What’s the environment got to do with it?

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Golden Rules of Infection Prevention

- Hand hygiene
- Environmental hygiene
- Engineered processes of care
Hand Hygiene

Hand Hygiene Hospital-wide 2008-2016

percent compliance


Percent Compliance
Bundle implementation (SSI prevention)

• Pharmacologic
  – Mechanical bowel prep
  – Oral antibiotics the day prior to surgery (Correct drugs, doses)
  – Prophylactic intravenous antibiotics (Appropriate selection, timing, re-dosing, post op limitation)

• Non Pharmacologic
  – Preoperative showers
  – Appropriate hair clipping
  – Appropriate skin prep
  – Maintain body temperature
  – Postoperative oxygenation
  – Laparoscopic when possible

• Technical
  – Reduce intraoperative contamination -- minimize spillage
  – Maintain “clean” areas separate from contaminated
  – Change gloves, gowns, suction, bovie tip
  – Protect superficial wound
  – Recognize high risk situations -- Delayed primary closure

• Systematic
  – Time-out
  – Check list
  – Debriefing form
  – Quarterly data review
NATIONAL ACUTE CARE HOSPITALS

Healthcare-associated infections (HAIs) are infections patients can get while receiving medical treatment in a healthcare facility. Working toward the elimination of HAIs is a CDC priority. The standardized infection ratio (SIR) is a summary statistic that can be used to track HAI prevention progress over time; lower SIRs are better. The infection data are reported to CDC’s National Healthcare Safety Network (NHSN).

HAI data for nearly all U.S. hospitals are published on the Hospital Compare website. This report is based on 2014 data, published in 2016.

**CLABSIs**
- **50% LOWER COMPARED TO NAT'L BASELINE**

Central Line-Associated Bloodstream Infections

When a tube is placed in a large vein and not put in correctly or kept clean, it can become a way for germs to enter the body and cause deadly infections in the blood.

- U.S. hospitals reported a significant decrease in CLABSIs between 2013 and 2014.
- 10% Among the 2,442 hospitals in U.S. with enough data to calculate an SIR, 10% had an SIR significantly higher (worse) than 0.50, the value of the national SIR.

**CAUTIs**
- **0% NO CHANGE COMPARED TO NAT'L BASELINE**

Catheter-Associated Urinary Tract Infections

When a urinary catheter is not put in correctly, not kept clean, or left in a patient for too long, germs can travel through the catheter and infect the bladder and kidneys.

- U.S. hospitals reported a significant decrease in CAUTIs between 2013 and 2014.
- 12% Among the 2,880 U.S. hospitals with enough data to calculate an SIR, 12% had an SIR significantly higher (worse) than 1.00, the value of the national SIR.

**MRSA Bacteremia**
- **13% LOWER COMPARED TO NAT'L BASELINE**

Laboratory Identified Hospital-Onset Bloodstream Infections

Methicillin-resistant Staphylococcus aureus (MRSA) is bacteria usually spread by contaminated hands. In a healthcare setting, such as a hospital, MRSA can cause serious bloodstream infections.

- U.S. hospitals reported a significant decrease in MRSA bacteremia between 2013 and 2014.
- 8% Among the 2,042 U.S. hospitals with enough data to calculate an SIR, 8% had an SIR significantly higher (worse) than 0.87, the value of the national SIR.

**SSIs**

Surgical Site Infections

When germs get into an area where surgery is or was performed, patients can get a surgical site infection. Sometimes these infections involve only the skin. Other SSIs can involve tissues under the skin, organs, or implanted material.

- U.S. hospitals reported no significant change in SSIs related to abdominal hysterectomy surgery between 2013 and 2014.
- 6% Among the 794 U.S. hospitals with enough data to calculate an SIR, 6% had an SIR significantly higher (worse) than 0.83, the value of the national SIR.

- U.S. hospitals reported a significant increase in SSIs related to colon surgery between 2013 and 2014.
- 8% Among the 2,051 U.S. hospitals with enough data to calculate an SIR, 8% had an SIR significantly higher (worse) than 0.98, the value of the national SIR.

