What Do You Mean I Caused That Surgical Complication

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KnowledgeNETWORK
KIMBERLY-CLARK HEALTH CARE EDUCATION

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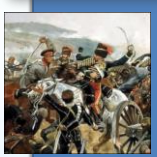
What Do You Mean I Caused That Surgical Complication

Objectives:

1. Identify the role contaminated surfaces can play in pathogen transmission
2. Explain how pathogen adaptations emphasize the criticality of prevention over treatment
3. Describe patient complications associated with lint & other foreign particles

Florence Nightingale



Crimean War 1853 - 1856

- Florence Nightingale visited wounded soldiers
- 10 times the soldiers died from infections they acquired in the hospital than directly from their battle wounds!

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Advances in Earliest Ambulatory Surgery Centers

Nightingale

- Connected cleaning & disinfection with reducing hospital infections
- Results: 6 months of disinfection dramatically reduced infections & deaths of wounded soldiers

42% wounded died before disinfection started
2% wounded died after disinfection started

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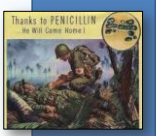
Continuing Remarkable Strides!



- 1940s World War II: first antibiotics used (penicillin)
- 1950s hygienic design into US hospital standards
- 1970-90s drugs developed to combat viruses
- 1978 United Nations so confident antibiotics and vaccines would change the world, announced:

*by the year **2000** infectious diseases would not pose a major threat to human beings even in the poorest countries !!*

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However……

- Since 1970 over 40 new human infectious diseases emerged
- 1998 alone 15 million died of infectious diseases globally
- Bacteria developing many ways to resist antibiotics and drugs depended upon for treatment!
- Over 70% of pathogens now resistant to at least one of the primary antibiotics/drugs used for there treatment

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Antibiotic/Drug Resistant Pathogens – Partial List

- Acinetobacter baumannii
- Aspergillus
- Candida albicans
- Clostridium difficile
- Diphtheroids
- Enterococcus
- Escherichia coli
- Klebsiella pneumoniae
- Morganella
- Mycobacterium tuberculosis
- Proteus
- Providencia
- Pseudomonas aeruginosa
- Salmonella
- Staphylococcus aureus
- Stenotrophomonas maltophilia
- Streptococcus pneumoniae
- Streptococcus pyogenes

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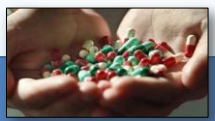
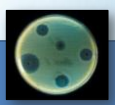
CDC Congressional Testimony 2010

Antibiotic Resistance
Threat to Public Health

"… we are potentially headed for a post-antibiotic world in which we will have few or no clinical interventions for some infections."

Thomas Frieden, M.D., M.P.H., Director Centers for Disease Control and Prevention





http://www.cdc.gov/washington/testimony/2010/t20100428.htm Accessed 9.28.10

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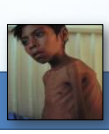
In Addition to Defending Against Treatment Drugs, Pathogens are…

- Adapting to humans as hosts rather than animals such as chickens, pigs, monkeys, prairie dogs, parrots, civet cats, mice
- Adjusting to new routes of entrance into the body
- Developing new mechanisms for causing illness (pathogenesis)
- Becoming more aggressive (virulent) to secure strongholds
- Traveling faster and further with modern transportation
- Immigrating with individuals into regions of naïve populations
- Incubating in institutionalized elderly; transported to care centers



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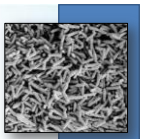
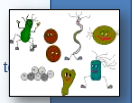
Why All The Microbial Alterations?



- They are surviving instinctually when threatened
- We are destroying their normal niches
- They've been around a lot longer than we have
- They are more evolutionarily adaptable:
  - survivors rapidly multiply – giving their survival genetics t the next generation



We just thought we were in control; we must tighten our prevention strategies and develop new weapons

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How Fast Do Bacteria Multiply (Reproduce)?

- Depends on many variables, but an example below

Time	Number of Bacteria
12:00	1
12:20	2
12:40	4
1:00	8
2:00	64
3:00	512
4:00	4,096
5:00	32,768
6:00	262,144
7:00	2,097,152!!

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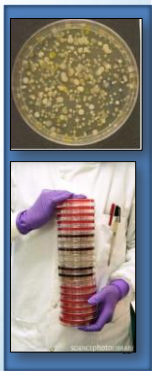
World Population To Reach 7 Billion in 2011 (Taken Est. 12,000 Years)



- Each Petri plate to the right contains 200 colonies
- Each colony started from a single bacterium
- In seven hours, total population of the 19 plates increased from 3,800 to 7.6 billion bacteria with survival-defensive attributes of initial parent

Pseudomonas: Antibiotic Resistant Bacteria + Increased Virulence

Multi drug resistant *Pseudomonas* (MDRP)

- Mariana Bridi Da Costa 20 year old finalist Brazilian stage of Miss World pageant
- 2009 hands and feet amputated to save her life one week after MDRP infection diagnosed
- Died a week later

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Enterococcus: Antibiotic Resistant + Increased Virulence

Vancomycin Resistant *Enterococcus* (VRE)

- Virulence via amplified toxins: destroy tissues
- And are resistant to Vancomycin, one of the most powerful antibiotics we have
- Whole hospital units often closed when VRE outbreaks occur

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Acinetobacter
Antibiotic Resistance + Virulence

Acinetobacter bacteria used to be harmless

- recently became resistant to many antibiotics
- causes serious infections in patients & wounded soldiers

- Hard to kill on surfaces
- Transports well on wounded troop transports

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Staphylococcus aureus: Resistance + Virulence

Robert McDougall (diabetic)

