Extra-pulmonary NTM Infections

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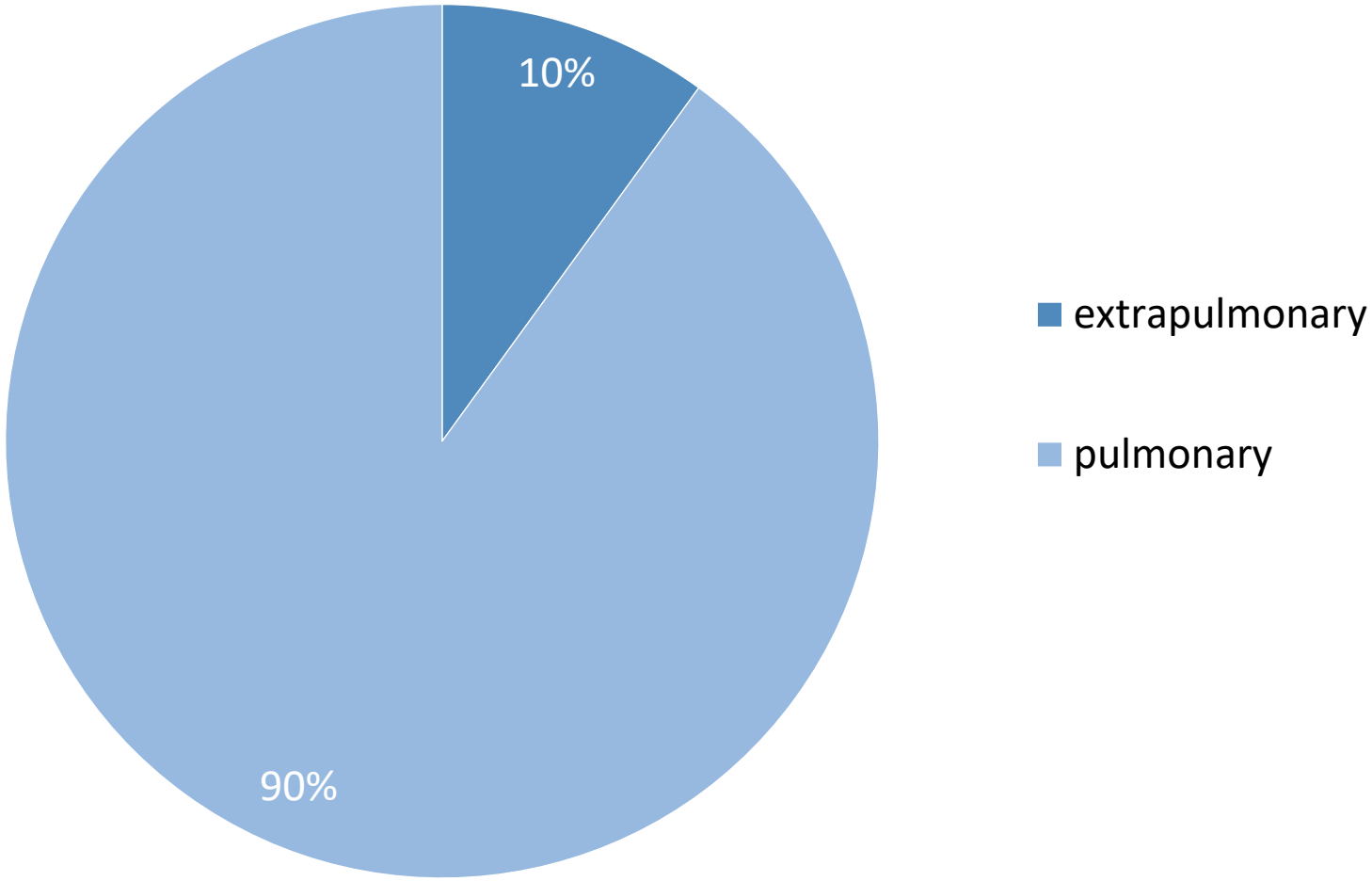
Disclosure

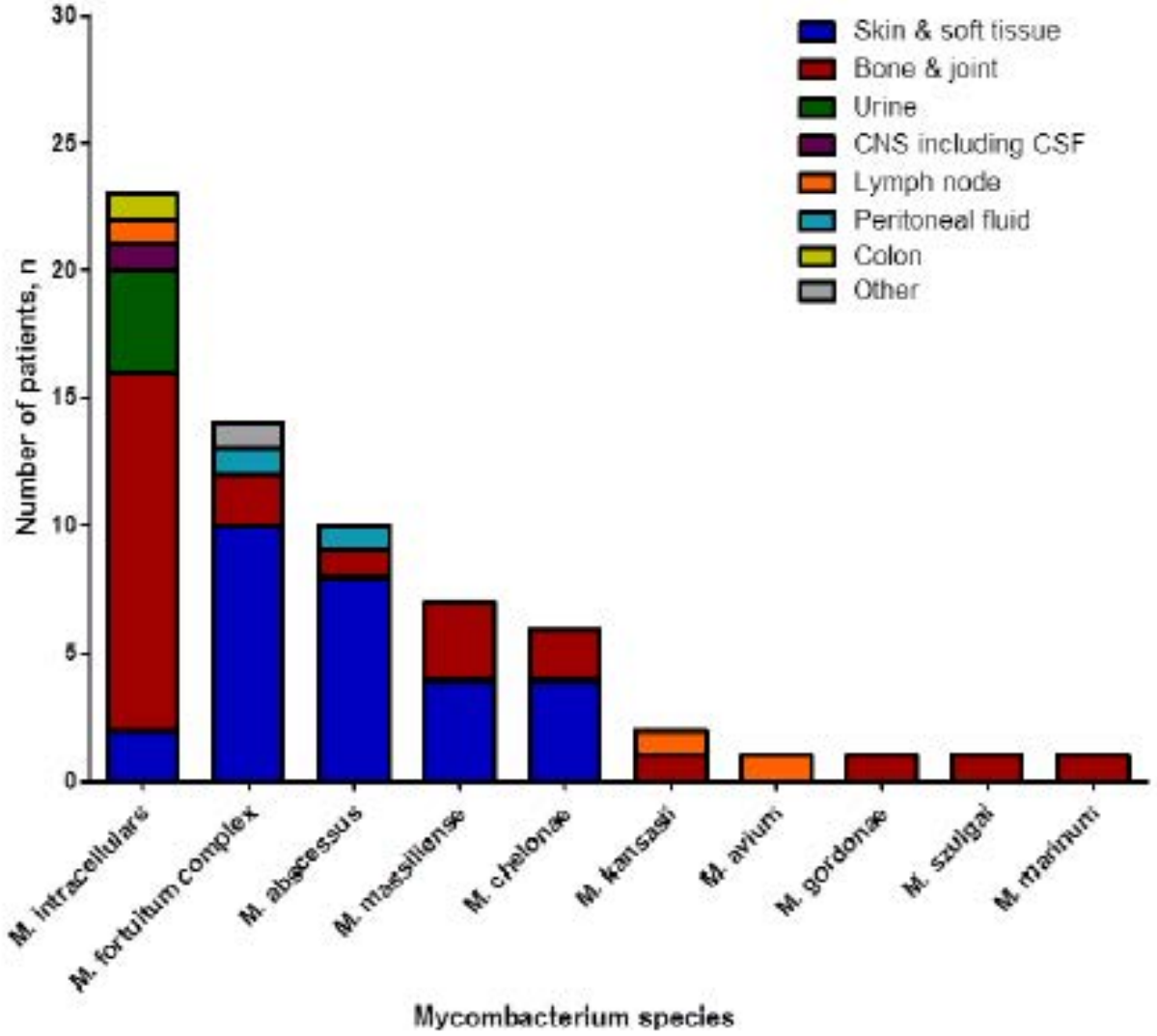
- Nothing to disclose

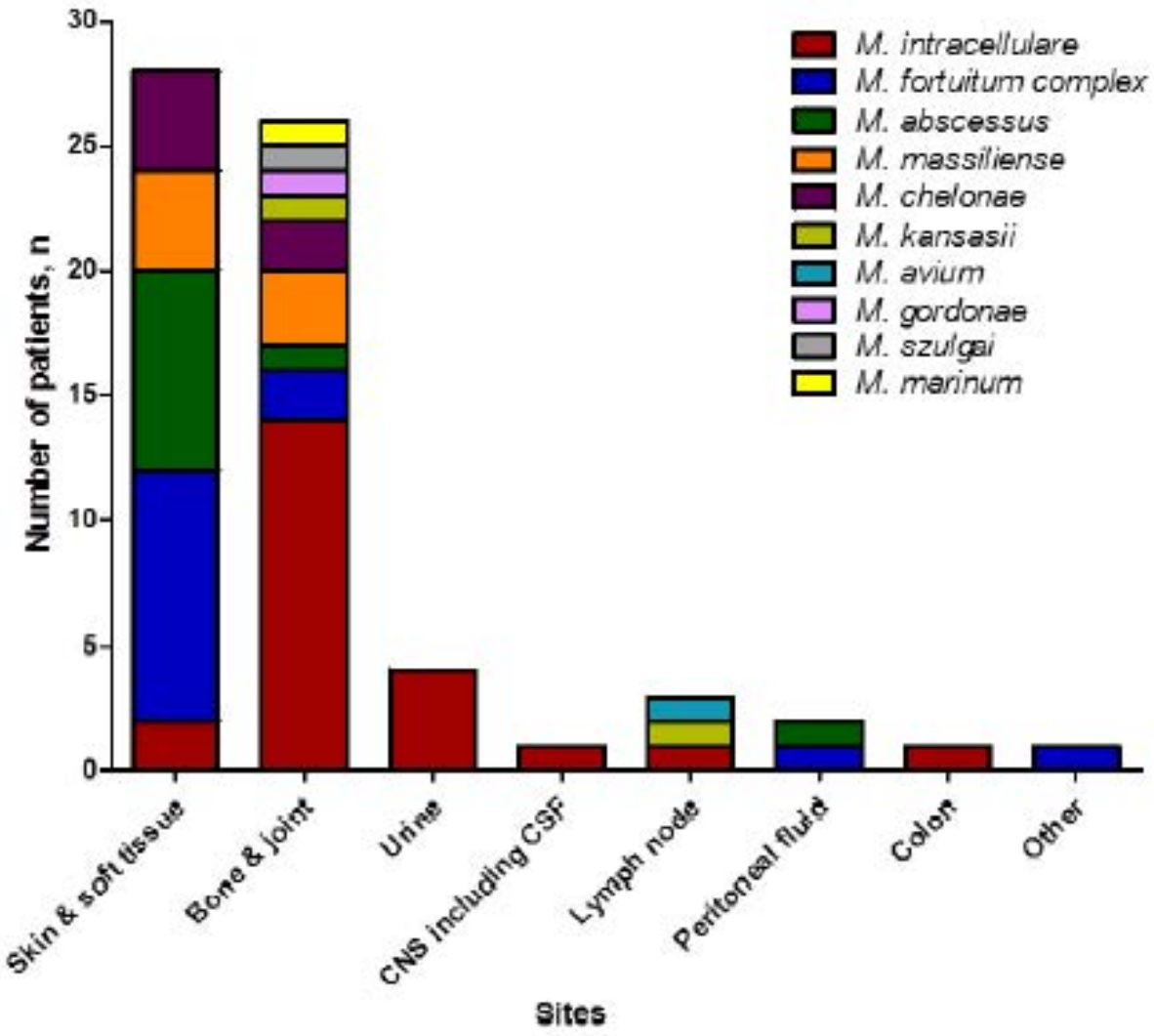
Objectives

- Introduce the species commonly identified in extrapulmonary infections
- Illustrate several different clinical manifestations
- Review risk factors for extrapulmonary infection
- Discuss the medical and surgical approach in patients with extrapulmonary disease

Clinical Manifestations of NTM







Pathogens 2020;9(11):949

Criteria for NTM disease

- Extrapulmonary
  - Isolation of NTM from a sterile site
  - Concomitant signs of inflammation

    - Preferable to send tissue biopsy or fluid aspirate
    - Wound swab= low yield
    - Send for acid fast smear and culture

Lymphadenitis

[1]*Tuber Lung Dis* 1995;76:300–310
[2]Pediatr Infect Dis J. 2008;27(10):920

- Sub-acute/chronic unilateral cervical nontender lymphadenitis in children (< 5 years old)
- *M. avium* complex, *M. scrofulaceum*, *M. malmoense*, *M. haemophilum*
- ~300 cases/year in US
- Risk factors
  - Children
  - Immunocompromised
  - Protective effect of BCG vaccination?[1]
- Diagnosis: LN biopsy
- Treatment:
  - surgical excision (95% cure)
  - Observation[2]

Buruli Ulcer

- Caused by M. ulcerans (neglected tropical disease)
- Exotoxin (mycolactone)
- Environments with stagnant water?
- Tx: rifampin + streptomycin → all oral regimen; wound management, surgery?

