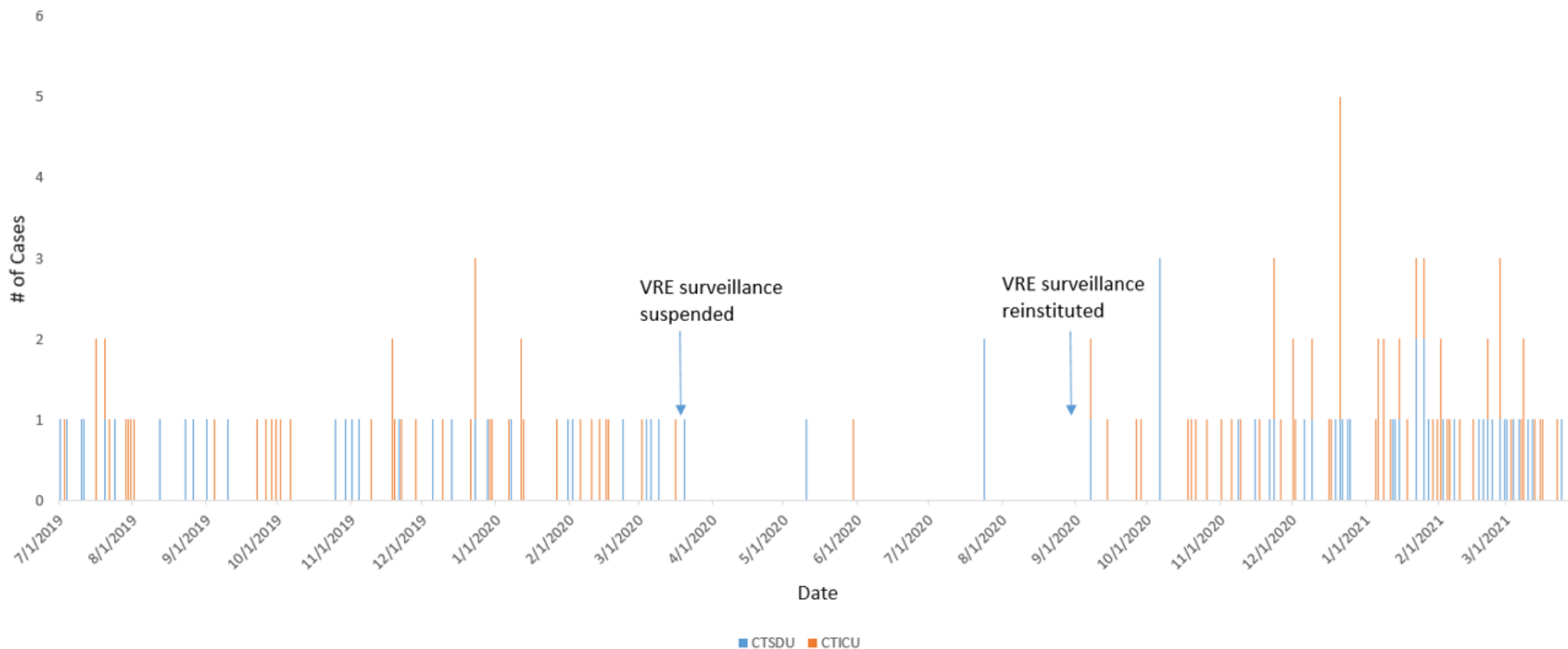
Once VRE surveillance was reinstated in the CTICU and CTSDU, screening compliance rates reached pre-pandemic levels within 6 weeks:

- CTICU: 95%
- CTSDU: 80%



# Comprehensive VRE Epidemic Curve

VRE Epidemic Curve  
CTICU and CTSDU - All Cases





# VRE Colonization Rates

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## Pre-Pandemic (July 2019 – February 2020)

- CTICU: 103.3 cases per 10,000 patient-days
- CTSDU: 48.9 cases per 10,000 patient-days

## Study Period (December 2020 – March 2021)

- CTICU: **157.5 cases per 10,000 patient-days**
- CTSDU: **91.4 cases per 10,000 patient-days**



# VRE Infection Rates

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## Pre-Pandemic (July 2019 – February 2020)