- *MRSA Staphylococcus:* resistant to many antibiotics
- A few bacteria caused tiny infection after surgery
- 19 months and 17 surgeries later: leg removed
- Spread to other leg
- "Just take it off "



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Staphylococcus aureus: Resistance + Virulence

US: David Fitzgerald

- MRSA infection after surgery
- Septic shock = damaged all limbs
- Gangrene ensued: all limbs removed
- $17.5 million by jury, but state caps on pain and suffering reduced to $7.5 million

Hanberger 2011 study in 75 countries: MRSA 50% higher death rate than infection with antibiotic sensitive *S. aureus* (MSSA)

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Hospital-Associated Infections: USA Impact Each Year

Acquire hospital infections	1,700,000
Die from those infections	99,000

Compare to:

Motor vehicle deaths	43,458
Breast Cancer deaths	42,297
AIDS deaths	16,516
	102,271






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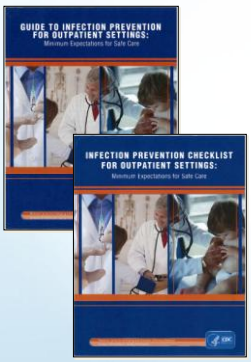
HAI from CDC NNIS 2006 survey

http://www.cdc.gov/HAI/settings/outpatient/outpatient-care-guidelines.html



CDCs Minimum Expectations for Safe Care

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CDC Audits of ASC Facilities, 2008

- 3 months: 68 facilities in Maryland, North Carolina, Oklahoma
- Audited 5 infection control categories:
  - cleanliness of the facility
  - hand hygiene
  - injection safety and medication handling
  - handling of blood glucose monitoring equipment
- 70% at least one lapse in infection control:
  - 19% failed to properly clean & disinfect surfaces in patient areas
  - 20% improper handwashing
  - 30% mishandled medications, or single-dose vials on multiple patients
  - 50% failed to handle blood glucose monitoring tools properly

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Pathogens Most Implicated In Environmental Transmission

Bacteria
- *Staphylococcus aureus* (MRSA)
- Enterococcus spp. (VRE)
- *Acinetobacter baumannii*
- *Pseudomonas aeruginosa*
- *Clostridium difficile* spores

Viruses
- Rotavirus
- Norovirus
- SARS Coronavirus
- Influenza

Fungus (esp. immune compromised wards)
- Aspergillus fumigatus
- Aspergillus flavus

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OK, many things are contaminated, but they die within minutes on dry, inanimate surfaces. **Right?**

Not Exactly!
Not Even Close!

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Survival on Dry Inanimate Surfaces

Bacteria	Survival on Dry Inanimate Surfaces
Acinetobacter	3 days to 5 months
Clostridium difficile (spores)	5 months
Escherichia coli	1.5 hours to 16 months
Enterococcus spp. Including VRE and VSE	5 days to 4 months
Pseudomonas aeruginosa	6 hours to 16 months; 5 weeks dry floors
Staphylococcus aureus (including MRSA)	7 days to 7 months
Streptococcus pyogenes	3 days to 6.5 months
Fungi/Yeast	
Aspergillus conidia (spores)	Months or longer
Candida albicans	1-120 days
Viruses	
HBV	2 hours to 60 days
HIV	More than 7 days
Papillomavirus 16	More than 7 days

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Kramer A. BMC Infect Dis 2006;6:130//(Viruses) Bonilla H F. ICHE.1996;17:770-71

Touch "Pick Up" Efficiency

- Hands contaminated from touch of contaminated surface:

Pathogen Contaminating Surface	Hand Contamination Rate
Escherichia coli	**100%**
Staphylococcus aureus	**100%**
Candida albicans	**90%**
HAV	**22% - 33%**

Contaminated hands then transferred pathogens to

- 5 or more surfaces
- 14 individuals

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(1) Scott E 1990 (E. coli, Salmonella, S. aureus; (2) Rangel-Frausto MS 1994 (Candida); (3) MbithiJN 1992 (HAV)

Gap Between Perception and Reality

Hand Hygiene Compliance Assessment Means	Compliance
Self-reported	**85%**
Estimate of compliance by co-workers	**51%**
Actual observed	**28%**

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Weinstein RA. Emerg Infect Dis. Mar-Apr 2001;7(2):188-92

Even If 100% Compliant with Handwashing How Long Are Hands Free of Pathogens?

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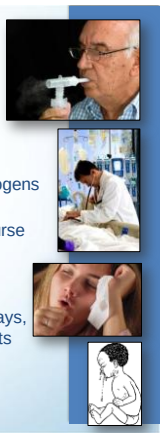
Surfaces Contaminated With Bacteria



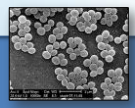
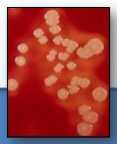
Surfaces continually being re-contaminated

- From the infected patient or HCP:
  - **droplets:** coughing, speaking, sneezing pathogens onto surfaces
  - **touch transfer:** touching table, TV remote, nurse call button, bed rail with contaminated hands
- Items contaminated by patient to other surfaces
  - **contaminated objects:** tissue boxes, food trays, gloves, thermometers, telephone, cords, charts data monitors

Even After Daily Cleaning/ Disinfection

Boyce Tested 350 surfaces in MRSA patient rooms

- 73% rooms MRSA contamination on surfaces
- 42% of the staff that touched surfaces but not patient still contaminated their gloves with MRSA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Boyce JM, 8th Annual Mtg of SHEA; April 5-7 1998, Ontario, Florida; Abstract 574:52

Acinetobacter baumannii

Catalano M: (2004) 4 month outbreak *A. baumannii*

- On bedrails 9 days post discharge & terminal cleaning
- Outbreak stopped only after thorough disinfection
- Confidence: 3 New *A. baumannii* patients resulted in no new outbreaks - credited to new disinfection program

Acinetobacter burn infection and pneumonia


Ling ML: 8 month outbreak *A. baumannii*

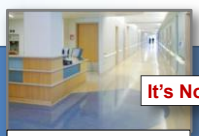
- 82 colonized and 17 infected patients
- Outbreak did not stop until thorough cleaning and disinfection of all surfaces

Conclusions: Hospital surfaces a primary source of Acinetobacter. Only way to end outbreaks is to kill them on the surfaces

Catalano M, J Hosp. Infect 1999;42:27-35//Ling ML, 2001;22:48-49

Monitoring Methods

Perception



Shiny, feels & smells good!