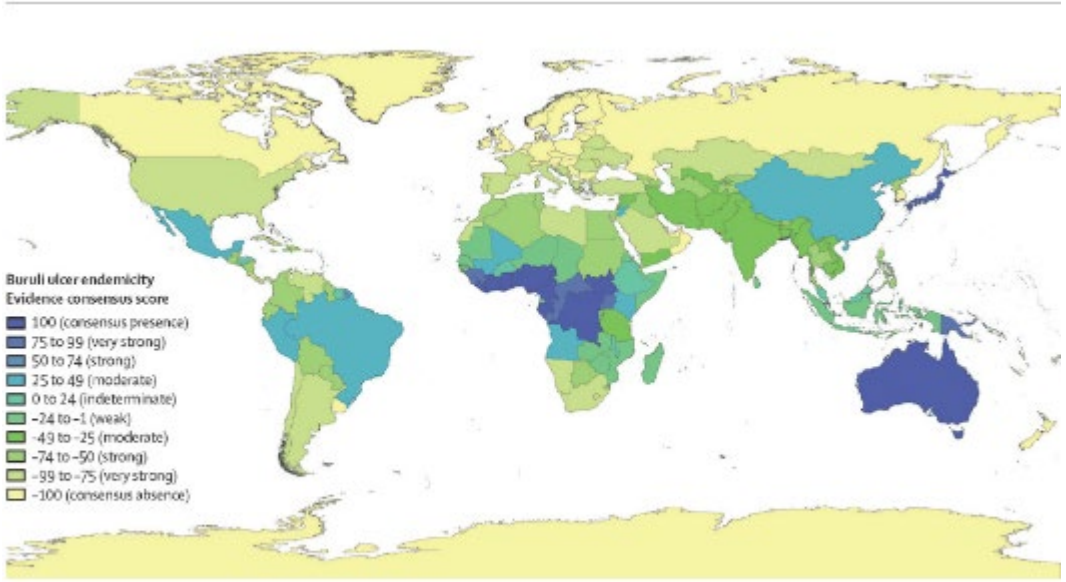
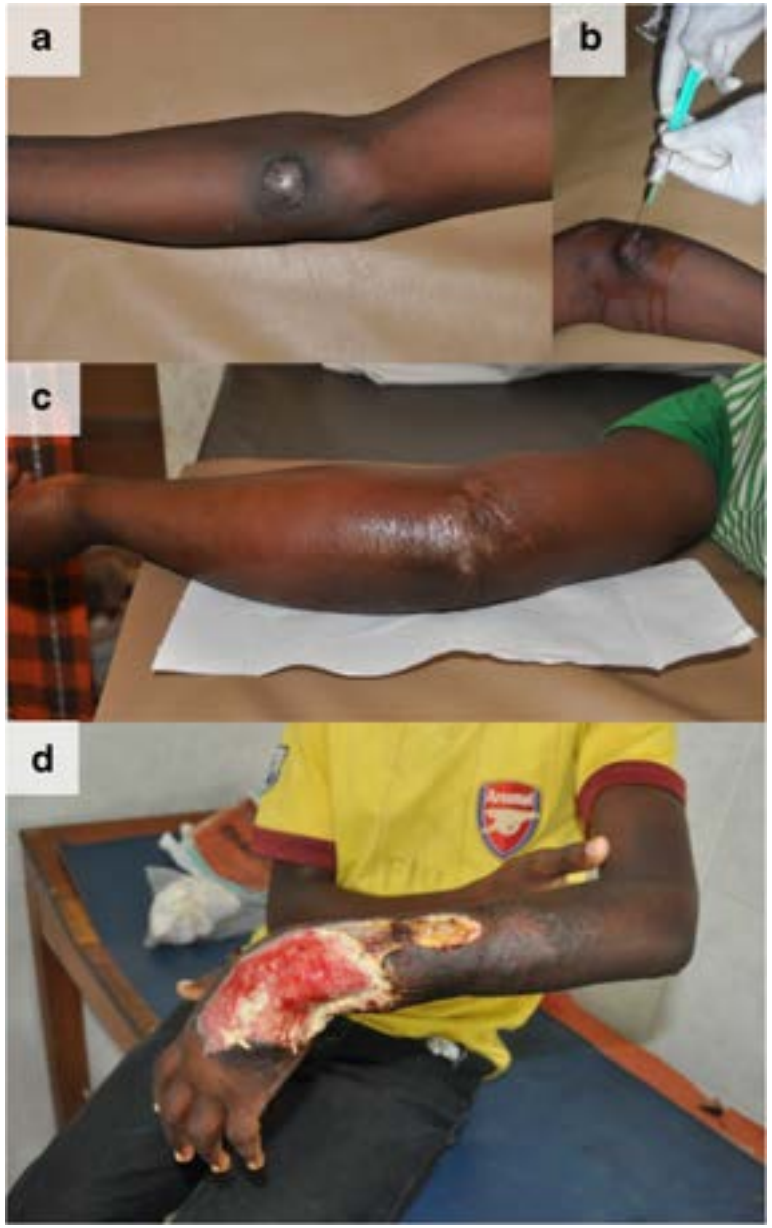


Figure 4 Evidence consensus for Buruli ulcer presence and absence worldwide

Curr Trop Med Rep 2018;5(4):247-256

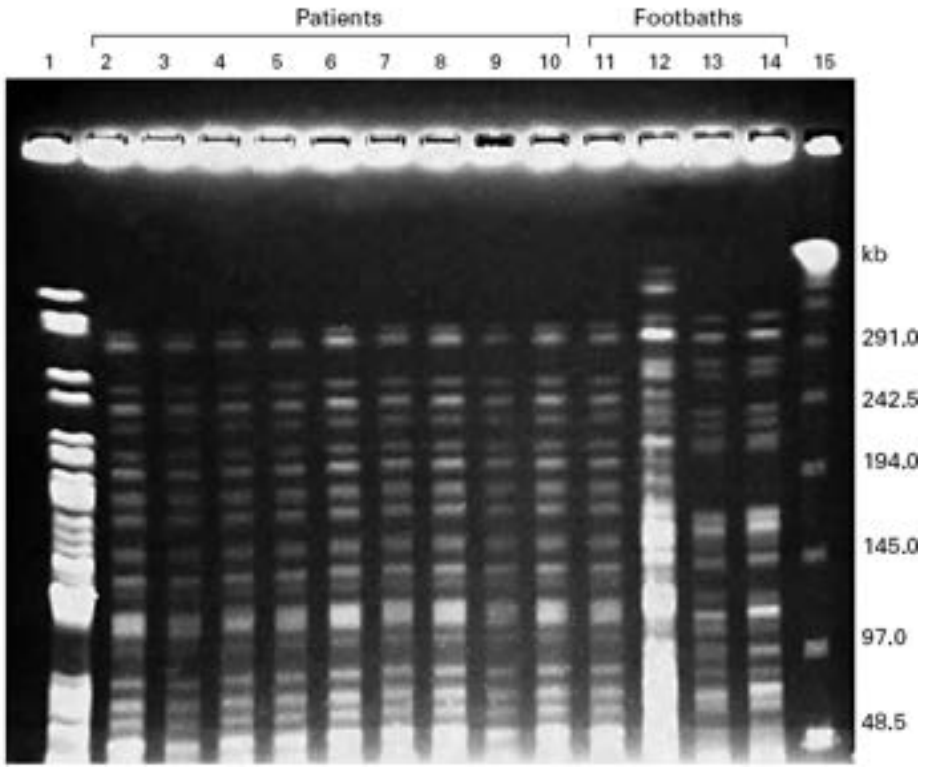
Lancet Glob Health 2019;7(7):e912-e922



Nail salon outbreaks

NEJM 2002;346:1366-71

Nail salon outbreaks



Shaving the legs with a razor before pedicure was a risk factor for infection (70 percent of patients vs. 31 percent of controls)

Nail Salon Outbreaks:*M. fortuitum*

- Surgical resection is NOT necessary
- Early antibiotics benefit patients with more than one furuncle
- Untreated skin infection may be self limited
- Mean duration 4 months
- Recommend: quinolone + tetracycline

CID 2004;38(1):38-44.

Fish Tank Granuloma: *M. marinum*

- Solid nodule, plaque or ulceration
- Culture: 33 degrees Celsius
- Risk factors:
  - Contact with aquatic environment (fresh or saltwater)
- Diagnosis: Biopsy with AFB smear and culture

Ac

Fish Tank Granuloma:
M. marinum

- Treatment: 3-4 months with two active agents
  - Clarithromycin/ azithromycin
  - Ethambutol
  - Rifampin
  - Trimethoprim-sulfamethoxazole
  - Doxycycline/minocycline
- Surgery:
  - tendonitis/arthritis
  - failure to respond to standard therapy
- Heat

Dermatology Online Journal 10 (3): 21.