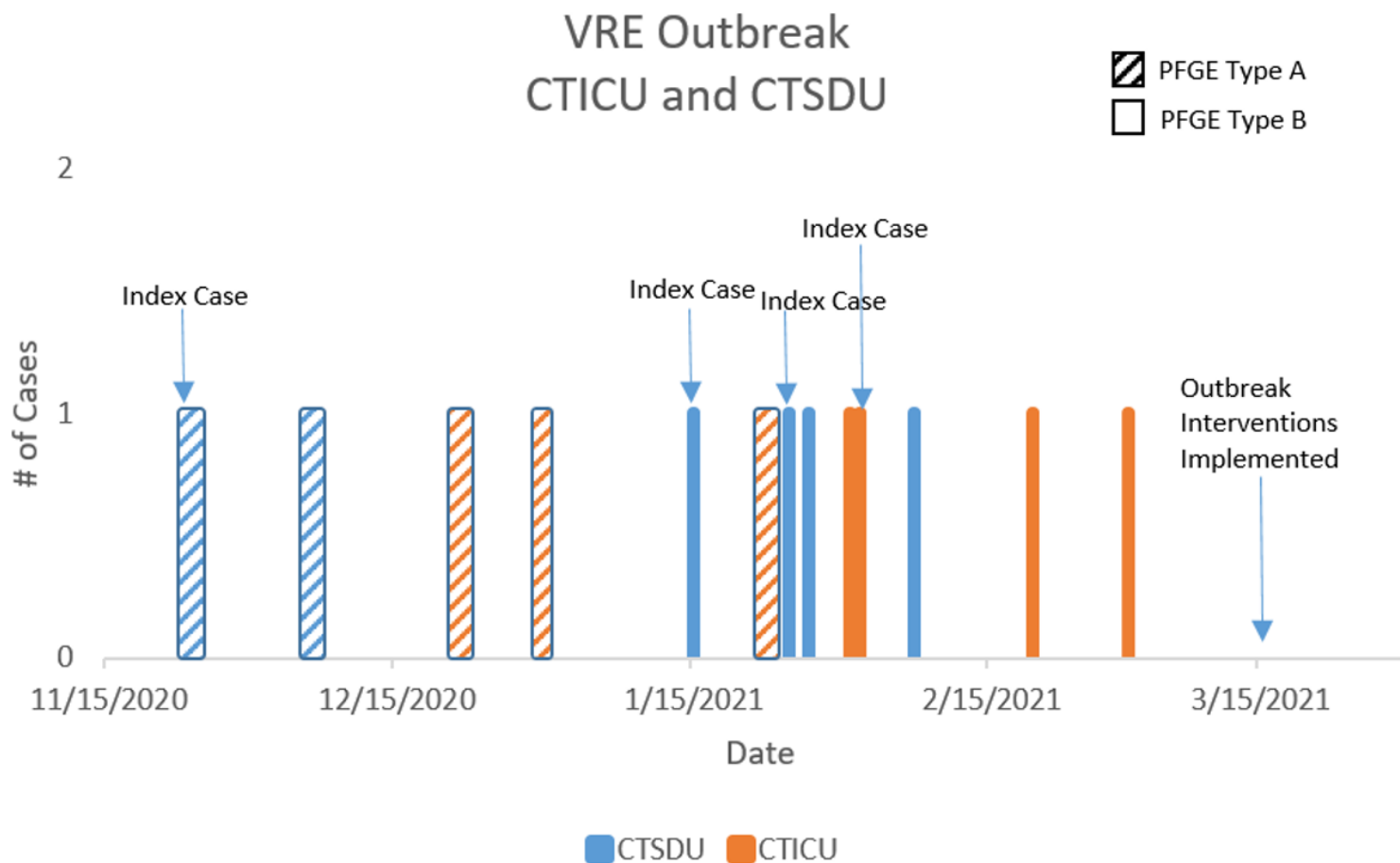
- CTICU: 4.7 cases per 10,000 patient-days
- CTSDU: 0 cases per 10,000 patient-days

## Study Period (December 2020 – March 2021)

- CTICU: **26.2 cases per 10,000 patient-days**
- CTSDU: **9.5 cases per 10,000 patient-days**



# VRE Outbreak Epidemic Curve





# VRE Outbreak Summary

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Outbreak involved 13 patients, 4 index cases, 9 transmissions, and 2 outbreak strain types.

