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Role of Clinical Endoscopy to Emphasize Endoscope Disinfection

running title; Highlight to Endoscope Disinfection

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ABSTRACT

Through unexpected MERS (Middle East Respiratory Syndrome) virus outbreak in Korea, it was noticed that the virus can spread more easily and the exposure to MERS in hospital carries extreme risk to infection as well as mortality and it was reminded that the sharing the information was the royal road to control. Though the incidence of exogenous infections related with the contaminated endoscope is very low, the majority of published outbreaks have been caused by various deficiencies in reprocessing procedures, which might also be supported by insufficient training or awareness. After the inauguration of “Clinical Endoscopy” as an English journal of the Korean Society of Gastrointestinal Endoscopy from 2011, the journal published several articles on the subject of “Disinfection of endoscopy and accessories”. Also, there have been many SCI journals which emphasized high level disinfection of the gastrointestinal endoscope. Especially, many papers were produced since outbreak of carbapenem resistant Enterobacteriaceae in 2013. The recent review papers concluded that quality control is the most important among the all aspects of procedural cares including the efficiency of the GI endoscopy unit and reprocessing room. Thorough reprocessing of endoscopes using high level disinfection and sterilization methods may be essential to reduce risk of infection.

Keywords: endoscopes, disinfection, MERS-CoV, outbreak, CRE, Clinical Endoscopy

ROLE OF SOCIETY JOURNAL, CLINICAL ENDOSCOPY, ON EMPHASIZING DISINFECTION; A RECENT LESSON FROM UNEXPECTED MERS VIRUS OUTBREAK IN KOREA
Conclusively from the recent outbreak of MERS in Korea, we have reminded of the following two lessons, “we can’t emphasize endoscopy disinfection too much” and “journal can’t be too careful in sharing the way of endoscopy disinfection”. MERS, caused by the coronavirus, have warned "a threat to the entire world" hung around Saudi Arabia and some Middle East countries because they have recently made the leap to South Korea and triggered the second largest outbreak outside the Middle East area. In South Korea, more than 180 people have been infected, more than 35 have died, and more than 30 thousands have been under quarantine segregation, bothering Koreans more than 2 months. What made the South Korea situation so serious might be, we speculated, due to lack of spread of enough information to general populations and the failure of early block in hospital led to exposure to other hospital. It was only discovered in 2012, but the countries that previously harbored the virus haven't always been transparent about their findings, also low concerning in countries out of Middle East countries. Experts still don't understand exactly how MERS is transmitted. Unfortunately, worsened countermove was done in Korea. MERS was first discovered in a patient who died in June 2012 in Jeddah, Saudi Arabia, but the government did not put this fatality seriously because the virus has largely stayed in Saudi Arabia, where it's believed that virus lives in bats and camels, rarely sickening humans. This misled information was repeated in Korea. Through MERS virus outbreak in Korea, it was seriously noticed that there's an exception for hospitals, where the virus can spread more easily and the exposure to MERS to sicken people such as underlying illness, poor ventilation, and spatial separation carries extreme risk to infection as well as mortality, a nosocomial infection. Though MERS is still fairly mysterious and possible contender for an epidemic, the lesson experienced from Korea epidemic strongly tell the importance of sharing knowledge and optimal information, also the importance of journal. This is why journal editors prepared the current focused review series in this issue of Clinical Endoscopy.

**Endoscopy disinfection is prerequisite step for preventing any contagious diseases** When the MERS virus was first discovered in human, it frightened the public health community for a couple of key reasons. It's very deadly, and a lot is still unknown about it. It's a respiratory virus, and the possibility of airborne transmission hasn't been ruled out. And the countries that typically harbor the most cases, like Saudi Arabia, United Arab Emirates, and Qatar, haven't been good about sharing information or promptly reporting cases to the global health community. In same meaning, endoscopy disinfection is very essential to either patients or endoscopist and assistant. Recently, accumulation of bacteria within duodenoscopes with possibility of infections passing from patient to patient was big issue. Unidentified organisms harbor the no countermeasure
and the virus or unnoticed microorganisms could also just as easily go away. For example, like there's still no specific treatment or cure for MERS, stressing the cleaning endoscopy with the best, leading to high level belief that prevention might be the best.