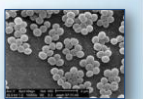
It's Not Enough!

White glove test

But when tested, hospitals did not fare well

Reality

Visibly clean	82-91%
Bacteria still present	65-70%



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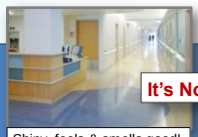
Griffith CJ, J Hosp Infect 2000;45(1):19-28

Monitoring Methods

Perception



Shiny, feels & smells good!

It's Not Enough!

White glove test

Organic Soil or Load

Blood
Urine
Food
Vomit
Saliva
Feces
Mucous
Oil supplements
Ooze from wounds
Respiratory droplets
Body oils & skin flakes

Reality

Visibly clean	82-91%
Bacteria still present	65-70%
Organic soiling still present	76-90%

Griffith CJ, J Hosp Infect 2000;45(1):19-28

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We Have To Do A Better Job

- Patient assigned a room previously occupied by a patient with any of the following infections has a greater chance of getting the same infection!
  - *Staphylococcus aureus* including MRSA
  - Vancomycin-resistant enterococcus (VRE)
  - Antibiotic-resistant *Acinetobacter* spp
  - *Clostridium difficile (C. difficile; or C. diff)*
  - *Norovirus*
- Terminal cleaning & disinfection not good enough
- Ambulatory care centers focus on treatment areas

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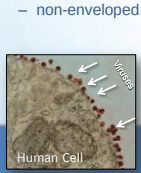
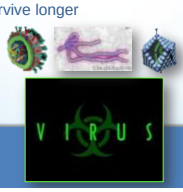
Viruses Cannot Reproduce Alone

- They take over cells forcing them to make viral copies
- One virus infected cell produces thousands to hundreds of thousands of viruses before the cell is so damaged it dies
- That's why virulent viruses so contagious and so devastating
- Viruses survive days or months on surfaces depending on type
  - enveloped viruses die out more easily
  - non-enveloped survive longer





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What They Lose in Reproduction They Make Up In Numbers Produced

Virus counts below are approximate per milliliter (mL) blood

One mL equals 1 square centimeter

- HIV: 10 to 10,000: (10^1-10^4) viruses
- HBV (hepatitis B): 10,000,000 to 10,000,000,000,000 (10^7-10^{13})
- HCV (hepatitis C): 1,000,000 (10^6)



Bennett NT 1994 American College of Surgeons 178 (2): 107 - 110

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Contaminated Exterior of Sharps Containers

- Runner: sharps container contamination
  - 90% positive for bacteria
  - 30% positive for viruses:
    - 13.3% hepatitis C
    - 10.0% HIV
    - 6.7% hepatitis A
    - 6.7% hepatitis B
- Neely: 99% of sharps containers contaminated
  - bacteria and viruses
  - instituted changes to decrease contamination
  - infection rates dropped from 5.8% to 3.2%


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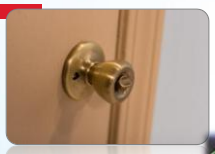
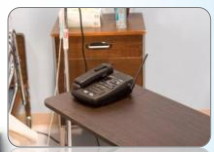
Hard to constantly be mindful of things you cannot see!

If seeing is believing ..

… Lets Visualize


- Now you have the creepy-crawlies and luminous thingies

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Why Are We Not More Successful?

- Is it education on the criticality and the nature of pathogens?
- Is it the cleaning (removal of organic contamination)?
- Is it the disinfectant?
- Is it the technique?

It's All of the Above

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Disinfectant

Type, Quality of Preparation & Techniques All Make a Difference

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First: Levels of Surface Kill Difficulty

Extremely Hard to kill

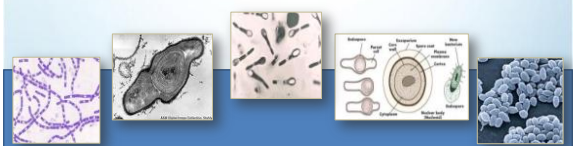
Harder to Kill

Easy to kill

Prions	Transmissible Spongiform Encephalopathy (TSE); Creutzfeldt-Jakob disease(CJD) Mad cow disease; Scrapies
Bacterial Spores	Spores of: C. difficile; C. tetanus; C. botulinum; C. perfringens; Anthrax
Mycobacteria	M. Tuberculosis (TB); M. avium; M. leprae
Viruses without envelopes	Norovirus; Rotavirus; Rhinovirus; Poliovirus; Papillomavirus (HPV); Coxsackie; Adenovirus
Fungi includes fungal spores	Aspergillus fumigatus, A. flavus; A. niger; Candida albicans
Gram negative bacteria	Pseudomonas, Acinetobacter, Klebsiella, E. coli; Enterobacter, Legionella
Gram positive bacteria	Staphylococcus; Enterococcus; Streptococcus; Clostridia vegetative rods
Viruses with lipid envelopes	Influenza; HBV; HCV; HIV; RSV; Coronavirus; CMV; HSV; Measles, Mumps; Rubella; VZV (Varicella-Zoster) Shingles/ Chickenpox