M. Marinum tenosynovitis

- Multiple surgeries
- Azithromycin, ethambutol, rifampin
- Clofazimine
- IV amikacin (limited by tinnitus)
- Drug levels (history of gastric bypass)

Skin, Soft Tissue and Bone Infection

- Nodular skin lesions or ulceration
- Consequence of dissemination or direct inoculation
- Typical pathogens:
  - *Slow growing (M. ulcerans, M. marinum*, *M. haemophilum*, *M. avium* complex)
  - Rapidly growing (M. abscessus, M. chelonae, M. fortuitum)
  - Incidence: unknown
- Diagnosis: recommend surgical biopsy of the skin, soft tissue or bone for afb smear and culture
- ***Beware steroids for "immune condition" when in fact NTM is the cause***

Skin, Soft Tissue and Bone Infection

- Treatment: 2-4 active drugs (or more)
  - Superficial
    - 4 months (or longer) for soft tissue infection
  - Deep
    - 3-6 months of IV therapy often required (with orals)
    - 6-12 months total duration (or longer) for cartilage/bone infection
  - Treatment length is inversely proportional to the degree and effectiveness of debridement
  - *Erm* gene functionality (inducible macrolide resistance?) for rapidly growing mycobacteria (RGM)
  - Treat until no ***clinical or radiological (+/- microbiological)*** evidence of infection and often further therapy beyond this point for residual undetectable infection

Surgical Considerations

- **Surgical debridement usually required**
  - **especially organisms less sensitive to antibiotics (e.g., *M. abscessus*)**
  - **infections of closed space (tendon, joint)**
  - **removal of foreign material**

- **Best chance of cure with first debridement, inadequate debridement prolongs antibiotic therapy**

- Obtain cultures with every surgical intervention

- Bring back to surgery for persistent/recurrent disease on imaging
  - Antibiotic holiday several weeks prior to repeat surgery
    - Help with toxicities (limited effect until proper debridement)
    - May help with further culture growth from new specimens

M. Abscessus subsp. abscessus hand infection

Autoimmune hemolytic anemia (prednisone), hearing loss
Tx: IV imipenem + ceftazidime, clofazimine, omadacycline

M. Abscessus subsp. abscessus ankle infection

amik/imi/clofaz/linez → imi/ceftaz/clofaz/linez/omada

Skin and soft tissue infection (RGM)

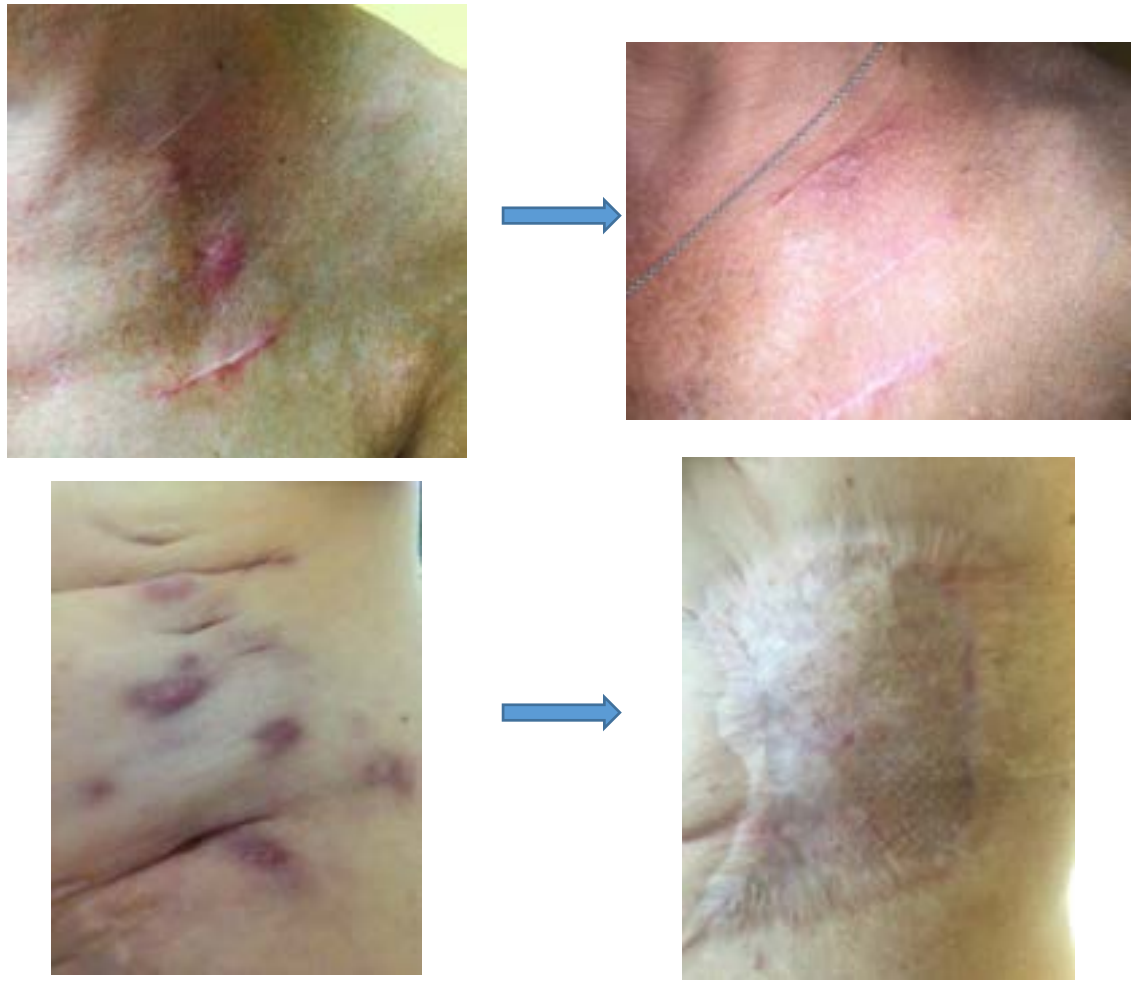
Age/sex	Comorbidity	Location	Cause	Organism	Surgery	Antibiotics (weeks)	Outcome (months p Rx)
71 M	DM, CKD	Left palm	trauma	*M. fortuitum*	I/D	AMK,CLR,CIP (4) CLR,CIP (20)	Cure (4)
68 F	Vasculitis	RLE	Public bath	*M. fortuitum, ulcerans and marinum*	None	AMK,CFX,RIF,CLR(3) CLR/MOX (13)	Cure (2)
72 M	COPD*	R shoulder	Post-op 4wks, public bath?	*M. fortuitum*	I/D	AMK,CFX,CLR (4) DOX,MOX (24)	Cure (3)
71 F	None*	R shoulder	Post-op 6 wks, public bath?	*M. fortuitum*	I/D	AMK,CFX,CLR (4) CLR,MOX (20)	Cure (4)
78 F	DM,CKD, AI	Left foot	Public bath	*M. chelonae*	Amputa-tion	AMK,CFX,CLR (2) RFT,CLR (6) CLR (3)	Death

* Hardware in place for rotator cuff repair

AMK, amikacin; CFX, cefoxitin; CLR, clarithromycin; CIP, ciprofloxacin; MOX, moxifloxacin;RFT,rifabutin; DOX, doxycylcine

Infect Chemother 2013;45(1):85-93.

M. abscessus Post Fat transfer



Abscesses due to *Mycobacterium abscessus* Linked to Injection of Unapproved Alternative Medication

Karin Galil,* Lisa A. Miller,† Mitchell A. Yakrus,* Richard J. Wallace Jr.,‡ David G. Mosley,§ Bob England,§ Gwen Huitt,¶ Michael M. McNeil,* and Bradley A. Perkins*

*Centers for Disease Control and Prevention, Atlanta, Georgia, USA; †Colorado Department of Public Health and Environment, Denver, Colorado, USA; ‡University of Texas Health Center, Tyler, Texas, USA; §Arizona Department of Health Services, Phoenix, Arizona, USA; and ¶National Jewish Medical and Research Center, Denver, Colorado, USA

An unlicensed injectable medicine sold as adrenal cortex extract (ACE*) and distributed in the alternative medicine community led to the largest outbreak of *Mycobacterium abscessus* infections reported in the United States. Records from the implicated distributor from January 1, 1995, to August 18, 1996, were used to identify

CDC Centers for Disease Control and Prevention

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EMERGING INFECTIOUS DISEASES®

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Volume 22, Number 8—August 2016

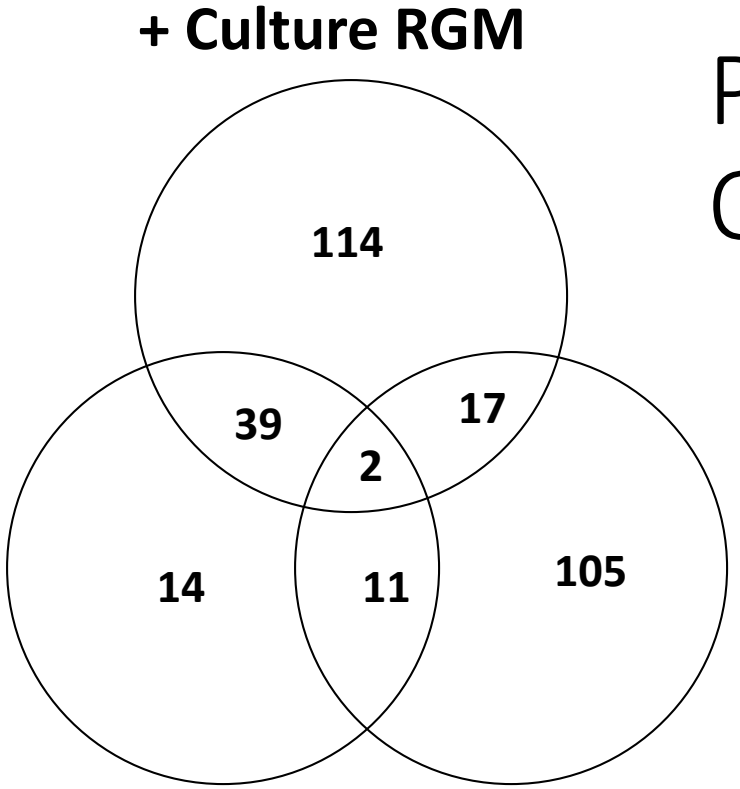
Synopsis

Multistate US Outbreak of Rapidly Growing Mycobacterial Infections Associated with Medical Tourism to the Dominican Republic, 2013–2014[1]

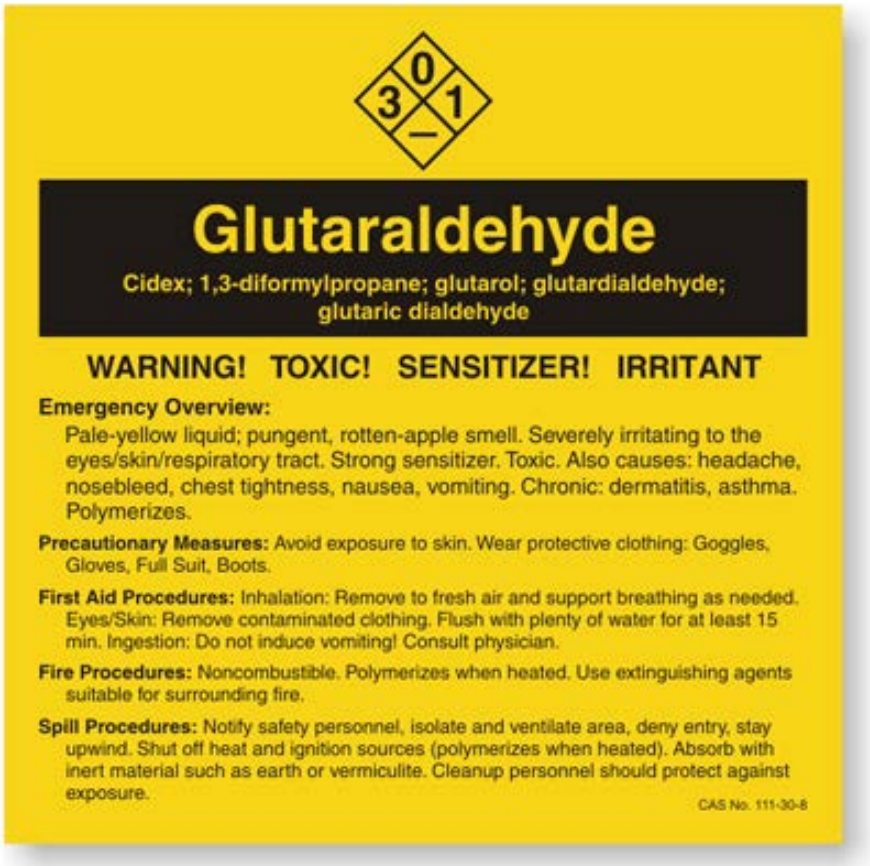
David Schnabel✉, Douglas H. Esposito, Joanna Gaines, Alison Ridpath, M. Anita Barry, Katherine A. Feldman, Jocelyn Mullins, Rachel Burns, Nina Ahmad, Edith N. Nyangoma, Duc T. Nguyen, Joseph F. Perz, Heather Moulton-Meissner, Bette J. Jensen, Ying Lin, Leah Posivak-Khouly, Nisha Jani, Oliver Morgan, Gary W. Brunette, P. Scott Pritchard, Adena H. Greenbaum, Susan M. Rhee, David Blythe, Mark Sotir, and the RGM Outbreak Investigation Team