- CTICU: 6 transmissions
- CTSDU: 3 transmissions

7/13 patients (54%) were on the transplant service.

- Heart Transplant (n=2), Lung Transplant (n=2), LVAD (n=2), ECMO as bridge to lung transplantation (n=1).
- Remaining 6 patients were post-surgical patients without advanced heart/lung failure circulatory support.



# Clinical Characteristics

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Age in years, median (IQR)	67 (55,73)
Sex at birth, N (%)	
Male	10 (77)
Race and Ethnicity, N (%)	
White/Not Hispanic or Latino	9 (69)
Black or African American/Not Hispanic or Latino	2 (15)
Other/Not Hispanic or Latino	1 (8)
White/Declined	1 (8)
COVID-19 Disease Status, N (%)	
Prior history	2 (15)

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# Clinical Characteristics

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## Length of Stay (days)

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Total length of stay at hospital, median (IQR)	45 (33,81)
Length of stay at hospital prior to VRE detection, median (IQR)	24 (16,36)
Total length of stay in CTICU, median (IQR)	13 (10,32)
Length of stay in CTICU prior to VRE detection, median (IQR)	12 (8,16)
Total length of stay in CTSDU, median (IQR)	11 (7,16)
Length of stay in CTSDU prior to VRE detection, median (IQR)	4 (2,9)

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# Clinical Characteristics

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Admitting Service, N (%)	
Cardiac Surgery	7 (54)
OHT recipient	2 (29)
OHT + kidney recipient	1 (50)
LVAD patient	1 (14)
Pre-kidney transplant patient	2 (29)
Thoracic Surgery	4 (31)
BOLT recipient	2 (50)
VV ECMO patient	1 (25)
Pre-kidney transplant patient	1 (100)
Cardiology/Heart Failure	1 (8)
LVAD patient	1 (100)
Vascular Surgery	1 (8)



# Clinical Characteristics

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## Colonization vs. Infection

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Colonization, N (%)	13 (100)
Days between colonization and infection, median (IQR)	10 (5,22)
Infection <sup>1</sup> , N (%)	4 (31)
VRE bacteremia	2 (50)
Wound infection	3 (75)
<u>Intraabdominal infection</u>	1 (25)
Surgical intervention	4 (100)
Death <sup>2</sup>	3 (75)

<sup>1</sup> A single patient may have had more than one listed outcome.

<sup>2</sup> The causes of death were attributed to factors other than VRE infection.



# LOS Data

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2/13 (15%) patients had history of COVID-19 infection and extended LOS in CTICU.

- Patient #1 LOS: 36 days
- Patient #2 LOS: 62 days

## CTICU – Average LOS

- Cardiac Surgery: 17.6 days
- Thoracic Surgery: 33.4 days

## CTSDU – Average LOS

- Cardiac Surgery: 8.5 days
- Thoracic Surgery: 7.9 days



# Outcome of VRE Infections in Cohort

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4/13 (31%) patients developed clinical infection: cardiac surgery (n=2), pre-transplant (n=1), vascular surgery (n=1).

- Patient #1: VRE bacteremia and intraabdominal abscess.
- Patient #2: infected abdominal wound and sacral decubitus ulcer.
- Patient #3: VRE bacteremia and infected leg stump.
- Patient #4: mediastinal wound infection.

All 4 patients with infection required surgical debridement.

3/4 (75%) patients expired due to factors unrelated to VRE infection.



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# Multidisciplinary Process Improvement Team (MPIT)

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Convened on March 16, 2021 consisting of key stakeholders from IP, CTICU and CTSDU clinical leadership, EVS, and Microbiology.

Met weekly to review outbreak data and recommendations, and disseminated findings to relevant stakeholders.

Established action items organized by task and responsible party.



# MPIT Action Items: Hand Hygiene & PPE

Action Item	Task	Responsible Party
Hand Hygiene & PPE Education	Re-educate on adequate HH & PPE technique	Infection Prevention
Hand Hygiene & PPE Audits	Conduct interventional HH & PPE auditing	Infection Prevention, Nursing

## CTICU

- Hand hygiene compliance improved from 56% to 80%.

