Gastrointestinal endoscopy-associated infections and their contributing factors

Acknowledgements

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Exposure to infectious agents

• During an endoscopy, an endoscope is exposed to the native infectious agents of the patient.
• The number of bacterial species reported from the gut is approx. 500-1000!
• “Human feces contains at least $10^9$ eukaryotic and prokaryotic viruses per gram.”
• At least 268 fungal taxa have been identified in the gut.
• There are also parasites and prions!
How do we clean it?

• What would happen if we autoclaved (heat-sterilised) an endoscope?

  A. It would come out cleaner than when we purchased it.

  B. It would come out a pile of melted plastic.

  C. Somewhere in between.
Endoscope Reprocessing

START

Clinical Use

Pre-cleaning

Manual Cleaning

High-level disinfection

Drying

Storage
Does it work?

- **Most** of the time.
- Take-home message; “Endoscope reprocessing is not perfect and endoscopy-associated infections occur.”
- So what causes lapses in endoscope reprocessing?
Lapses in Endoscope Reprocessing

- Endoscope damage
- Bad disinfectant solution
- Wrong channel brush

START

Clinical Use

- Recontamination during storage
- Biofilm formation with waterborne organism

Pre-cleaning

- Contaminated rinse water
- Contaminated AER
- Disinfectant-resistant microorganisms e.g. Mycobacterium resistant to glutaraldehyde
- Inadequate rinsing
- Bad batch of disinfectant
- Biofilm formation

Manual Cleaning

- Fails leak test
- Operator does not properly brush channels or perform leak test
- Endoscope damage

High-level disinfection

Drying

- Drying step was too short
- Lack of air flow through channels allowing waterborne bacteria to adhere and colonise

Storage

- Recontamination during storage
- Biofilm formation with waterborne organism

• Inadequate rinsing
What happens when there is a lapse?

• The endoscope could be contaminated with infectious agent(s) from the previous patient.

• During future clinical use, the endoscope could contaminate other patients with the infectious agent(s).

• This could result in an outbreak, depending on the virulence of the agent, and could have particularly adverse patient outcomes if the agent is highly pathogenic e.g. multidrug-resistant *Klebsiella pneumoniae*. 
Gastrointestinal Endoscopy-Associated Infections and Outbreaks

• I performed a systematic review, searching EMBASE, PubMed and CINAHL to find studies describing an outbreak or infection related to gastrointestinal endoscopy.
Eligibility Criteria

Inclusion Criteria
1. The article describe case(s) of endoscopy-associated infection(s) or outbreak(s).
2. The article must be written in English.
3. The article must be published from 2010 onwards.

Exclusion Criteria
1. The article cannot describe endoscopy-associated infection(s) or outbreak(s) with a non-gastrointestinal endoscope e.g. a bronchoscope.
Looking for Literature!

Search date 26th April 2017
1975 records, duplicates not removed
PubMed – 662
EMBASE – 706
CINAHL - 607

1975 records screened

1647 records excluded

299 full-text articles excluded
N = 76 duplicates removed
N = 17 systematic reviews
N = 19 articles discussed outbreaks associated with other types of endoscopes
N = 160 articles did not describe an infection or outbreak
N = 23 sources which were either an abstract or letter to an editor
N = 2 articles which described the same outbreak as another paper
N = 1 eliminated because the type of scope used was unclear.
N = 1 because it did not have conclusive evidence that the endoscope was the source of the infectious agent.

328 full-text articles assessed for eligibility
Duplicates removed

21 additional full-text articles reviewed after screening reference lists of remaining 29 articles

37 full-text articles excluded
N= 5 duplicates removed
N= 16 articles which did not describe an outbreak or infection
N= 4 articles which discussed outbreaks associated with other types of endoscopes
N = 4 articles which described the same outbreak as another paper
N = 3 articles which described outbreaks but were published pre-2010

13 articles included
Results:

• 12 of the 13 articles described an outbreak occurring with a duodenoscope.

• 1 of the articles described an outbreak occurring with a gastroscope.

• Outbreaks were reported from the US, France, China, Germany, the Netherlands, and the UK.
Results:

- The causative organisms reported were:
  - *Klebsiella pneumoniae* (46.1%)
  - *Pseudomonas aeruginosa* (23.1%)
  - *Escherichia coli* (23.1%)
  - *Salmonella enteritidis* (7.7%)
Outbreak 1 - France

- In 2009, a duodenoscope was contaminated with a strain of carbapenemase-producing *Klebsiella pneumoniae*.

- This outbreak was detected by routine screening for multidrug resistant organisms.

- Shortly after a single patient produced a positive result, 2 other patients in the same ward tested positive.
Outbreak 1 - France

• Following identification of this outbreak, active screening was conducted on all contact patients, and retrospective analysis was conducted to identify which patients had been exposed to the contaminated duodenoscope.