Example: *Clostridium difficile* spores Extremely Hard To Kill

- Normal cleaning and disinfection practices in most hospitals will not kill *C. difficile* spores
- They are like golf balls with layer of tough hard protection
- Below, the white or area of concentric circles are spores



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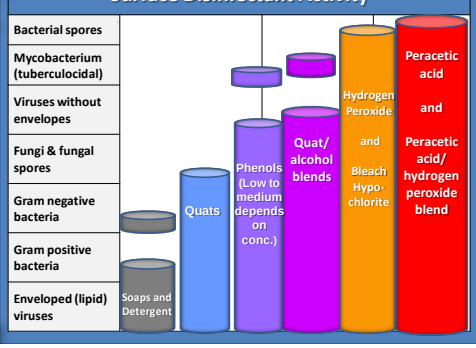
Surface Disinfectant Activity

Extremely hard to Kill

Harder to Kill

Easy to Kill

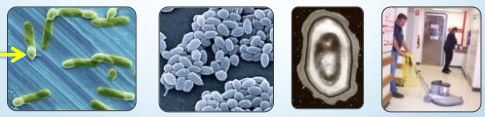


Clostridium difficile

Important: The following do NOT kill any spores

- Quaternary ammonium compounds
- Phenols
- Alcohols

They are not sporicidal



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Do Not Use Alcohol Hand Sanitizers for *C. difficile*!!!!

- Alcohol will not kill *C. difficile* spores (or any other other spores),
  - alcohol is actually used to clean and preserve spores!
- Use soap & water according to CDC or WHO instructions
- Soap cannot kill spores - "slips" them off skin and down the drain
- Careful of splashing: droplets containing spores still infectious
- Spores in sewage killed at processing plant
- Remove or disable alcohol hand sanitizer dispensers for CDAD+

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Examples of Recent ASC Infection Outbreaks & Patient Notifications

Outpatient Setting	Pathogen	Infection	Additional Patients Notified	Infection Control Breaches Reported
Allergy Clinic	Mycobacterium abscesses	Soft tissue infection	None	Inappropriate selection and dilution disinfectant
Primary Care Clinic	Staphylococcus aureus	Joint infection	None	• Inadequate hand hygiene • Incorrect disinfection of medical equipment • Contaminated multi-dose vial: treatment area

CDC

Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008

William A. Rutala, Ph.D., M.P.H.[1,2], David J. Weber, M.D., M.P.H.[1,2], and the Healthcare Infection Control Practices Advisory Committee (HICPAC)[3]

http://www.cdc.gov/HAI/settings/outpatirnt/outbreaks-patient-notifications.html

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OR Is Clean & Disinfected

Attention to:

- Preparation
- Techniques
- materials

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Microbial Hideouts

- Dermatitis, fungus or rash? – Don't scrub
- 5 cardiac patients with SSI from surgeon who had
  - onychomycosis (nail fungus) colonized with Pseudomonas
  - nail removed, treated, stopped associated patient infections
- Onychomycosis: most common nail disease of adults
  - incidence falls between 2-13%
  - up to 90% of elderly (check patient - especial toenails)
- Rash? hard to remove microorganisms on/in damaged skin
  - painful, making it difficult to scrub properly
  - broken skin provides nourishment for bacterial multiplication

Mermel LA Infect Control Epidemiol 2003;24(10):749-52

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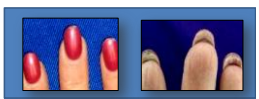
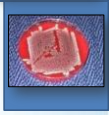
More Nails



- Artificial nails: organisms between natural nail & acrylic
  - scrubs cannot access the organisms
  - gram-negative organisms higher for artificial nails
- 1998: 89 OR nurses cultured for gram-negative bacteria
  - before scrub: artificial nails: 44% vs. 16% without
  - after 5 min. scrub: artificial nails: 37% vs. 6% without
- Passaro: *Serratia marcescens:* 7 cardiovascular SSI/1 death = artificial nails
- Malani: 27 sternal wound infections after Coronary Artery Bypass
  - 11 patients Candida albicans appearing
    - 7 patients within 28 days;
    - 4 patients within 48-150 days post-surgery (note, this is after the 30 definition)
  - 16 cases Pseudomonas aeruginosa
  - both pathogens from thumbnail onychomycosis of same circulating nurse



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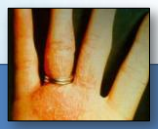
Baran R. J Cosm Dermatol 2002; 1:24-29; Passaro DJ. J Infect Dis 1997;175(4):992-5; Malani PN. Clin Infec Dis 2002;35:1316-

Rings and Things

- 10X number of bacteria on hands of nurses wearing rings
  - higher if more than one ring
  - pathogens most frequently recovered under rings after washing:
    - *Staphylococcus aureus*,
    - gram negative bacilli
    - *Candida* spp.
- Rings with sharp edges, cut gloves as can long nails



Trick WE, Clinical Infectious Diseases 2003;36:1383-90

52

Hair Is a Big Deal

- Hair: important source of *Staphylococcus*
  - proportional to length and cleanliness
- 20 group A Streptococcus SSIs for 2 years
  - settling plate collections during surgery: same Strep
  - all team members repeatedly negative
  - inventory check individual did not log in/not tested
  - she had psoriasis behind ear, colonized with Strep A
  - treatment did not prevent positive aerosolization
  - she was reassigned, and associated SSIs stopped
- Those who suffer from boils, furuncles, carbuncles: work with supervisor to treat







1.) CDC Guidelines & 198800.BAR pg 88; 2.)Mastro TM N Engl J Med

53

Head Covers

- Wear head covering that adequately covers exposed hair
  - even perfectly clean hair is a threat
- Dandruff increases bacterial and fungal shedding
  - treat and cover
- Place head covers in changing rooms so first PPE donned
  - preventing “fall-out” onto other apparel
- If personal head covers worn: fresh daily at least and low linting


54

Anesthesiology

Syringe re-use and poor disinfection: more common than you think!