**C. difficile Infections**

Laboratory Identified Hospital-Onset C. difficile Infections

When a person takes antibiotics, good bacteria that protect against infection are destroyed for several months. During this time, patients can get sick from *Clostridium difficile* (C. difficile), bacteria that cause potentially deadly diarrhea, which can be spread in healthcare settings.

- U.S. hospitals reported a significant increase in C. difficile infections between 2013 and 2014.
- 11% Among the 3,554 U.S. hospitals with enough data to calculate an SIR, 11% had an SIR significantly higher (worse) than 0.92, the value of the national SIR.

*Statistically significant*
Contaminated surfaces

- 70% of surfaces in colonized patients’ rooms are contaminated with MRSA or VRE or C. difficile.
  - Countertops
  - Bedrails
  - Equipment
  - Telephone, call button
- More than half the patients who became colonized with MRSA after entering the ICU acquire a strain **NOT** present on other patients there at the time.
- Once caregivers touch these surfaces, their hands or gloves are contaminated.

_Infection Control and Hospital Epidemiology_ (v. 9, 1997) 622-627.
_Infection Control and Hospital Epidemiology_ (v.20.2, 2006).
Survival of Multi-drug-resistant Organisms in the Environment

• Duration of survival of MRSA in dry conditions
  – Plastic charts = 11 days
  – Laminated table top = 12 days
  – Cloth curtains = 9 days

• Environmental survival of VRE
  – Upholstery, furniture and wall coverings = 7 days

• Survival of Clostridium difficile
  – Months

Huang et al, Infect Control Hosp Epidemiol 2006;27:1267-1269
Lankford et al, Am J Infect Control2006;34:258-263
Keyboards, Telephones, Equipment – all harbor Staph, Strep, and other Pathogens
Many personnel don’t realize when they have microorganisms on their hands

Nurses, doctors and other healthcare workers can get thousands of bacteria on their hands by doing simple tasks, like

- pulling patients up in bed
- taking a blood pressure or pulse
- touching a patient’s hand
- rolling patients over in bed
- touching the patient’s gown or bed sheets
- touching equipment like bedside rails, over-bed tables, IV pumps

Culture plate showing growth of bacteria 24 hours after hand placed on the agar plate
Role of asymptomatic carriage of *C. difficile* in patients at a LTCF


- 68 asymptomatic patients in LTCF
- 51% carriers of *C. difficile*
  - 49% of these had NAP-1 strain
- Carriers had high skin (61%) carriage
  - versus 70% in CDI cases
- Carriers had high environmental (59%) contamination
  - Versus 70% in CDI cases and 20% in non-carriers
- Prior CDI and recent (<3 mo) antibiotic use was associated with carriage
- 20% of carriers developed CDI over 4 mo follow-up
Where are the germs?
Where are the germs?
Why Aren't Hospitals Cleaner?

Not all deadly infections come from dirty hands

By Betsy McCaughey
Posted 7/15/07

Restaurants and cruise ships are inspected for cleanliness. Food processing plants are tested for bacterial content on cutting boards and equipment. But hospitals, even operating rooms, are exempt. The Joint Commission, which inspects and accredits U.S. hospitals, doesn’t measure cleanliness. Neither do most state health departments, nor the federal Centers for Disease Control and Prevention.

No wonder hospitals are dirty. New data presented in April at the annual meeting of the Society for Healthcare Epidemiology of America documented the lack of hygiene in hospitals and its relationship to deadly infections. Boston University researchers who examined 49 operating rooms found that more than half of the objects that should have been disinfected were overlooked. A study of patient rooms in 20 hospitals in Connecticut, Massachusetts, and Washington, D.C., found that more than half the surfaces that should have been cleaned for new patients were left dirty.

Germ-coated. Sad to say, cleanliness is not a priority for hospital administrators or most medical professionals. A new University of Maryland study shows that 55 percent of physicians and other medical professionals admitted they hadn’t washed their lab coat in at least a week, even though they knew it was dirty. Nearly 16 percent said they hadn’t put on a clean lab coat in at least a month. Lab coats become covered in bacteria when doctors lean over the bedsides of patients who carry the organisms. Days later the bacteria are still alive, repeatedly contaminating doctors’ hands and being carried to other patients.