On This Page

Post-surgical Outbreaks



J Clin Micro 2009;47(7): 2149–2155



- *M. massiliense* BRA100 strain
  - resistant to high gluteraldehyde concentrations (up to 7%)
  - substituted with orthophthaldehyde (OPA) and peracetic acid (PA)-based solutions for high level disinfection

J Clin Micro 2009;47(7): 2149–2155

Liposuction (8/2021)

9/27/’21 (left, center), before antibiotics
12/15/’21 (top right), 6 weeks on antibiotics
1/3/2’22 (bottom right), 8 weeks on antibiotics

Audience Question:

	M. abscessus group		
ANTIBIOTICS	MIC mcg/mL	INTRP	
Amikacin (IV)	32	I	
Augmentin	>32/16	NI	
Azithromycin	<=16	NI	D1
Azithromycin (14 Day)	<=16	NI	D2
Cefepime	>32	NI	
Cefotaxime	>64	NI	
Cefoxitin	32	I	
Ceftriaxone	>64	NI	
Ciprofloxacin	>8	R	D3
Clarithromycin	<=0.25	S	D4
Clarithromycin (14 Day)	0.5	S	D2
Clofazimine	<=0.5	NI	
Clofazimine/Amikacin	<=0.5/2	NI	D5
Doxycycline	>16	R	
Gentamicin	4	NI	
Imipenem	8	I	D6
Kanamycin	<=8	NI	
Linezolid	>16	R	
Minocycline	>8	NI	
Moxifloxacin	>4	R	
Tigecycline	1	NI	
Tobramycin	>16	R	D7
Trimethoprim/Sulfamethoxazole	>4/76	R	
x Compliance Statement		*	D8

Mycobacterium abscessus group

Drug Resistance Markers of Various NTM FINAL

11/17/21

A cytosine has been detected at position 28 (T28C) of the erm(41) gene.
THIS SUGGESTS SUSCEPTIBILITY TO MACROLIDES.

No mutations are present at rrl.
ACQUIRED (HIGH LEVEL) MACROLIDE RESISTANCE IS NOT PREDICTED.

No mutations are present at rrs.
THIS SUGGESTS SUSCEPTIBILITY TO AMINOGLYCOSIDES.

What Antibiotic Therapy do you choose?

1) Amikacin IV, Clarithromycin, Cefoxitin IV
2) Clarithromycin, Tigecycline IV, Linezolid
3) Azithromycin, Eravacycline IV…Clofazimine
4) Amikacin IV , Azithromycin, Imipenem IV, Omadacycline PO/IV
5) Amikacin IV, Azithromycin, Eravacycline IV… Clofazimine

What Antibiotic Therapy do you choose?

Amikacin IV, Clarithromycin, Cefoxitin IV

Clarithromycin, Tigecycline IV, Linezolid

Azithromycin, Eravacycline IV…Clofazimine

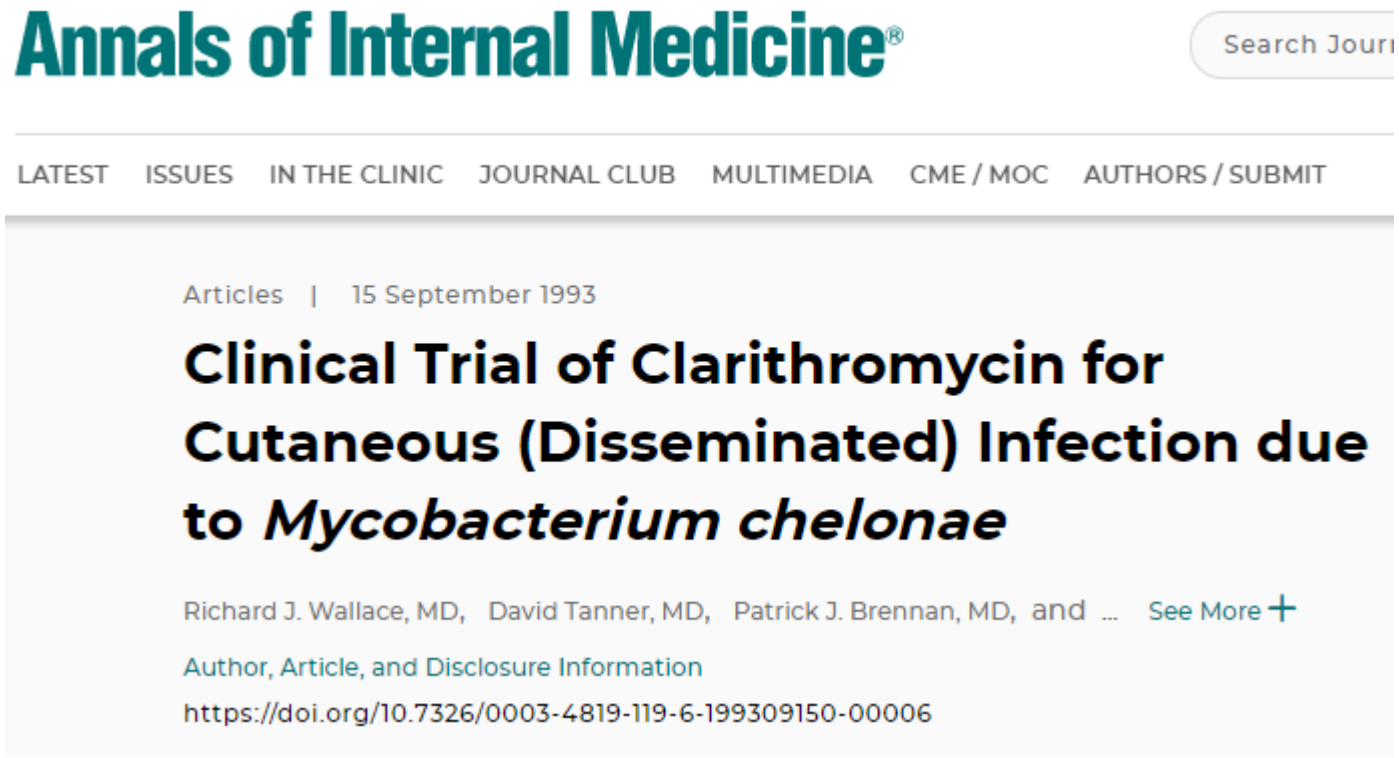
Amikacin IV , Azithromycin, Imipenem IV, Omadacycline PO/IV

Amikacin IV, Azithromycin, Eravacycline IV… Clofazimine

Following 1/11/2022 Surgery

National Jewish Visit 2/2022, new lesions on therapy

Rapidly-growing NTM: new lesions on therapy



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Articles | 15 September 1993

Clinical Trial of Clarithromycin for Cutaneous (Disseminated) Infection due to *Mycobacterium chelonae*

Richard J. Wallace, MD, David Tanner, MD, Patrick J. Brennan, MD, and ... See More +

Author, Article, and Disclosure Information

https://doi.org/10.7326/0003-4819-119-6-199309150-00006

- Determine if Clarithromycin 500mg bid x6 months monotherapy safe/effective Monitor AFB smears/cultures of skin lesions including clinical response, side effects, development of new lesions

- 14 patients (multicenter) with autoimmune disease or organ transplant (on steroids or cyclophosphamide)

- All patients with excellent response, ***new lesions in 6 patients with negative AFB smears/cultures***

- Non-adherent patient stopped at 3.5 months, previous lesion smear/culture positive 1 month later (clarithromycin-resistant)

Panniculectomies

Abdomen (2/26/2022)

Right hip (3/3/2022) [NJH cultures negative]

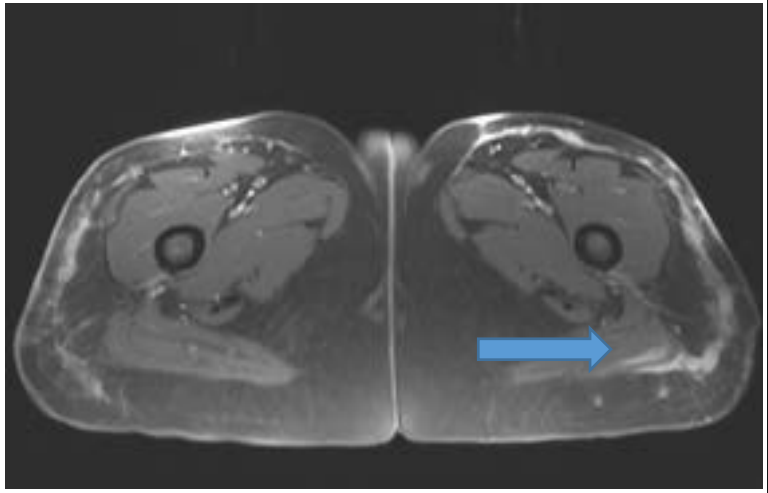
Right thigh (3/11/2022)

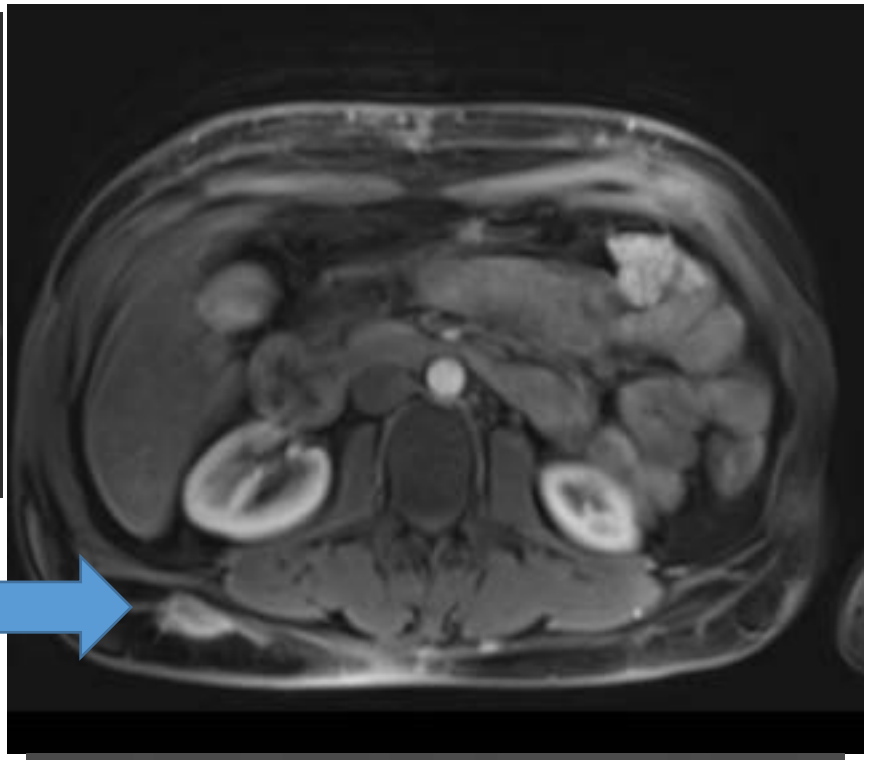
Left thigh & hip (3/24/2022)