- 52 surgery patients: Hepatitis C injected into IV ports using same syringe and needle by nurse anesthetist[1]
  - one-way valve made no difference
  - found if needle was changed but same syringe, same result
- Survey of 2,530 anesthesiologists: 39% reuse syringes[2]
- Another survey: 34% did not disinfect multi-use container stoppers[3]

1)Healthcare Purchasing News Nov 2002;2)Rosenberg AD. Am J Anesthesiol 1995 ;2(3):125-32;
3) Sawa T, *Anesthesiology Clinics of North America*, 1999;22:591-606

55

Examples of Recent ASC Infection Outbreaks & Patient Notifications

Outpatient Setting	Pathogen	Infection	Additional Patients Notified	Infection Control Breaches Reported
Pain Remediation Clinic	Hepatitis C Virus	Hepatitis	>2,000	• Syringe used on patient, then back into vial. • Syringe discarded but contaminated medication used on many patients
Radiology Facility	*Streptococcus salivarius*	Meningitis	NA	• Single dose vials used >1 patient • No masks worn for spinal injections
Primary Care Clinic	*Staphylococcus aureus*	Joint infection	NA	• Contaminated multi-dose vial: treatment area • Inadequate hand hygiene • Incorrect disinfection of medical equipment
Cardiology Clinic	Hepatitis C Virus	Hepatitis	1,205	• Syringe reuse
Surgical Center	Hepatitis C Virus; HIV	Hepatitis, HIV	>50,000	• Syringe reuse • Single use vial used for more than 1 patient
Multiple Gastro-enterology	Hepatitis C & Hepatitis B	Hepatitis	4,490	• Syringe reuse

http://www.cdc.gov/HAI/settings/outpatirnt/outbreaks-patient-notifications.html

56

American Civil War Devastating Minie-Ball

- Muzzle loaded rifles not accurate at distances until minie-ball invented by Claude-Étienne Miniè
- Banded design and aerodynamic shape improved accuracy
- 0.58 and 0.69 caliber (inches in diameter). Common domestic rifle bullets are 0.30 or 0.22 caliber
- Minie-ball made of soft lead with a hollow base, pancaked out when impacting the body

.69 caliber Minie-Ball

Modern .22 caliber

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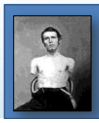
American Civil War Devastating Minie Ball



- Flattening out, increased diameter, ripping out pieces of contaminated clothing into depths of horrible wounds
- Most common Civil War surgery was amputation as death by infection was almost certain alternative.
  - just could not clean out the wound sufficiently
- If they performed the amputation within 24hours of the gunshot: 50% chance of survival – otherwise die
- 30,000 amputations performed by Union Surgeons
- Over 500,000 disfigured & disabled troops: combined North and South

58

What Does This Have To Do With The Present?

59

Foreign Bodies Increase SSI Risk

Foreign materials left in patient


- Cotton fibers & Mini-ball
- Wound drains
- Retractors
- Scissors
- Lap sponges
- Non-viable tissue left in wound
- Foreign debris:
  - hair
  - suture fragments
  - degrading implants
  - dust
  - lint
  - powder


CDC/HICPAC 1999 Prevention of SSI

60

Lint Fibers In The OR May Be Sterile, But Not Pure

- Fabric fibers soon to be lint

Coatings or absorbed substances may be:

- ✓Biocides and disinfectants
- ✓Soaps and Detergents
- ✓Fabric Softeners
- ✓Antistatic treatments
- ✓Fluid resistant treatments
- ✓Fire retardants
- ✓Anything absorbed from CS prep or in OR

61

Orthopedics: Focus on Low Particulate Surgery??

Why place instruments on lint-producing drapes when trying to reduce particulates.

....or use powdered gloves ....or expose the non-barrier gown cuff

62

Lint & Particulate Complications

- Increased infections
- Blood clots
- Granulomas
- Adhesions
- Amplified inflammation
- Poor wound healing

63

Lint and Other Particles Roles in Infection

1. Function as transport vehicle for microorganisms
2. Reduce surgical wound's ability to resist infection

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AORN 2011
Standards & Recommended Practices

- "Barrier materials used for gowns and drapes should be as lint-free as possible.
- Lint particles are disseminated into the environment where bacteria attached to them.
- This bacteria-carrying lint may settle in surgical sites and wounds with a
- resulting increase in post-operative patient complications."

Lint fiber with bacteria

Reducing Lint Reduces Surgical Site Contamination

- Before intervention cotton and spunbond/polypropylene:
  - 850 particles/m^3
  - 25 CFU/m^3
- Replacing OR staff garments with quality polypropylene:
  - 50 particles/m^3
  - 7 CFU/m^3
- Wound contamination:
  - dropped 46% during sternal surgery
  - dropped 90% during leg surgery

Verkkala. Eur J Cardio-thoracic Surg. 1998, 14 (issue) 2:206-210

66

Lint and Other Particles
Roles in Infection

1. Function as transport vehicle for microorganisms
2. Reduce surgical wound's ability to resist infection

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Routine Constant Vigilance

1) WBC receive signal of threat hug blood vessel wall

2) Macrophages squeeze through vessel wall between cells (red blood cells cannot get through)

3) Macrophage to the rescue reaches out to grab offender

4) Draws bacteria in to a small "bubble" inside (vacuole)

5) Then digests kills bacteria as enzymes dumped into vacuole

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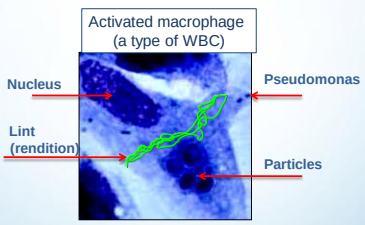
But When Lint, Powder or Other Particulates Appear…..