The CDC and other organizations urge caregivers to clean their hands between patients, and even advise patients to speak up and request that caregivers have clean hands.

That’s a start, but it’s not enough. As long as hospitals are inadequately cleaned, doctors’ and nurses’ hands will be recontaminated seconds after they are washed—when they touch a keyboard, open a supply closet, pull open a privacy curtain, or contact other bacteria-laden surfaces. In a recent Johns Hopkins Hospital study, 26 percent of supply cabinets were contaminated with a dangerous bacterium, methicillin-resistant Staphylococcus aureus (MRSA) and 21 percent with another stubborn germ,
The Challenge: to create an effective environmental hygiene program

- Cleaning Policies & Procedures
  - Everyone’s job!
  - Daily cleaning and terminal cleaning
  - High touch surfaces focus
  - Equipment cleaning
  - “Rolling stock” management
  - Unit core cleaning
- Staff need education on an ongoing basis.
- Check list for room cleaning
- Room turn-over time for an isolation patient takes approximately 45-60 minutes.
- Staff should be routinely evaluated on performance
  - Direct and Clandestine observation
Elements of the Interdisciplinary Cleaning and Disinfection Initiative

- Program implemented October, 2005
- Use of a fluorescent marker to detect surface cleaning
- Collaborative evaluation of cleaning process
- Nursing service performed cleaning assessments
- Ongoing evaluation of effectiveness
  - Group feedback to housekeeping department at large
  - Personal feedback on individual performance to manager
- Incorporation into performance management process
Environmental Sites Testing

- Toilet seat
- Toilet handle
- Toilet hand hold
- Sink
- Sink faucet handle
- BR door knob
- BR light switch
- Telephone
- TV control / call switch
- Side rails
- Tray table
- Bedside table
- Chair hand rail
- Room door knobs
Improving Cleaning of the Environment Surrounding Patients in 36 Acute Care Hospitals

Philip C. Carling, MD; Michael M. Parry, MD; Mark E. Rupp, MD; John L. Po, MD, PhD; Brian Dick, MS, CIC; Sandra Von Beheren, RN, BSN, MS, CIC; for the Healthcare Environmental Hygiene Study Group

OBJECTIVE. The prevalence of serious infections caused by multidrug-resistant pathogens transmitted in the hospital setting has reached alarming levels, despite intensified interventions. In the context of mandates that hospitals ensure compliance with disinfection procedures of surfaces in the environment surrounding the patient, we implemented a multihospital project to both evaluate and improve current cleaning practices.

DESIGN. Prospective quasi-experimental, before-after, study.

SETTING. Thirty-six acute care hospitals in the United States ranging in size from 25 to 721 beds.

METHODS. We used a fluorescent targeting method to objectively evaluate the thoroughness of terminal room disinfection cleaning before and after structured educational and procedural interventions.

RESULTS. Of 20,646 standardized environmental surfaces (14 types of objects), only 9,910 (48%) were cleaned at baseline (95% confidence interval, 43.4–51.8). Thoroughness of cleaning at baseline correlated only with hospital expenditures for environmental services personnel ($P = .02$). After implementation of interventions and provision of objective performance feedback to the environmental services staff, it was determined that 7,287 (77%) of 9,464 standardized environmental surfaces were cleaned ($P < .001$). Improvement was unrelated to any demographic, fiscal, or staffing parameter but was related to the degree to which cleaning was suboptimal at baseline ($P < .001$).

CONCLUSIONS. Significant improvements in disinfection cleaning can be achieved in most hospitals, without a substantial added fiscal commitment, by the use of a structured approach that incorporates a simple, highly objective surface targeting method, repeated performance feedback to environmental services personnel, and administrative interventions. However, administrative leadership and institutional flexibility are necessary to achieve success, and sustainability requires an ongoing programmatic commitment from each institution.