## CTSDU

- Hand hygiene compliance improved from 75% to 85%.



# MPIT Action Items: Environmental Cleaning

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Action Item	Task	Responsible Party
Daily Environmental Cleaning	Clean all 17 high touch surfaces; RNs to clean 5 select high touch surfaces per shift	EVS, Nursing
Discharge Environmental Cleaning	Increase auditing of discharge environmental cleaning	EVS

Discharge environmental cleaning determining environmental bioburden using 3M™ Clean-Trace™ Luminometer LX25 (Saint Paul, MN) was enhanced.





# MPIT Action Items: Shared Patient Equipment

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Action Item	Task	Responsible Party
Cleaning and Disinfection of Shared Patient Equipment	Audit cleaning and disinfection of shared patient equipment	Infection Prevention, Nursing

Cleaning and disinfection of shared patient equipment with PDI Super Sani-Cloth Germicidal Disposable Wipes (Woodcliff Lake, NJ) were enhanced.



# MPIT Action Items: Provider Rounding

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Action Item	Task	Responsible Party
Provider Rounding	Ensure only essential personnel enter rooms of VRE positive patients with a maximum of 4 team members during daily rounding.	CTICU and CTSDU Clinical Leadership (MD, APP)



# MPIT Action Items: VRE Screening Compliance

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Action Item	Task	Responsible Party
VRE Screening Compliance	Conduct audits to ensure that admit and weekly VRE rectal surveillance is being done	Infection Prevention, Nursing, Microbiology



# MPIT Action Items: Accountability

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Action Item	Task	Responsible Party
Accountability Plan	Re-educate to address repeated noncompliance with IP best practices	Nursing, CTICU and CTSDU Clinical Leadership

CTICU and CTSDU accountability plan involved active coaching and escalation to local leadership when needed.



# MPIT Action Items: ECMO

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Action Item	Task	Responsible Party
Cleaning of ECMO Machines and Heater-Cooler Devices	Establish stricter cleaning and disinfection schedules for ECMO machines and heater-cooler devices adhering to manufacturer's instructions for use	Infection Prevention, ECMO Team

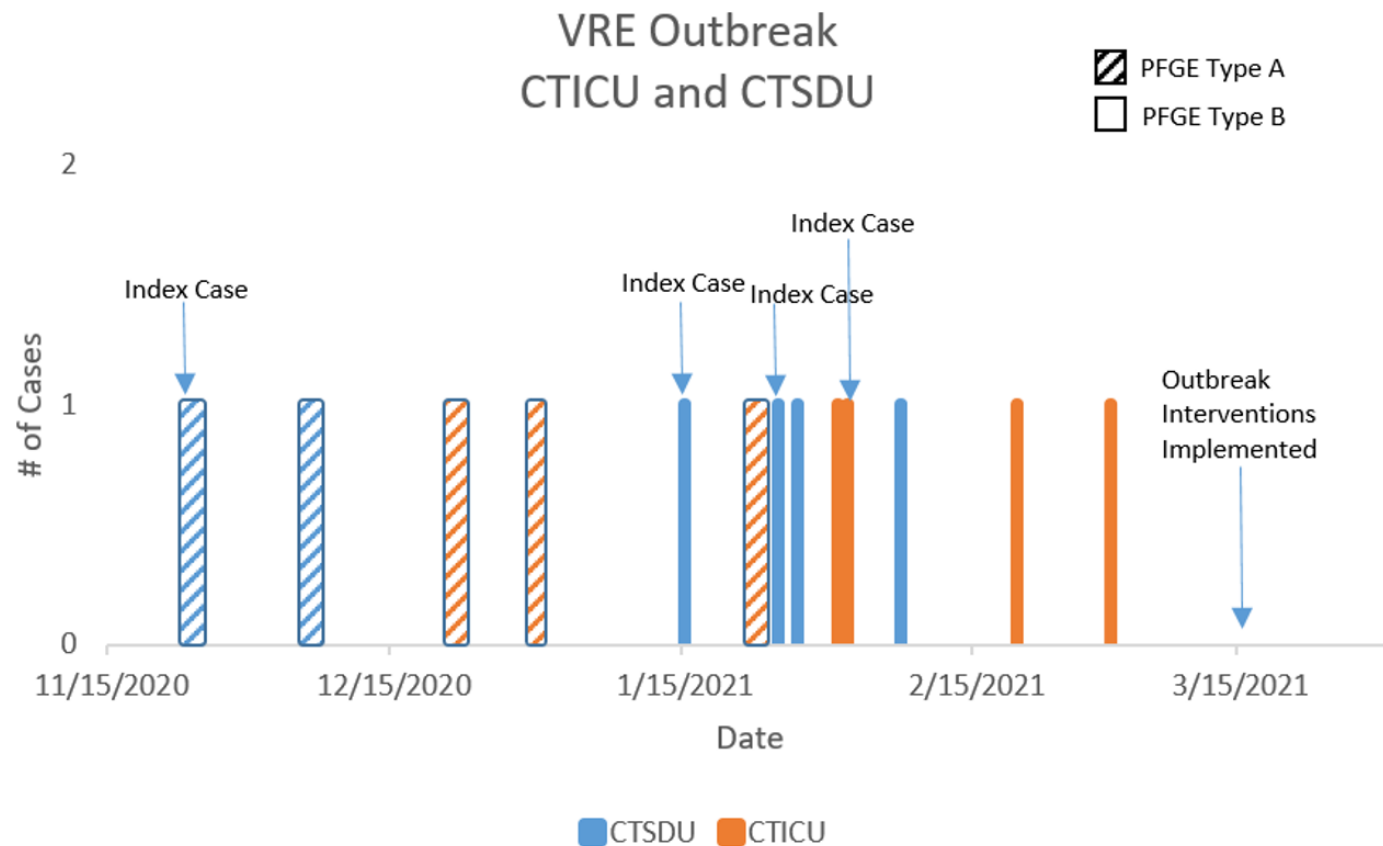
ECMO Machine: Cardiohelp system, Wayne, NJ