White blood cells act rapidly to remove debris threats



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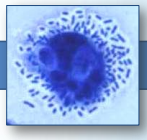
Altered Threshold for Infection



Elek:

- Wound: no particles = 10 million bacteria (10^7) to cause infection
- Wound: with suture fragment = 100 bacteria (10^2) to cause infection

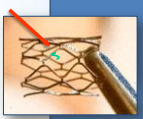
Jaffray:

- Wound: no particles = 1,000 (10^3) = 1/10 animals infected
- Wound: 2mg sterile particles = 1,000 (10^3) = 9/10 infected

70

Elek SD. *Br J Exp Pathol* 1957;38:573-86 // Jaffray DC1983 *J of Royal College of Surgeons of Edinburg* 28(4):219-22

Lint, Powder, Particulates



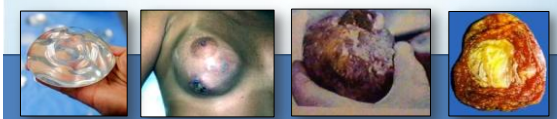
- Whelan: lint & powder deposited during stent preparation and then into vessel position:
  - increased infections
  - inflammation
  - stenosis as vessel wall grew around lint
  - clot formation

- Green: Particulates deposited on catheter then into the epidural space during anesthesia cause increased
  - fever
  - inflammation
  - infection

Whelan DM, 1997;40:328-32 // Green MA Br J Anesth 1995;75:768-770

Breast Implants

- Breast implant capsular contractures are hard scar tissues that form around the implant
- Now believe most a tissue reaction to a subclinical infection (e.g. Staphylococcus) micro-biofilm on implant surface
- Lint, powder and other particles increase likelihood
- DO NOT reprocess implants used for sizing pocket!



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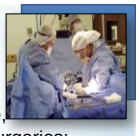
Pajkos AB 2003// Netscher D 2004// Mladick RA 2005// Netscher DT 2005

Breast Implants



- Convinced particles + few bacteria responsible, Plastic surgeon performed all breast implant surgeries:
  - Lint-free
  - No touch
  - No powder
  - No implant placement on sterile drapes
  - No touch of patient skin (even though prepped for surgery)

Eight years without a single capsular contraction!

- Little things (lint, powder, other particles matter!)
- Principle applies to all implants!!

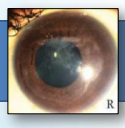
Mladick RA. Plast Reconstr Surg 2005; 1426-27

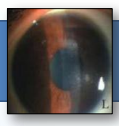
73

Lint, Microscopic Debris and Eye Surgery

2000-03 LASIK surgery one clinic:

- >100 cases diffuse lamellar keratitis
- All required re-surgery, irrigation and anti-inflammatory treatments





Cause:

- Airborne debris attracted to electric field created by ocular machinery
- Lint/particle producing fabrics in the procedure area
- Incorrectly installed filter in ventilation system

The Search for the Cause of 100+ Cases of Diffuse Lamellar Keratitis. Journal of Refractive Surgery 2002;8: 551-4

74

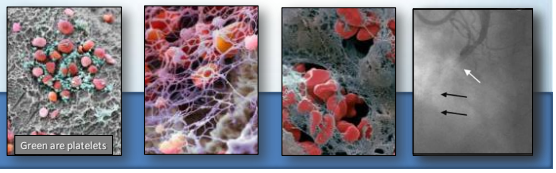
Lint & Particulates: Complications

- Increased infections
- Blood clots
- Granulomas
- Adhesions
- Amplified inflammation
- Poor wound healing

75

Lint Thrombi: "The Clot Plot" or "Snowball Effect"

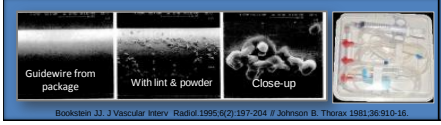
- Platelets trigger clotting cascade to wall off lint-foreign debris
- Fibrin starts to form net to trap it
- Blood cells and platelets catch in net form clot:
  - cycle continues "snow-balling"
  - clot expands, may clog catheter
  - break free into bloodstream = lint emboli



Guidewires, Catheters: Attract Lint, Create Thrombi & Emboli

- Static "cling" attraction
- Some deposited inside catheter from guidewire
- Caused clots to form within catheter lumen
- Clots inside lumen can
  - impede flow
  - increase risk of infection
  - break lose – becoming lint-emboli

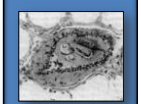
Bookstein



Bookstein JJ. J Vascular Interv Radiol.1995;6(2):197-204 // Johnson B. Thorax 1981;36:910-16.