Infect Control Hosp Epidemiol 2008; 29:1035-1041
Environmental Cleaning SH Overall Progress

High touch surface cleaning results 2011-2016

Minimum target
Percent of surfaces cleaned 10/12 to 6/15

The bar chart shows the percentage of different surfaces cleaned during the specified period. The surfaces include Toilet Seat, Toilet Handle, Sink Top, BR Light Switch, BR Door Handle, Bed Rail, Bed Table, Telephone, Call Box, Tray Table, PT Chair Rail, and Room Dr Handle. The percentages range from 0% to 100%, with most surfaces reaching or exceeding 80% cleaned.
Incidence of Hospital-acquired *Clostridium difficile* Infection.

Difficulties in controlling the spread of *C. difficile*

- **High community prevalence**
  - especially LTAC (30-50%); SNF (10-20%); community (3-6%)
- **Difficulty preventing infection in high risk settings** – “incident density” pressure
  - carriers + ill
- **Hospital “onset” versus hospital “acquisition”**
- **Antibiotic use and the microbiome**
  - necessary and unnecessary
  - breadth and length and type of rx
- **Prevalence of acid suppression therapy**
  - VAP prevention; other order sets
- **Prolonged fecal and skin carriage**
  - Clinically successful treatment doesn’t eradicate the spore
- **Frequent recurrence**
  - Treatment, age and immunocompetence dependent
- **Persistence of spores in the environment**
  - Resistance to germicides
  - Patient ingestion
Persistence of *C. difficile*
During and After Treatment

Percentage of positive cultures for *C. difficile* before, during, and after treatment

Prior to treatment | Day 3 of treatment | Resolution of diarrhea | End of treatment | 1-6 weeks after treatment

- **Stool**
- **Skin**
- **Environment**

Wafa Al Nassir, et al. Cleveland VA. ICHE, 2010
Diverse Sources of C. difficile Infection Identified on Whole-Genome Sequencing

David W. Eyre, B.M., B.Ch., Madeleine L. Cule, Ph.D., Daniel J. Wilson, D.Phil., David Griffiths, B.Sc., Alison Vaughan, B.Sc., Lily O’Connor, B.Sc., Carmilla L.C. Ip, Ph.D., Tanya Golubchik, Ph.D., Elizabeth M. Batty, Ph.D., John M. Finney, B.Sc., David H. Wyllie, Ph.D., Xavier Didelot, D.Phil., Paolo Piazza, Ph.D., Rory Bowden, Ph.D., Kate E. Dingle, Ph.D., Rosalind M. Harding, Ph.D., Derrick W. Crook, M.B., B.Ch., Mark H. Wilcox, M.D., Tim E.A. Peto, D.Phil., and A. Sarah Walker, Ph.D.

RESULTS

Of 1250 C. difficile cases that were evaluated, 1223 (98%) were successfully sequenced. In a comparison of 957 samples obtained from April 2008 through March 2011 with those obtained from September 2007 onward, a total of 333 isolates (35%) had no more than 2 SNVs from at least 1 earlier case, and 428 isolates (45%) had more than 10 SNVs from all previous cases. Reductions in incidence over time were similar in the two groups, a finding that suggests an effect of interventions targeting the transition from exposure to disease. Of the 333 patients with no more than 2 SNVs (consistent with transmission), 126 patients (38%) had close hospital contact with another patient, and 120 patients (36%) had no hospital or community contact with another patient. Distinct subtypes of infection continued to be identified throughout the study, which suggests a considerable reservoir of C. difficile.

CONCLUSIONS

Over a 3-year period, 45% of C. difficile cases in Oxfordshire were genetically distinct from all previous cases. Genetically diverse sources, in addition to symptomatic patients, play a major part in C. difficile transmission. (Funded by the U.K. Clinical Research Collaboration Translational Infection Research Initiative and others.)
Panel A shows the number of single-nucleotide variants (SNVs) between each sample obtained during the period from April 1, 2008, through March 31, 2011, and the most closely related previous sample obtained after September 1, 2007. Panel B shows the percentages of isolates that were classified as genetically related, according to the different SNV thresholds, along with the epidemiologic links between related isolates.
Table 1.