• 17 patients had been exposed, 10 were screened and 6 were colonised with *K. pneumoniae*. 
Outbreak 1 - France

• An audit of the reprocessing method was undertaken and two issues were found:

  1. The pre-wash of the endoscope in question may have been delayed by 24 hours.
  2. After the peracetic acid wash, the drying procedure was not long enough i.e. endoscopes were not completely dried before storage.

• Following this review, the reprocessing method was updated to ensure proper drying, and microbiological surveillance is now undertaken more frequently than previously (twice a year).
Outbreak 2 - USA

• This outbreak began with 7 matching isolates collected from patients following ERCP at the same hospital.

• This prompted a review of routine carbapenemase-resistant Enterobacteriaceae screening and retrospective analysis of 29 AmpC E. coli samples.

• The investigation found a total of 32 patients who had been infected with this strain of E. coli.
Outbreak 2 - USA

• An audit of the endoscope reprocessing method found that the unit was above the industry standard and adherent to guidelines in regards to endoscope reprocessing.

• However, 7 of the 8 ERCP duodenoscopes inspected by the manufacturer had at least 1 critical defect; 3 failed a leak test performed by the manufacturer.
Outbreak 3 – The Netherlands

• This outbreak found the source of the outbreak to be related to the design of a specific duodenoscope; the Olympus TJF-180V, which was subsequently removed from clinical use.

• The duodenoscope had a fixed distal cap, and a sealed elevator wire channel port. This made thorough cleaning impossible.
Outbreak 3 – The Netherlands

• Scanning electron microscopy of the distal caps and its components found a few interesting things:
  – A rough fibrous surface and a brown layer on the O-ring
  – Sludge behind the glass that covers the light-guide lens
  – A crack in the fixed cap
  – Brown staining of the frame of the distal tip
Outbreak 3 – The Netherlands

• There were no identified lapses in the endoscope reprocessing procedure.

• Culturing of the duodenoscope found *P. aeruginosa*.

• 30 patients were infected with a VIM-2-positive *P. aeruginosa* strain.

• 22 cases of which were directly attributed to the contaminated endoscope.
Outbreak 4 – France (again)

• This outbreak was associated with a gastroscope!

• Bronchoalveolar lavage culture of a patient revealed the presence of (ESBL) Extended-spectrum beta-lactamase-producing *P. aeruginosa*.

• This strain had been isolated in another patient 2 months earlier.
Outbreak 4 – France (again)

• This prompted an investigation, which found another two patients; 4 in total infected with *P. aeruginosa*.

• No screening of exposed patients was performed, “as neither treatment strategies nor specific precautions exist for colonization with MDR-PA.” – There may have been more!
Outbreak 4 – France (again)

- An audit of the reprocessing method found the following:
  - Initial manual cleaning did not adhere to guidelines; brushing and flushing of channels occurred within 10 minutes.
  - Suction cylinders used for the manual cleaning of channels were disinfected, NOT sterilized every day.
  - A single-diameter channel cleaning brush was used for all gastrointestinal endoscopes.
  - Drying was not sufficient as endoscopes were still wet at the end of the cleaning process.
Outbreak 4 – France (again)

- Furthermore, the manufacturer found wear of the adhesive at the distal sheath of the contaminated gastroscope.
Factors contributing to endoscopy-associated infection:

1. Duodenoscope elevator mechanism

2. Lapses in endoscope reprocessing; specifically drying which was identified as inadequate in 4 outbreaks.

3. Biofilm formation; not identified in any outbreaks but still a potential risk factor

4. Disinfectant-resistant infectious agents e.g. glutaraldehyde-resistant mycobacteria
Factors contributing to endoscopy-associated infection:

5. Endoscope damage facilitating infectious agent colonization or biofilm formation.

6. Endoscope reprocessing has an inherent failure rate which is different for each endoscopy unit, but a few articles have arrived at similar percentages.
   - One article calculated 1.8% for gastroscopes and 1.9% for colonoscopes.
   - One article calculated 2% for endoscopes.
   - One article calculated 1.9% for duodenoscopes.
Strategy 1 - Screening

• Add a rapid indicator test to the reprocessing method to determine whether an endoscope is contaminated before patient use.

• Rapid indicator tests include ATP measurement, protein measurement, carbohydrate measurement, haemoglobin measurement.

• Our team has worked with ATP before and found that it significantly correlated with microbiological load detected from gastroscope and colonoscope samples prior to high-level disinfection.
Strategy 2 – Sterilise vs. HLD

• Adopt methods of low-temperature sterilisation:
  – Ethylene Oxide gas has many disadvantages and was shown in a follow-up study on one of the reviewed outbreaks to still carry a 1.2% failure rate.
  – Liquid chemical sterilisation; a paper was published in 2016 reporting the SYSTEM 1E Liquid Chemical Sterilant Processing System.
The End! Phew!

• Thank you very much for listening to my presentation!

“Thats all Folks!”