Johnston

Lint pulmonary emboli



24 hrs after cellulose entered pulmonary bloodstream

Lint granuloma: Emboli to lung tissue

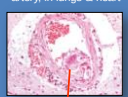
Lint Thrombi Clinical Consequences

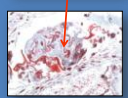
- Lint-emboli can also clog narrow vessels in the
  - brain
  - heart
  - lungs
- Surrounding tissues starved of blood die (infarction)

Rarely are clots histologically examined for cause

62 yr old Male brain infarct caused by lint-emboli

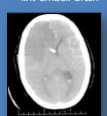
Lint-emboli, perforated artery, in lungs & heart





Shannon P 2006

62 yr old Female lint-emboli brain



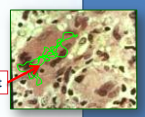
Lint-emboli surrounded by inflammatory cells

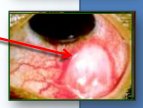
Shannon P. AJNR.2006;27:278-81

Causes Foreign Body Reaction

The Process:

- White cells merge to wall off fibers
- Then comes the fibrin
- Then comes the collagen
- …And we have a **granuloma**





General Surgery:

- 45 cases of granulomatous disease
- Mild to severe consequences
- 18 intra-peritoneal: peritonitis
- 27 extra-peritoneal sites

Peritonitis with ascites & granulomas

Histopathology: Cellulose fibers from newly purchased drapes

Tinker MA. The Amer Jr Surg 1977; 133:134-9

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Cellulose Fiber Complications

Number of Patients	Complications Presented
6	▪ Severe granulomatous peritonitis: ▪ One death
6	▪ Acute abdominal pain ▪ Intestinal obstruction ▪ Dense, thick adhesions: Required adhesiolysis
6	▪ Required re-operation; without diffuse peritonitis
6	▪ Treated with steroids; without surgery

Histopathology: Cellulose fibers caused granulomas and adhesions

Janoff: American Journal of Surgery

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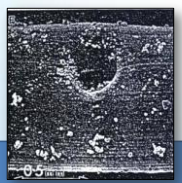
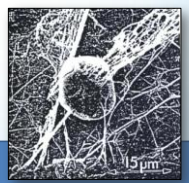
Example of Walling Off Threat

- Body deposits fibrin trying to wall off particles, protecting body

Sterile particles on epidural catheter surface



Fibrin strands lash powder to surface of catheter - 26hrs



Green MA. Brit J Anaesth

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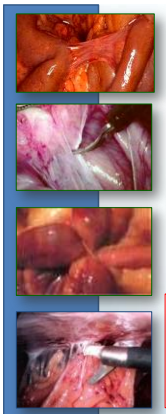


Adhesions

- Fibrin deposited to wall off particles
- If particles persists, adhesions thicken
- Granulomas often at center of adhesion
  - Lint, powder and other particulates like biofilm chunks at center of the granuloma
- Adhesion contracts causing pain; can strangle organs or their blood supplies

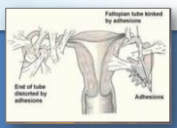
1 month after kidney stone removed from ureter
- Severe pain
- Thick adhesions caused by particles from surgery
- Adhesions strangled kidney blood supply
- Lost kidney

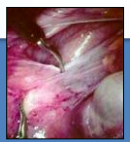
82

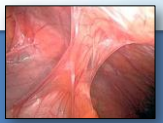
L Holmdahl, Eur J Surg 1997; Suppl 577:56-62; Jeekel H, Eur J of Surgery 1997; 163 Supp 579: 43-45; Chenoweth C. 1981 Urology

Consequences of Adhesions

- 60-80% intestinal obstructions due to post-surgical adhesions (FDA, 1997)
- 10% mortality for adhesiolysis to relieve intestinal obstruction USA (Mintzes)
- 50% abdominal hysterectomy patients, developed adhesion-related complications requiring hospitalization at some time in their life (SCAR)
- Infertility and ectopic pregnancies often caused by adhesions in/on fallopian tubes or ovaries after surgery on local or remote site







Journal of the American College of Surgeons, Vol. 186, No. 1, January 1998: pp.1-9//Holmdahl L. Adhesions: Pathogenesis and Prevention 83
Panel Discussion and Summary. Eur J Surg 1997; Suppl 577:56-62//Lower AM, 10 year SCAR study. *BJOG*. 2000;107(7):855-862.

Identify Causes and Eliminate

- Duron excised chronic adhesions: histopathology shown in chart
- Eliminating the cause of chronic adhesions prevents their existence

	JJ Duron 1997
Lint / Fibers	80%
Cornstarch Glove Powder	3%
Sutures	2%

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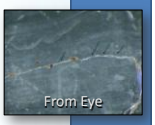
Duron JJ, Eur J Surg 1997; 579(Suppl),15-16

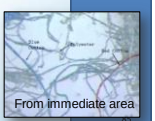
Ophthalmic Surgery

Lint on instruments into the eye?

On air currents into the eye?



Impact?



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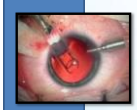
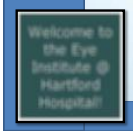
Intraocular Lens

- Debris attracted to plastic sleeves
- Contaminate lens during insertion
- Endophthalmitis
- Toxic lens syndrome

"With the potential to make curable blindness incurable"



- Synechiae



Fiber actually removed from eye

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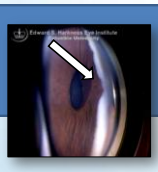
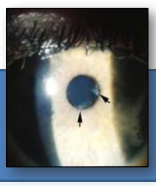
Adhesions After Ophthalmic Surgery

- Ophthalmic surgery where adhesions are: Synechiae





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ASCRS/ASORN Guidelines

- ASCRS/ASORN Guidelines: “All materials should be low linting”
- Debris attracted to plastic sleeve: deposited with intraocular lens on insertion: Powder, lint, phakic debris, detergent residue, etc.
- Fibers can enter the anterior chamber during or after surgery
- Toxic Anterior Segment Syndrome (TASS), sterile ophthalmitis, toxic lens syndrome, fibrosis can all be intiated by lint & debris

ASCRS/ASORN Recommended Practices for Cleaning and Sterilizing of Intraocular Surgical Instruments, 2007