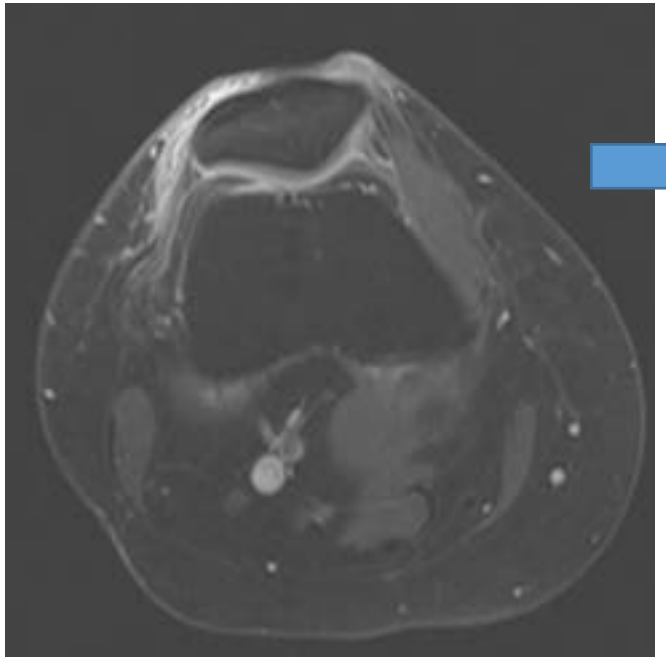
Pictures from 1/20/2023

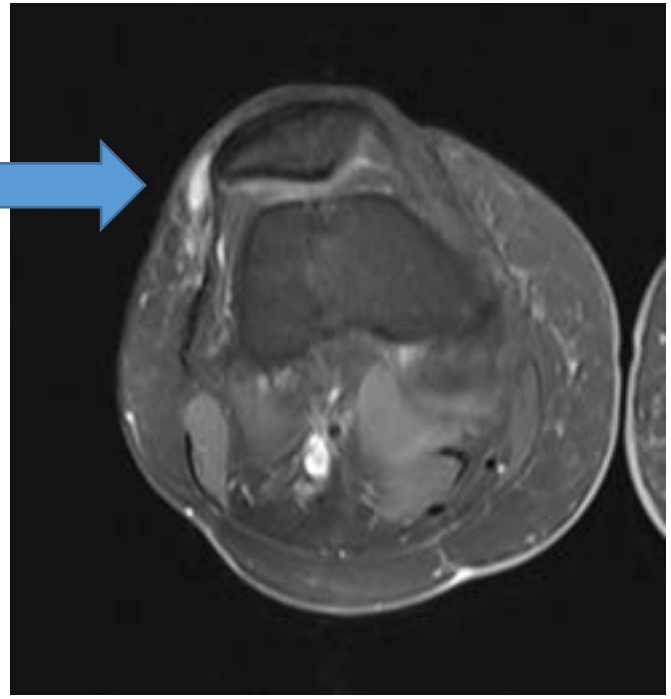
Persistent Disease?

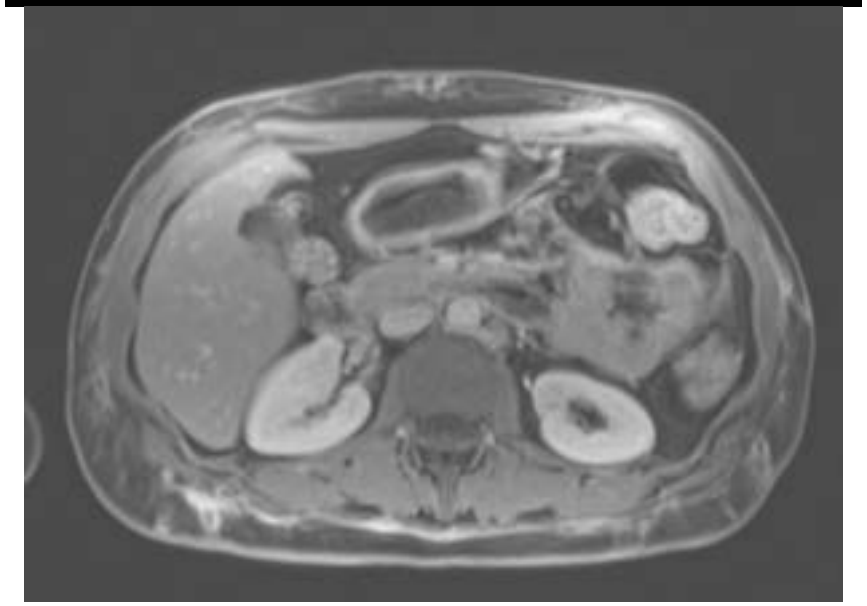
Right Knee, Right Back Left Gluteal?
(Gray: 2/3/2022,
Black: 9/16/2022,
except gluteal 2/3/'22)



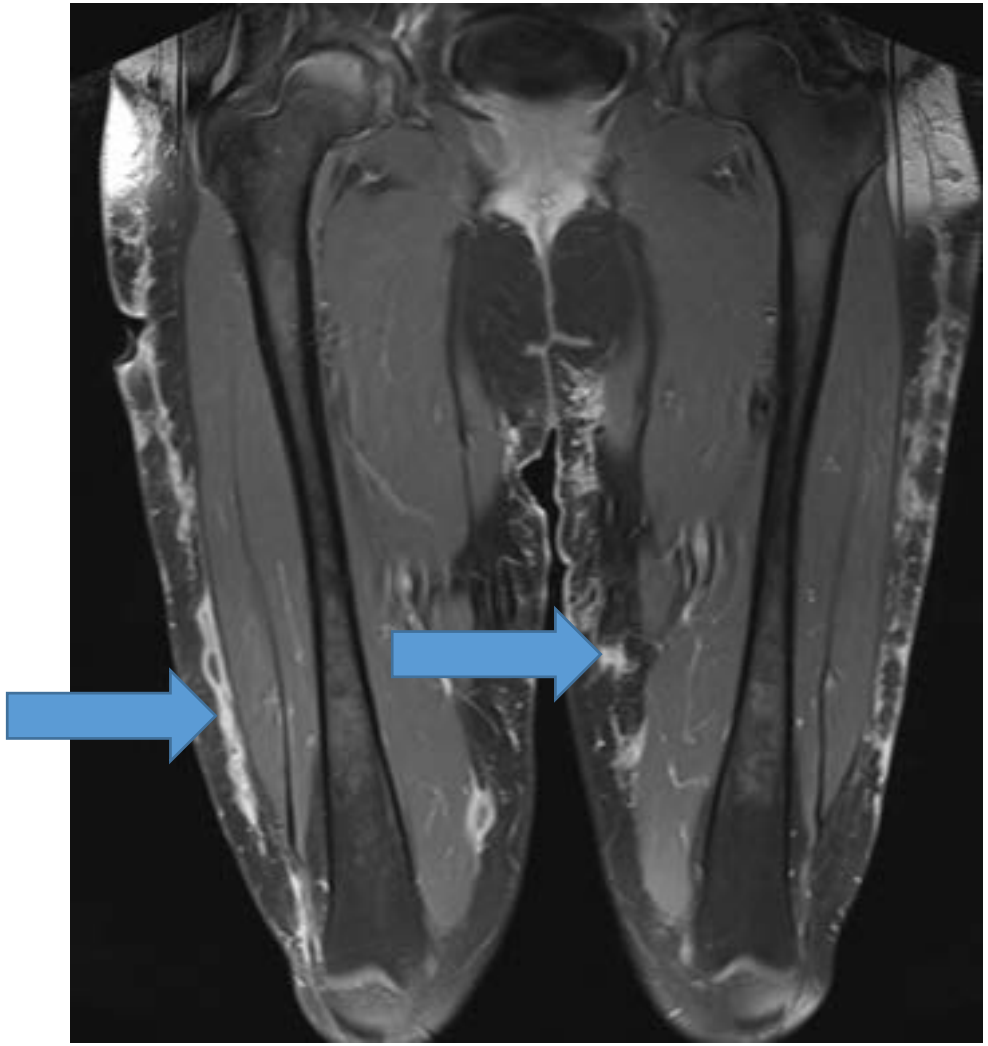


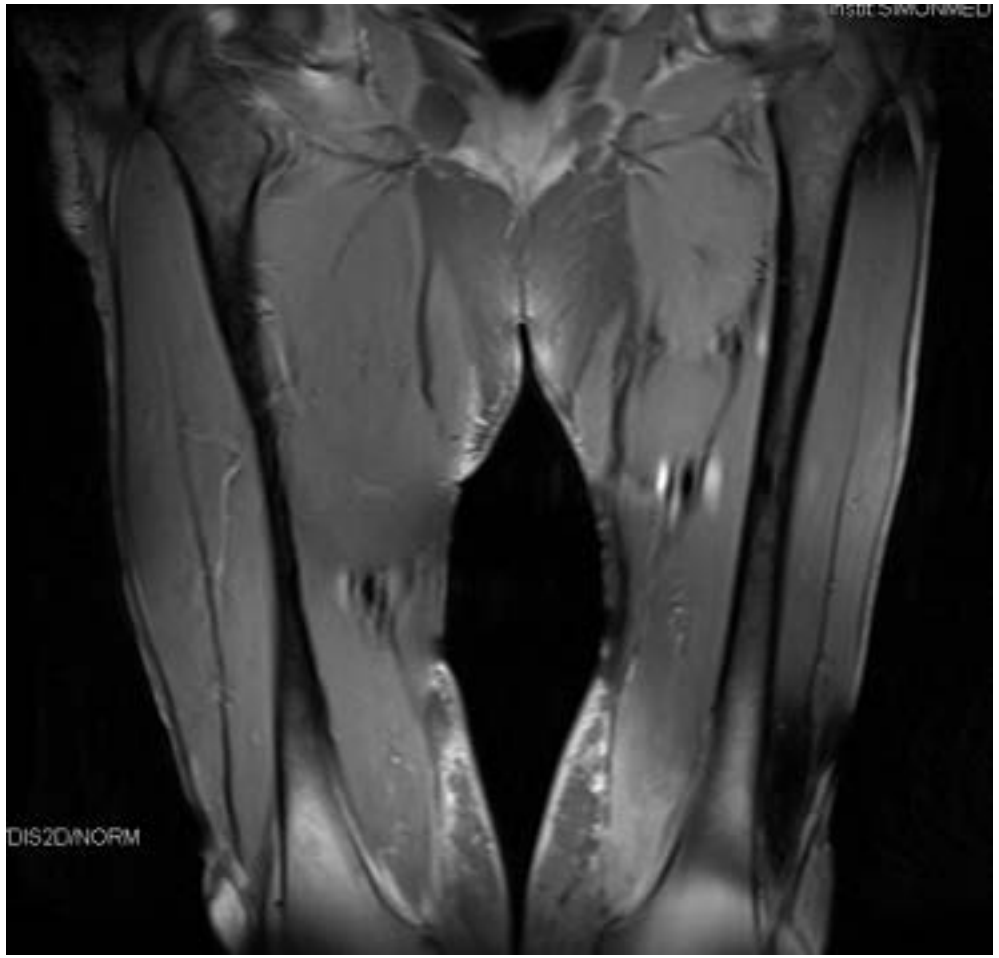






Legs before and after surgery





NTM Prosthetic Joint infection(CO)