ECMO Heater-Cooler Device: CardioQuip MCH-1000, College Station, TX



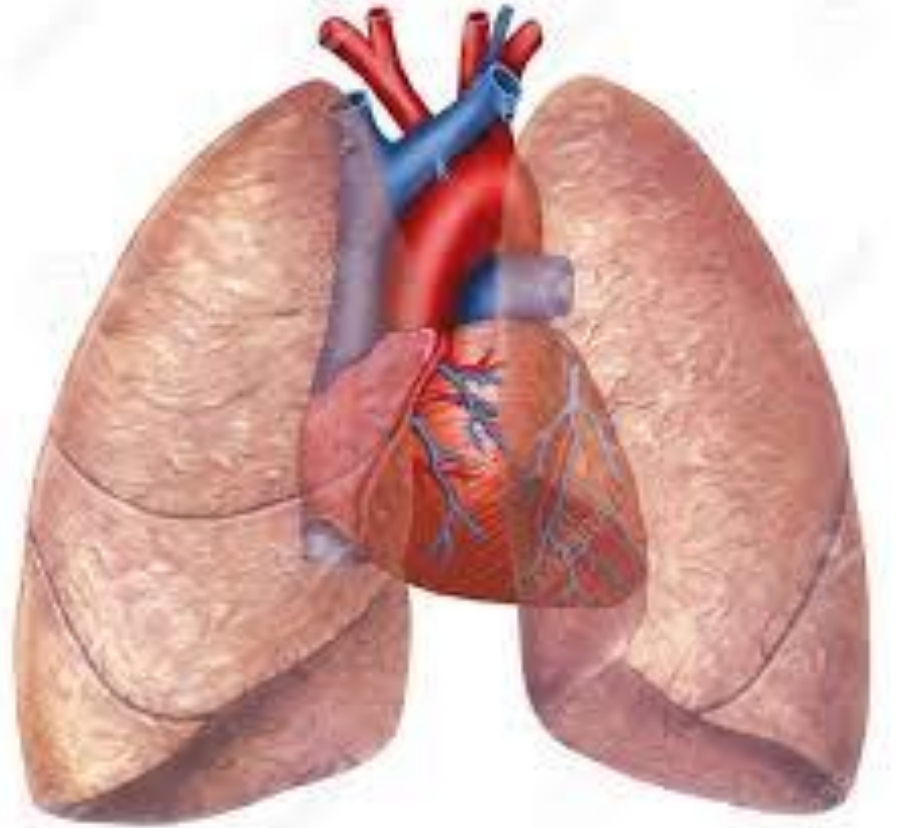
# Outbreak Resolution

Outbreak resolved on April 14, 2021 (4 weeks without transmission).