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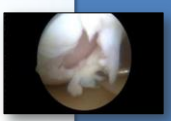
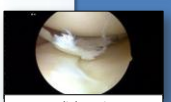
Torn Meniscus Repair

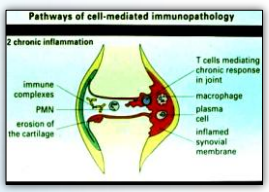
- Leaving pieces of meniscus in knee
  - pain
  - irritation
  - set up for arthritis
- Depositing lint, dried biofilm chunks, debris there
  - pain
  - irritation
  - set up for arthritis





Knee medial meniscus Tear

Amplified Inflammation In Orthopedics Limits Quality of Life



White Blood Cells attack foreign debris as defense, but end up injuring healthy tissues

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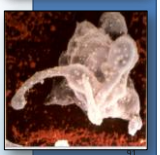
When Lint or Other Particles Enter Into Any Wound

- Cell and tissue injury occurs due to:
  - physical abrasion
- Cell and tissue damage due to
  - neutrophil (white cell aka PMN) disperses chemical/enzymes onto surrounding tissues
  - inflammation
  - tissue injury
  - pain
  - set-up for arthritis if chronic



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Quality of Healed Tissue Is Sub-Optimal

- Increased scar volume hurting aesthetics
- Decreased scar
  - strength
  - toughness
  - resilience
  - flexibility
- Delayed healing
- Increased risk of infection
- Increased risk of dehiscence (especially if reacting to chemicals)

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Supplying The OR With Particles

Potential lint sources:

- Gowns
- Drapes
- Table covers
- Sterilization wrap
- Instrument tray liners
- Drying mats for drain and dry

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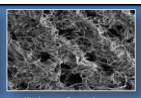
Materials Themselves


Cellulose drape


Cellulose & polyester


Polypropylene

- Guidewires, dilators, catheters set on and dragged across sterile drape:
  - break off lint
  - attract lint to surface of guidewires and catheters by static cling
- Lint then co-inserted with device into circulating blood or inside catheter
- Linting amount varies; cellulose highest linter (cellulose = paper, cotton)
  - high: full paper drapes or paper-synthetic combinations
  - high: paper fenestration in any drape
  - high: cotton materials
  - extremely low: polypropylene
- Cellulose fibers are both:
  - high linting
  - very bioactive foreign bodies

…More Particles Headed For The OR

- Absorbent towels
- Tip cushions
- Materials used to lock hemostats open
- Lint producing warming blankets

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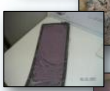
CS Particle Sources

- Sweaters hung in open areas
- Wearing fleece vests
- Sweeping or dry dusting
- Areas that are out of reach to clean
- Transport carts poorly cleaned
- Worn or corroded re-useables
- Poor air filtration systems



Can end up in the pack….and in the patient!!

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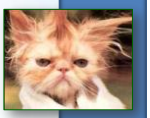
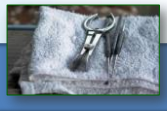
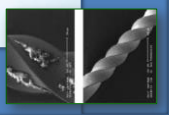
It's The Little Things!

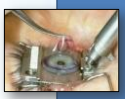


- Dust / dirt / hair
- Particles from poorly cleaned re-useable instruments:
  - tissue fragments
  - dried blood
  - fat clumps
  - feces
  - biofilm fragments





Patient and Environment



- Lint producing carpets, furniture, curtains
- Patient apparel and hair
- Quality of air filtration
- Quality of environmental services cleaning

Inadequate Instrument Processing

Proper Device Preparation

Pre-clean per endoscope reprocessing guidelines

SGNA

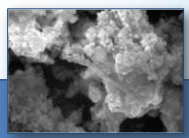
"Immediately after removing the endoscope from the patient, wipe the insertion tube with the wet cloth or sponge soaked in the freshly prepared enzymatic detergent solution."

According to Manufacturer's Instructions

Bolander S 2005 SGNA Standards of Infection Control in Reprocessing of Flexible Gastrointestinal Endoscopes

APIC Guideline for Infection Prevention and Control in Flexible Endoscopy

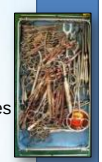
- Encrustations of patient material (blood, feces, gastric mucin) inside scope even though flushed and brushed before disinfection
- Contributes to disinfection failures by harboring microbial biofilm preventing germicide penetration
- Some disinfectants are inactivated by organic material (ex. bleach)

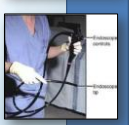


Alvarado CJ. AJIC Am J Infect Control 2000;28:138-55

Improper Cleaning and Disinfection

- Breaches in disassembly, cleaning, disinfection guidelines
- Not following manufacturers instructions
- Inadequate or contaminated cleaning agents
- Inappropriate or poorly prepared germicides
- Improper or inadequate drying
- Defective damaged instruments or equipment
- Contaminated rinse water
- Contaminated germicide



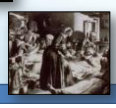


Rutala WA APIC Text 2005 Vol 1: Essential Elements 2005 Chapter 21

So Many Opportunities!!








- To reduce post-operative complications:
  - infections
  - blood clots
  - granulomas
  - adhesions
  - amplified inflammation
  - poor wound healing
  - excessive scaring
  - damage to visual acuity

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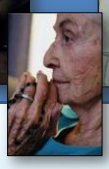
Patients Entrust Their Quality Of Life And Life Itself Into Our Care





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Remember

With…

- the best Practices
- the right up-to-date Products & Technologies
- an embraced attitude of Continuous Improvement
- an inner realization that we alter people's lives daily

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We Can All Win!!

Staff are Proud of it

Accounting loves it

Thank You!

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QUESTIONS?

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