Location	Knee (4), Hip (2)
Interval from implantation to symptoms	Median 6 months (0-300 mo)
Interval from symptoms to explantation	Median 8.5 months (3-16 mo)
Cure	All (but 1 required hemipelvectomy)

Emerg Infect Dis. 2019 Jun;25(6):1075-1083

NTM Prosthetic Joint infection(CO)

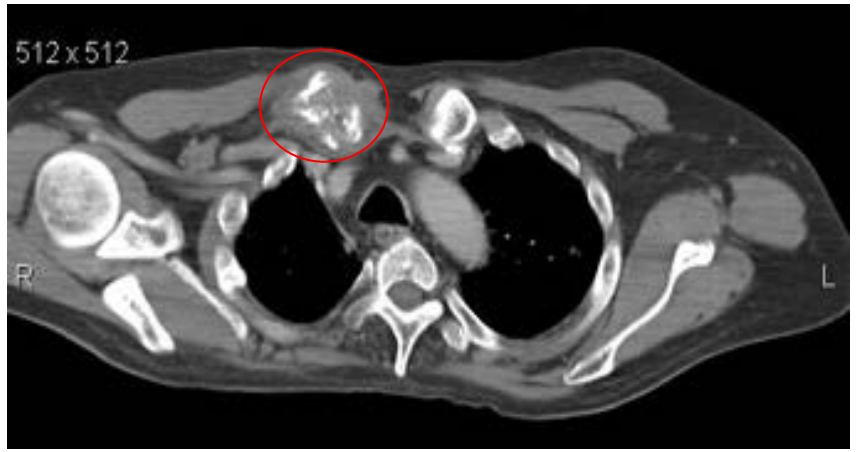
Age	Location	Organism	# of abx	Therapy Duration (mo)	Time to re-implantation (mo)	Cure
48 F	Left Hip	*M. abscessus*	4 (IV)	20	N/A	yes
69F	Right Hip	*M. fortuitum*	4 (IV)	5	4	yes
79M	Left knee	MAC	4 (IV)	39	12	yes
77F	Right knee	MAC	3	9	7	yes
83M	Left knee	*MAC*	3	7	5	yes
49F	Right knee	*M. gordonae*	4 (IV)	16	6	yes

2009-2015

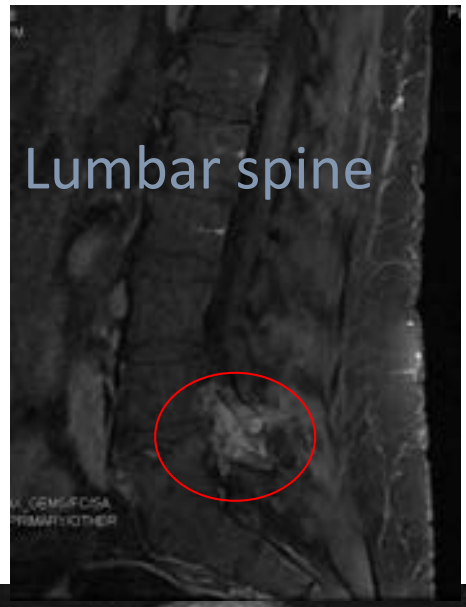
Emerg Infect Dis. 2019 Jun;25(6):1075-1083

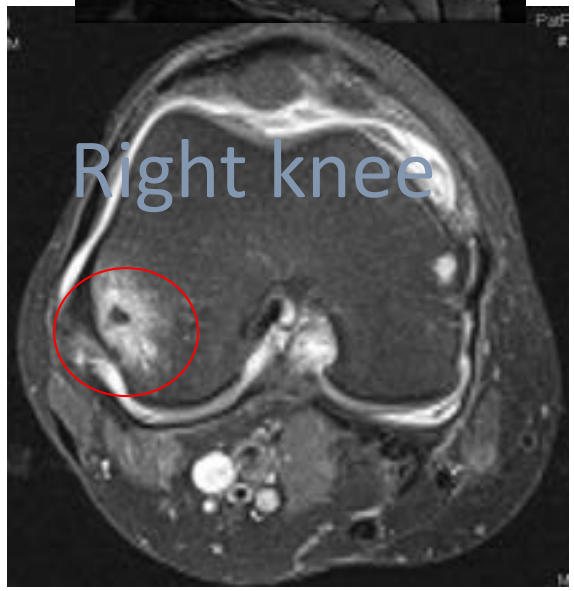
55 year-old man steroid injections for left ankle pseudogout?

Further studies



Right ankle





Prosthetic Joint infection

- Most patients >60 years old & immunocompetent
- Culture yield
  - Mycobacterial culture (100%)
  - NTM recovered in routine culture low (1/9)
- **Only patients with resection arthroplasty (REA) attained cure**
- Duration of effective antibiotic therapy
  - post REA 16-55 weeks
- Staged re-implantation:
  - successful in 3/6 without lifelong suppressive antibiotics
  - 30+ weeks after REA
- Retention of prosthesis (4), all *M. fortuitum*
  - Successful in 2/4 with suppressive antibiotics

CID 2007;45:687-94.

Vertebral osteomyelitis

- Series 38 cases 1965-2003
  - *M. avium* complex (22), *M. xenopi* (3), *M. fortuitum* (6), *M. abscessus* (3) *M. bovis* (1) *M. simiae* (1), *M. celatum* (1).
  - Mean age 56
  - ~30% immunosuppressed
  - Most frequent sites: lower thoracic, upper lumbar
  - Trauma (4)
  - Post-laminectomy (1)

J Infect Chemother. 2013 Oct;19(5):972-7.

Vertebral osteomyelitis

- Treatment: no consensus
  - surgical and antimicrobial therapy is often required to completely eradicate the infection.
  - Indications for early surgery: progressive destruction of vertebral bodies, neurological compression, and abscess formation, drug resistant organism

Catheter related blood stream infections

*N=11 CRBSI w/ RGM

- Oncology patients
- 6/11 neutropenic
- 4/4 cured w removal + antibiotics
- 7/7 failure with antibiotics alone

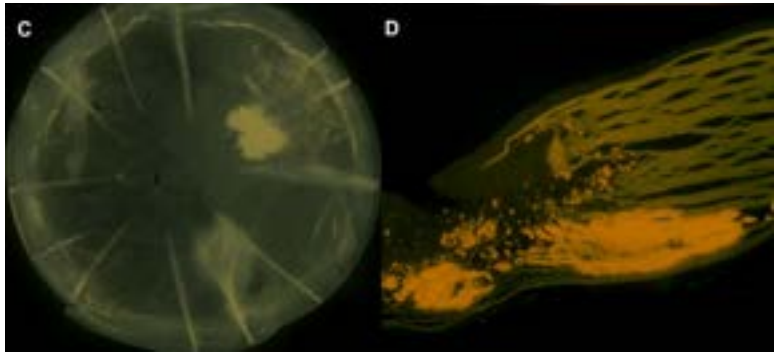
No official recommendations exist for the choice of antibiotics or duration

Suggest: 2 active antibiotics for a minimum of 2 months with resolution of symptoms and removal of the line

MUST REMOVE

Diagn Microbiol Infect Dis. 2008 Jun;61(2):187-91.
Pediatr Infect Dis J. 2003 Dec;22(12):1108-9.
*Rev Infect Dis. 1991 Nov-Dec;13(6):1120-5.

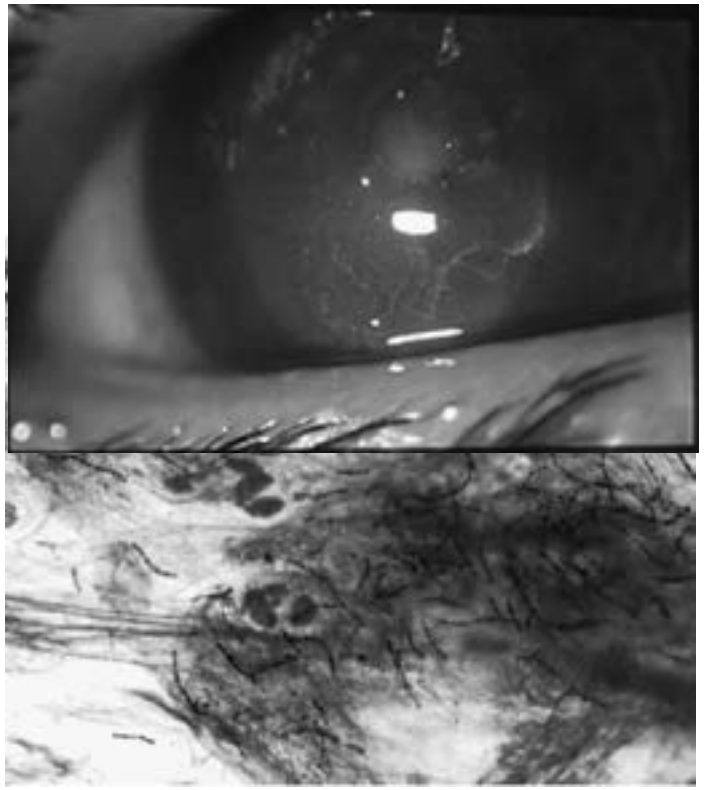
NTM Keratitis



- Inflammation of the cornea
- Indolent (>3.5 wk) pain redness, photophobia, decreased vision
- Most common NTM: RGM (M. *chelonae)*
- Risk Factors:
  - LASIK,
  - eye surgery
  - contact lens use
- Dx: early irrigation/culture

NTM Keratitis

- Triple Topical Treatment: amikacin, clarithromycin + moxifloxacin gtts +/- PO macrolide
- Rx: No consensus on duration
- Surgery: indications for flap removal
  - Nonadherence of the flap
  - Lack of clinical improvement on medical therapy
- Avoid topical corticosteroids



Int Ophthalmol Clin. 2007;47(2):73-84.
J Cataract Refract Surg 2010; 36:843–846

Disseminated Disease

- Typical presentation : HIV/AIDS
  - (CD4 <50)
- Any of the NTM can cause dissemination
  - >90% secondary to *M. avium* complex
- Introduced: lungs or intestinal tract
- Clinical presentation
  - Fever, night sweats, weight loss, diarrhea
  - Bacteremia (intermittent), elevated alkaline phosphatase, LDH, anemia

Disseminated Disease

- Incidence
  - DMAC ~40% of AIDS patients with CD4 of <10
  - 3.7/100 person years → 0.9/ 100 person years in the HAART era
- Risk factors: Immunocompromised, central line infection
- Diagnosis: + blood cultures
  - Recommend liquid and solid medium
  - 96% + in liquid culture by 14 days
- Treatment:
  - Clarithromycin/azithromycin + ethambutol +/- rifabutin
  - Key to success in HIV/AIDS is antiretroviral therapy

- A 53 year old male describes cryptic fevers for 3 months and fatigue. He has a normal exam apart from an well healed sternotomy incision related to aortic valve replacement (AVR) 6 years ago. His labs note anemia, hepatitis and an elevated creatinine.
- Blood cultures are + for MAC.
- What is this related to?