# Discussion





# VRE Literature in SCT/Abdominal SOT Population

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Transplant recipients are at higher risk of VRE colonization and infection (Nosotti 2018).

- Chronic immunosuppression
- Prolonged antibiotic exposure
- Frequent and extended contact with healthcare system

SCT and abdominal SOT populations historically have highest infection rates with up to 32% of colonized patients subsequently developing infection (Scheich 2017, Bucheli 2014).





# VRE Literature in Cardiothoracic Transplant Population

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Literature on VRE colonization, prevalence, and associated morbidity is limited and controversial (McFarlane 2021).

*Enterococcus sp.* are a frequent cause of VAD infections, and those infected may wait longer for heart transplantation (Monkowski 2007).

*Enterococcus sp.* are frequent organisms causing infections in ECMO patients, potentially delaying lung transplantation and contributing to early mortality for those cannulated post-transplantation (Biffi 2017).



# Lessons Learned: VRE Morbidity

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31% of colonized patients in cohort developed infections.

This infection rate suggests that cardiothoracic surgery/transplant patients may have a similar risk for VRE-associated morbidity compared to that of heme/onc, SCT, and abdominal SOT patients.



# Lessons Learned: Outbreak Management

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Hand hygiene and PPE audits with real-time intervention and coaching were especially effective.

Forming a MPIT to establish expectations, intervene for noncompliance, and disseminate data to stakeholders helped rapidly control the outbreak.

Interventions created a framework for sustainable infection prevention practices in this complex patient population.



# Lessons Learned: Discontinuing MDRO Surveillance

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Discontinuing VRE surveillance in the cardiothoracic transplant population likely led to:

- Delayed recognition of outbreak
- Outbreak on a larger scale than would have otherwise occurred

These two units were extraordinarily impacted during the COVID-19 pandemic with a population requiring mechanical support and lung transplantation.



# Impact of Pandemic-Prompted Shift in Patient Population on Risk of VRE Acquisition

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Bridging patients to lung transplantation with ECMO has been used increasingly with growing success in recent years (Langer 2019).

A fairly significant proportion of SARS-CoV-2 patients progressed to acute respiratory distress syndrome (ARDS) requiring mechanical ventilation (Bharat 2021).

ECMO has been used as a lifesaving rescue therapy for a small subset of patients with severe COVID-19 ARDS (Combes 2020).



# Impact of Pandemic-Prompted Shift in Patient Population on Risk of VRE Acquisition

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ECMO has been increasingly utilized as a bridge to transplantation for critically ill patients not exhibiting signs of lung recovery (Bharat 2021).

Patients requiring mechanical support due to COVID-19 ARDS and lung transplantation at our institution had complicated postoperative stays (Lepper 2021).

- Continued mechanical support
- Prolonged LOS in ICU



# Impact of Pandemic-Prompted Shift in Patient Population on Risk of VRE Acquisition

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ICU LOS is an independent risk factor for VRE acquisition in surgical patients (Kampmeier 2018).

VRE acquisition risk was likely increased by prolonged antibiotic exposure in the setting of critical illness and COVID-19.



# Limitations

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Small number of patients involved in the outbreak (n=13).

Subsequent investigations of VRE colonization, infection, and outbreaks in this population will shed additional light on rates reflected in the study.





# Conclusion

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Limited resources and deviations in infection prevention strategies throughout the pandemic led to many institutions experiencing a rise in MDRO rates (Perez 2020, Kampmeier 2020).

The pandemic-prompted shift in the cardiothoracic transplant population likely increased the risk for hospital-acquired VRE acquisition and subsequent transmissions.

Our experience in this unique population may inform infection prevention recommendations during pandemics and when resources are limited.



# Acknowledgments

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- NMH Healthcare Epidemiology & Infection Prevention
- NMH CTICU and CTSDU leadership
- NMH Transplant Infectious Diseases
- NMH Microbiology Laboratory
- NMH Environmental Services
- NMH ECMO Team



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Questions?