Trends in number and rate of CDI by year and community-associated or healthcare-associated status, New Haven County Connecticut, 2011-2015

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<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>% Δ</th>
<th>X² Trend</th>
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<td>cases</td>
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<td>185</td>
<td>168</td>
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<td>p&lt;0.001</td>
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<tr>
<td>cases</td>
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<td>1146</td>
<td>1001</td>
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<td>159</td>
<td>137</td>
<td>134</td>
<td>117</td>
<td>104</td>
<td>-35%</td>
<td>p&lt;0.001</td>
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<tr>
<td>cases</td>
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<td>407</td>
<td>433</td>
<td>434</td>
<td>542</td>
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<td>48</td>
<td>51</td>
<td>51</td>
<td>63</td>
<td>+37%</td>
<td>p&lt;0.001</td>
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</table>

Figure 1.

Number and Rate of Incident CA and HA Clostridium difficile Infection
New Haven County, CT 2011-2015
Stamford Hospital-acquired *C. difficile*

![Hospital-associated C. difficile](chart.png)
Environmental Cleaning and C difficile Rates

![Chart showing cleaning rates and C difficile rates from 2011 to 2016.](chart.png)

- Cleaning rate (percent)
- C difficile rates (cases per 10,000 pt-days)

- Cleaning percentage
- CDI rate

Yearly data points:
- 2011: 90% cleaning, 10 cases
- 2012: 95% cleaning, 8.5 cases
- 2013: 80% cleaning, 9 cases
- 2014: 90% cleaning, 7 cases
- 2015: 100% cleaning, 5 cases
- 2016: 95% cleaning, 8 cases
C. difficile bundle

- Environmental cleaning program
- Bleach / peracetic acid program
- Daily and terminal cleaning
- Isolation for C diff
  - Gown and Glove
  - Soap and water
  - Duration of hospitalization
- Rapid detection
  - PCR
  - Isolate for diarrhea
  - Readmission flag
- Dedicated equipment
  - Yellow stethoscopes; disposable BP cuffs, thermometers, etc
  - No rectal temperatures
- Treatment initiatives – vancomycin and fidaxomycin
- PPI reduction initiative
- Antibiotic stewardship program
- Fecal transplantation program
- New Hospital initiatives
The New Stamford Hospital
What help is on the horizon?

- Antimicrobial surface engineering
  - Copper, silver
  - Nanotechnology
  - Fabrics (curtains, scrubs, linens)
- UV light and other light technologies
- Aerosols
- Focus on the microbiome
  - Fecal transplantation
  - Synthetic stool
  - Alternative treatment modalities
- Focus on the immune system
  - Monoclonal antibodies
  - Immunization
Microbial Load on Environmental Surfaces: The Relationship Between Reduced Environmental Contamination and Reduction of Healthcare-Associated Infections (The BETRDisinfection Study)

ID WEEK Abstract 262, 2016

WILLIAM RUTALA, et al University of North Carolina Health Care, Chapel Hill, NC

Background: Disinfection of noncritical environmental surfaces and equipment is an essential component of infection prevention as surfaces may contribute to cross-transmission of epidemiologically important pathogens (EIPs).

Results: Enhanced disinfection interventions (i.e., Quat/UV, Bleach, Bleach/UV) were significantly superior to a Quat alone in reducing EIPs.

Conclusion: Comparison of the best strategy with the worst strategy (i.e., Quat vs Quat/UV or Bleach/UV) revealed that a reduction of >90% in EIPs led to a 35% decrease in subsequent patient colonization/infection. Our data demonstrated that a decrease in room contamination was associated with a decrease in subsequent patient colonization/infection.
Antimicrobial Activity of a Continuous Visible Light Disinfection System

ID WEEK Abstract 267, 2016

WILLIAM RUTALA and DANIEL SEXTON, et al. University of North Carolina, Chapel Hill, NC and Duke University Medical Center, Durham, NC

Background: An overhead light fixture technology, which continuously and safely disinfects the environment was assessed to determine the effectiveness for the reduction of EIP. This technology creates a narrow bandwidth of high-intensity visible blue light with a peak output of 405nm that generates reactive oxygen species and kills microorganisms.