1. HIV infection
2. Idiopathic CD4 lymphopenia
3. Contamination of a device from the OR 6 years ago

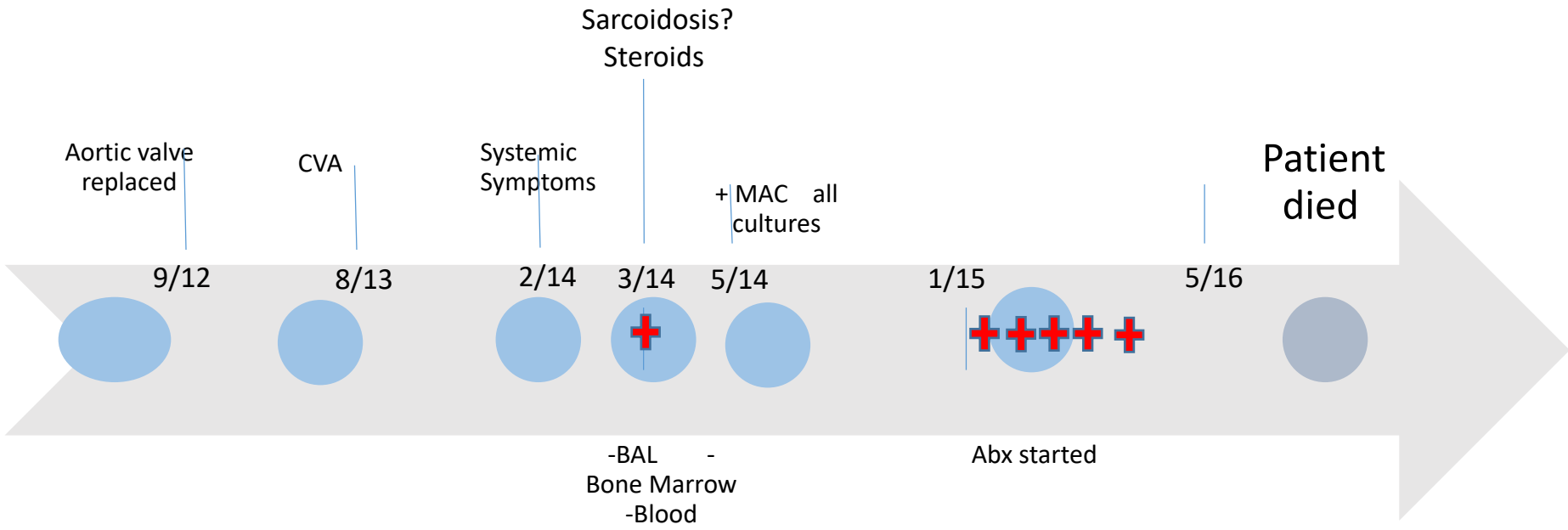
Blood cultures are + for MAC. What is this related to?

HIV infection

Idiopathic CD4 lymphopenia

Contamination of a device from the OR 6 years ago

Clinical Case



The Outbreak: Heater-Cooler Units

-Warm or cool a patient to an optimal temperature

-250,000 procedures in the US/year

-3T: 60% US market share

3T - USA

Home > Products > Cardiac Surgery Solutions > Perfusion > Heart Lung Machine > 3T - USA

Catalogue: USA

FAST AND EFFICIENT PATIENT TEMPERATURE CONTROL

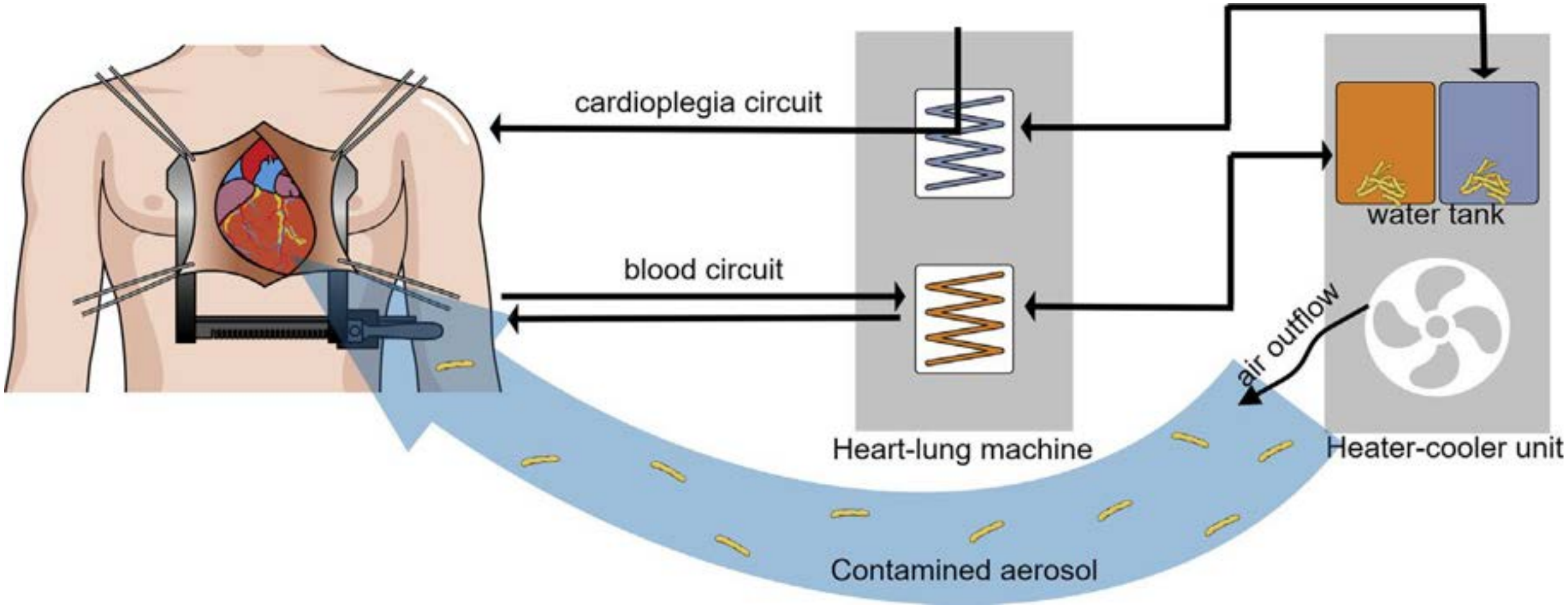
The Sorin 3T Heater-Cooler System provides 3 circuits for fast and efficient heating and cooling to meet your patient and cardioplegia temperature needs.

Compressor-based cooling and 3 independent water tanks eliminate the need for ice and water supply in the operating room, providing separate settings for warm cardioplegia, cold cardioplegia and patient temperature.

EASE OF USE

Patient temperature settings can be adjusted to the tenth decimal point for accurate temperature control.

To facilitate cleanup, a water evacuation feature allows pulling back water from the lines into the tanks at the end of a procedure.



J Infect Chemother 2020;26(3):199-205

Mycobacterium chimaera

Possible clinical pictures
(3-72 weeks after cardiothoracic surgery)


Surgical site infection
Mediastinitis


Pseudoaneurysm


Vascular graft infection


Prosthetic valve endocarditis


Aortic root abscess


Aortic dissection


Myocarditis


Osteomyelitis


Bone marrow involvement


Arthritis


Panuveitis


Chorioretinitis


Splenomegaly
Hepatitis
Nephritis


Disseminated granulomatous disease


Pneumonia
(also as colonization of the airways in cystic fibrosis and COPD)


Constitutional symptoms

Microbiology

- Coccobacillus
- Slowly growing (up to 6-8 weeks to culture)
- Non pigmented
- Acid-fast positive
- Non motile
- Non-spore forming
- Natural drug resistance

Diagnosis

- Clinical suspicion
- Not otherwise explained clinical manifestation lasting >3 weeks
- Evaluation of medical history, exposure and risk factors

Lab abnormalities: pancytopenia, hypoalbuminemia, alkaline phosphatase >150IU/L, C-reactive protein <50mg/L

M. chimaera identified by DNA sequencing in an invasive sample (blood, pus, biopsy, prosthetic material)

Treatment

The therapeutic management of M. chimaera infections, in the absense of guidelines, is inferred from the management of NTM infections and is not always sufficient to achieve the therapeutic target.

- Macrolides
- Ethambutol
- Rifamycins
- Aminoglycosides

J Infect Chemother 2020;26(3):199-205

Clinical Presentation

Time to Presentation – median 21 months (5-40)

Symptoms	Fever, Fatigue, Weight loss, Shortness of breath
Signs	Splenomegaly Chorioretinitis
Laboratory Values	Anemia, Lymphocytopenia, Thrombocytopenia, Elevated CRP Elevated transaminases Elevated creatinine

Achermann Y, et al. J Clin Microbiol 2013;51:1769
Sax H, et al. Clin Infect Dis 2015;61:67
Kohler P, et al. Eur Heart J 2015;36:2745

J Infect Chemother 2020;26(3):199-205

Table 1
Case definition of M. chimaera infections potentially associated with heater-cooler units.

CLINICAL CRITERIA Any of the following: • Prosthetic valve endocarditis • Prosthetic vascular graft infection • Sternotomy wound infection • Mediastinitis • Manifestation of disseminated infection including embolic and immunologic manifestations, e.g. splenomegaly, arthritis, osteomyelitis, bone marrow involvement with cytopenia, chorioretinitis, lung involvement, hepatitis, nephritis, myocarditis.	**EXPOSURE CRITERIA** Surgery requiring cardiopulmonary bypass in the five years prior to the onset of symptoms of infection.

CONFIRMED CASE
Clinical + exposure criteria + M. chimaera detected and identified by DNA sequencing in an invasive sample (blood, pus, tissue biopsy or implanted prosthetic material)

PROBABLE CASE
- Clinical + exposure criteria + M. chimaera detected by direct PCR and amplified DNA sequencing in an invasive sample (blood, pus, tissue biopsy or implanted prosthetic material)
- Clinical + exposure criteria + MAC detected by culture or direct PCR from an invasive sample (blood, pus, tissue biopsy or implanted prosthetic material)
- Clinical + exposure criteria + histopathological detection of non-caseating granuloma and foamy/swollen macrophages with acid-fast bacilli in cardiac or vascular tissue in the proximity of the prosthetic material or in specimen from the sternotomy wound.

MAC = *Mycobacterium avium* complex.
PCR = Polymerase chain reaction.
Adapted from 2015 ECDC case definition [22].

Prolonged outbreak of *M. chimaera* infection after open-chest heart surgery

N= 6 males affected between 2006-2012

Ages 49-64

Sx: fatigue, fever, hepatitis, splenomegaly, renal insufficiency, pancytopenia

Latency of symptoms : 1.5-3.6 years

5/6 abnormal echocardiogram

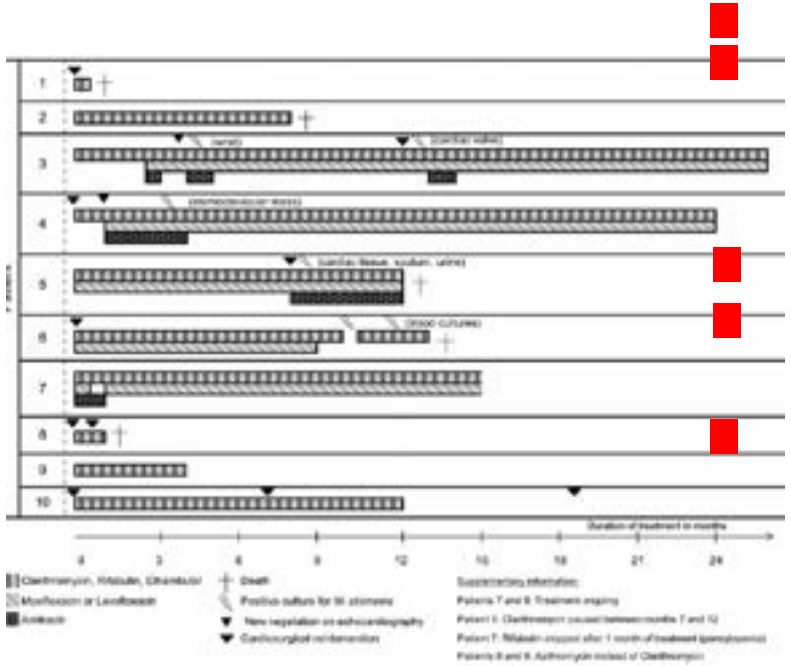
3/6 underwent PV replacement

1 repeated surgical debridement

2/6 died despite antibiotic therapy

Sax, H et al. Clinical Infectious Diseases 2015;61(1)67-75.

Healthcare associated *M. chimaera* infections subsequent to open heart surgery



- 10 patients with disseminated *M. chimaera*
- 3 European hospitals
- Latency 18 months (median)
- Diagnosis 21 months (median)
- Fever, SOB, fatigue, wt loss
- Splenomegaly
- Anemia, lymphocytopenia, thrombocytopenia
- Rx: macrolide/rifamycin/ethambutol
- +/- amikacin, quinolone
- 8/10 treatment failure, 5 deaths

Kohler P, et al. Eur Heart J 2015;36:2745-53.

J Infect. 2020 Feb;80(2):197-203. doi: 10.1016/j.jinf.2019.12.007. Epub 2019 Dec 19.

Long-term follow-up of post-cardiac surgery Mycobacterium chimaera infections: A 5-center case series

Kathleen G Julian [1], Tonya Crook [2], Eugene Curley [3], A Ben Appenheimer [4], Catharine I Paules [2], Barbara Hasse [5], Daniel J Diekema [4], Charles L Daley [6], Jorgelina de Sanctis [7], Walter C Hellinger [8], Adrah Levin [6], George McSherry [2], Carol Freer [2], Cynthia J Whitener [2]

Affiliations + expand

PMID: 31863789 DOI: 10.1016/j.jinf.2019.12.007

Disseminated *Mycobacterium chimaera* Infection After Cardiothoracic Surgery

Nicholas Tan,[1] Rahul Sampath,[2] Omar M. Abu Saleh,[2] Marysia S. Tweet,[3] Dragan Jevremovic,[4] Saba Alniemi,[5] Nancy L. Wengenack,[1,6] Priya Sampathkumar,[2] and Andrew D. Badley[2]

[1]Department of Internal Medicine, [2]Division of Infectious Disease, [3]Division of Cardiovascular Diseases, [4]Department of Hematopathology, [5]Department of Ophthalmology, and [6]Division of Clinical Microbiology, Mayo Clinic College of Medicine, Rochester, Minnesota

Tan N et el. Open forum Infect Dis 2016:3:ofw131.

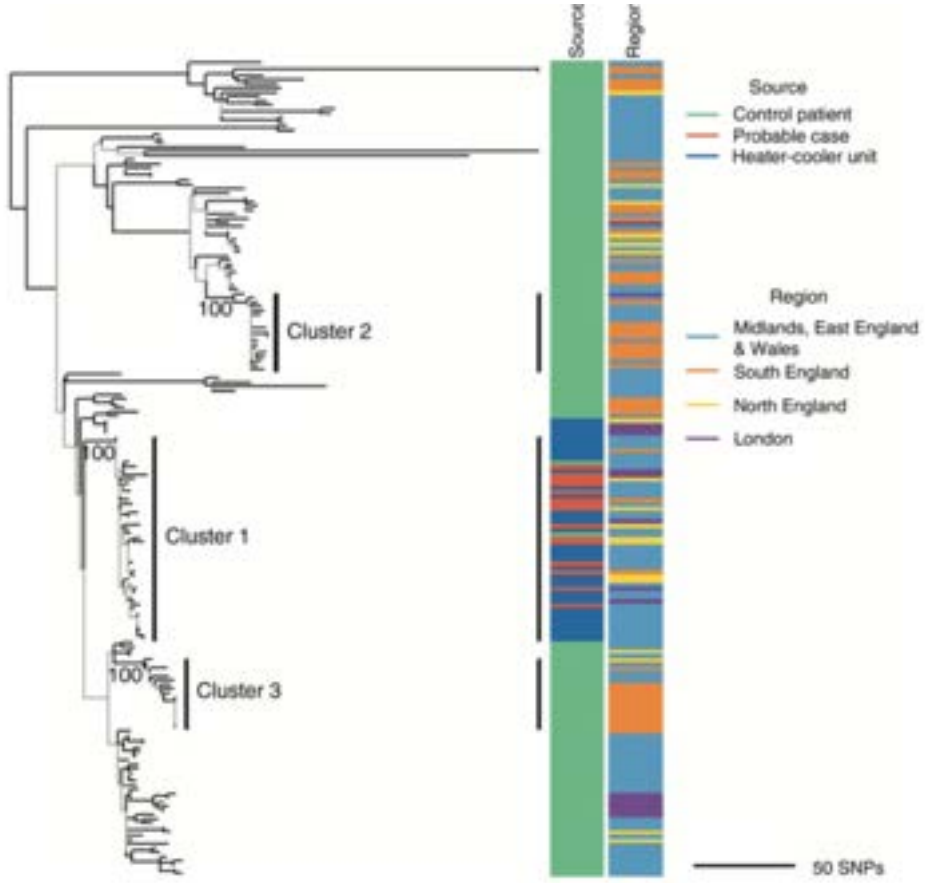
Manifestation of Infections

- Prosthetic valve endocarditis
- Vascular graft infection
- Manifestations of disseminated disease:
  - Emboli
  - Bone marrow involvement
  - Splenomegaly
  - Nephritis
  - Myocarditis
  - Osteomyelitis

Achermann Y, et al. J Clin Microbiol 2013;51:1769
Sax H, et al. Clin Infect Dis 2015;61:67
Kohler P, et al. Eur Heart J 2015;36:2745

M. chimaera typing

Phylogenetic analysis found close clustering of strains from probable cases



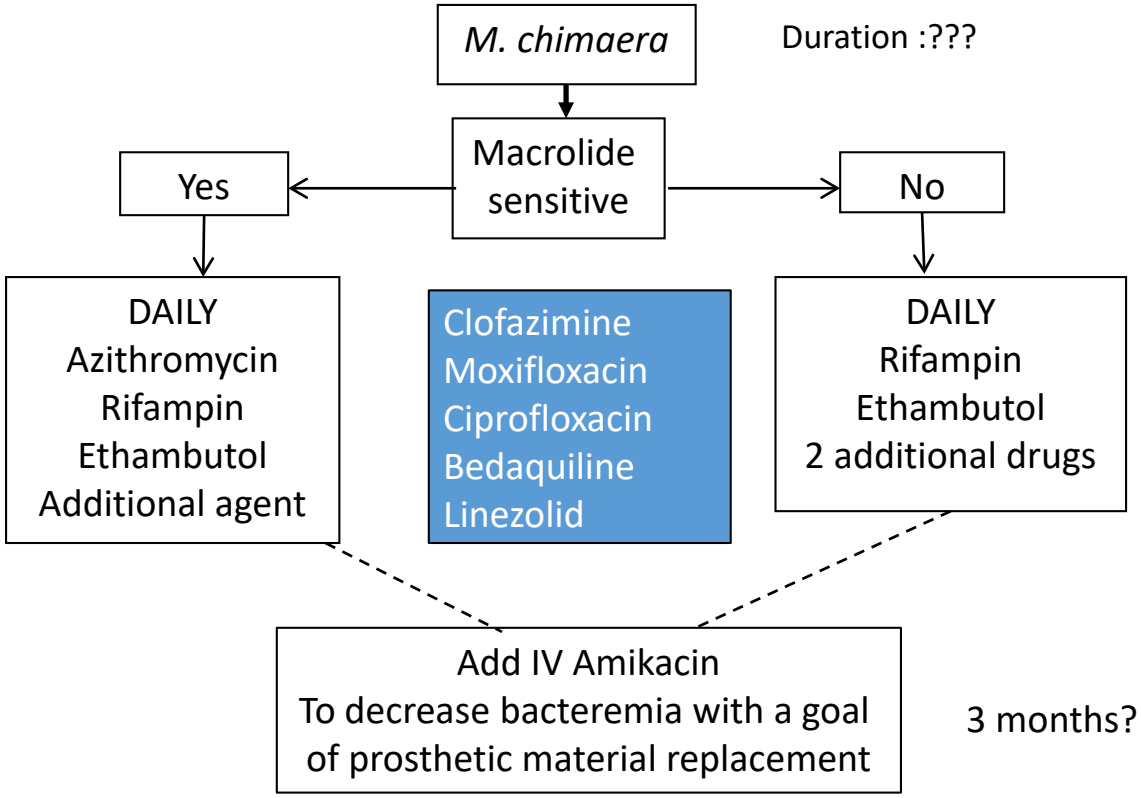
Chand et al. Clinical Infectious Diseases 2017;64 (3)335-42.

The Outbreak Summary

- An outbreak with global distribution
- Worldwide case count >=150 in 2019
- The isolates from Europe, US and Australia are genetically identical
- The source of contamination originated at the manufacturing site

Trans Am Clin Climatol Assoc. 2019;130:136-144.

Treatment Disseminated *M. chimaera*



Clin Infect Dis. 2019 Mar 19;68(7):1244-1250

Move the unit

Courtesy of Jakko van Ingen

Extrapulmonary NTM: Summary

- Sub-acute, chronic
- Consider:
  - immunocompromised patient or post-operative patient with a sub-acute presentation
- Must be have a high index of suspicion
- Avoid monotherapy
- Treatment is measured in months
- Remove all foreign material
- *M. abscessus*
  - Pathogenicity + drug resistance
  - surgical debridement is often necessary for cure

Questions ?