Results: These results demonstrated that the 405nm light inactivated three vegetative bacteria (MRSA, VRE, MDRA) on surfaces with contact times of 1-96hr. Statistical differences (p< 0.05) were observed using blue light for VRE at 24 hr, for MRSA at 3-7hr, for MDRA at 5-24hr, and for C. difficile spores at 5hr and 72hr. The inactivation was more significant when the surface irradiance was increased by adding the blue light.

Conclusion: High intensity light technology could be considered for several healthcare decontamination applications.
Figure 2. Survival in MDR-Acinetobacter (A), MRSA (B), VRE (C), and C. difficile (D) with Blue Light
Reduced Healthcare Associated Infections in an Acute Care Community Hospital using a Combination of Self-Disinfecting Copper-Impregnated Composite Hard Surfaces and Linens

IDWEEK Abstract 263, 2016

COSTI SIFRI, MD, KYLE ENFIELD, MD and GENE BURKE MD. University of Virginia Health System and Sentara Healthcare, Norfolk, VA

Background: Efforts to decrease environmental bioburden are associated with reduced transmission of microbial pathogens and development of HAIs. Copper oxide has potent biocidal activity. Here we report the results trial of a copper oxide-impregnated composite product incorporated into hospital countertops, molded surfaces, patient gowns and linens.

Results: The study was conducted over a 25.5-month time period. HAI rates obtained from the copper-containing new tower (72 beds; 14,479 patient-days) and the unmodified hospital wing (84 beds; 19,177 patient-days) were compared to those from the baseline period (204 beds; 46,391 patient-days). The new tower had 78% (P = .023) fewer healthcare-associated infections due to MDRO s or C. difficile, 83% (P = .048) fewer cases of C. difficile infection, and 68% (P = .252) fewer infections due to MDRO s relative to the baseline period. No changes in rates of healthcare-associated infections were observed in the unmodified hospital wing.

Conclusion: Copper oxide-impregnated composite hard surfaces and linens may be useful technologies to prevent healthcare-associated infections in the acute care hospital setting.
The Antiseptic Scrub Contamination and Transmission (ASCOT) Trial to Determine the Impact of Antiseptic-Impregnated Scrubs on Healthcare Worker Contamination

ID WEEK Abstract 1351, 2016

DEVERICK ANDERSON, MD et al. Duke Infection Control Outreach Network, Duke University Medical Center, Durham, NC

Background: HCP clothing becomes contaminated during patient care and can serve as a vector for subsequent transmission. Antimicrobial-impregnated clothing may reduce contamination, but clinical data are lacking.

Methods: Scrubs impregnated with (1) a complex element compound with a silver-alloy, or (2) an organosilane-based quaternary ammonium and a hydrophobic fluoroacrylate copolymer emulsion, were compared to standard cotton-poly scrubs during clinical care.

Results: 167 unique patients received care from 40 nurse subjects over 120 individual shifts. 2,185 cultures were obtained from HCP clothing, 455 from patients, and 2,919 from patients’ environments. The median unadjusted increases in contamination were similar among scrub types. Scrub type was not associated with a decrease in HCP clothing contamination.

Conclusion: Antimicrobial-impregnated scrubs did not lead to decreased contamination of nurses clothing.
Are Antimicrobial Curtains as Clean as You Think?

ID WEEK Abstract 260, 2016

SHELASRIAR, MD, et al. Medical College of Wisconsin, Milwaukee, WI,

Background: We aimed to determine the degree of bacterial contamination on antimicrobial curtains within our medical intensive care unit (ICU).

Results: We found that out of 20 curtains, 95% (n=19) showed bacterial growth. Out of the 10 door curtains 50% (n=5) showed Gram-negative bacilli and 100% (n=10) had Gram-positive organism(s). Out of the 10 commode curtains, 10% (n=1) showed Gram-negative organism(s) and 90% (n=9) had Gram-positive organism(s).

Conclusion: Antimicrobial curtains are contaminated with pathogenic organisms; therefore, they should be thoroughly disinfected, exchanged, or totally foregone in between patients.
Thank you!

Questions?