"Clinical Endoscopy" society journal strives hard for the prevention of epidemics, contributes to good quarantine. Medical journal plays an enormous role as a means of communication in exchanging knowledge and new technology. All journals have its own aims, scope and policies and editors of medical journal have an important responsibility to publish and enforce them. Editos of Clinical Endoscopy want to explore challenging and timely issues to share knowledge in the field of gastrointestinal (GI) endoscopy. In this focused review article, as endeavor to emphasize the importance of endoscopy disinfection in preventing the risk of “infection”, we prepared the in-death reviewses regarding endoscopy disinfection through searching publications in this matter. “Sterilization” is used primarily for processing endoscope accessories and is accomplished by either physical or chemical methods and the term “sterilization” should not be equated with “disinfection” and that there is no such state as “partially sterile.” Since flexible endoscopes do not tolerate high processing temperatures higher than > 60 °C and cannot be autoclaved or disinfected using hot water, various methods adopting steam under pressure, dry heat, ethylene oxide gas, hydrogen peroxide, gas plasma, and liquid chemicals are principally sterilizing methods used in health-care facilities.

RECENT CHANGES OF GASTROINTESTINAL ENDOSCOPE DISINFECTION; STATISTICS FROM “PUBMED” SEARCH

In 2015, MERS Korea outbreak started from only one patient. Until now, 186 people have been infected and 36 (19.4%) people died of MERS.¹ It would not have caused many deaths if the first patient had been detected earlier, diagnosed and isolated properly. We realized how important initial response was through this event. The main culprit of MERS Korea outbreak was a nosocomial infection. Hospitals are, to tell the truth, places with many pathogens although they are recognized as clean and sanitary space. Therefore, there are some chances for patients to be transmitted with infectious pathogens through procedures performed in hospitals despite medical personnel’s efforts. Microorganisms such as bacteria, viruses, prion, and parasites are known to be disseminated during endoscopy. Almost all microorganisms can be eradicated except for a few spores if high level disinfection is performed according to the existing reprocessing guideline with disinfectants. The incidence of exogenous infections linked to contaminated endoscope is very low with an estimated at 1 case per 1.8 million
procedures. It is difficult to estimate the causal relationship between endoscopy and pathogen transmission for several reasons, such as long latent period, subclinical symptoms, and unrecognized infections. The majority of published outbreaks have been caused by various deficiencies in reprocessing procedures, which might also be supported by insufficient training or awareness. Until now, such outbreaks have been associated with lapses in essential reprocessing steps such as incomplete cleaning, lack of appropriate disinfection, improper drying, or cross-contamination between clean and dirty devices.

**Spaulding classification** The gastrointestinal endoscope belongs to the class of semi-critical devices because the instruments may touch with mucous membranes during clinical procedure, thus bearing a relative degree of infection risk if contamination occurs during use. At the very minimum, they should receive high level disinfection. Most guidelines for endoscope reprocessing prescribe the following seven steps: pre-cleaning, cleaning, rinse, disinfection, rinse, drying (air/alcohol), and storage. Compliance with guidelines is the chief factor compromising the safety of endoscope reprocessing. The consequences of failure to follow recommendations may be not only transmission of pathogens, but also misdiagnosis, instrument malfunction, and a shortened instrument lifespan. Recently, the awareness of endoscope disinfection has been enhanced among endoscopists because the outbreak of CRE infection after endoscopic retrograde cholangiopancreatography (ERCP) procedure have occurred, especially due to that duodenoscopes for ERCP have a complicated structure, that is, featuring a specific channel that allows manipulation of a guide wire, at the terminal end of this channel is a cantilevered elevator mechanism that is used during procedures to manipulate and control the direction, and the necessity of fine movements of accessories inserted and passed through the endoscope’s accompanying instrument channels. Finally, the elevator wire mechanism is difficult to access and not readily amenable to cleaning and high-level disinfection.

**The published outbreaks in “PubMed” search** On search Pubmed by “endoscopy disinfection”, 609 publication are available (August 2015), of which publications were steeply increasing in recent 10 years. Critical report by Noronha AM and Brozak S, they critically described as “endoscopic procedures provide lifesaving diagnostic information, but do they put patients at unnecessary risk of deadly infection from cross contamination?” Conclusively, they stated that though reprocessing is time consuming, labor intensive, somewhat expensive, most importantly susceptible to failure, and finally problematic features of an endoscope structure, the luminal channels, which often become contaminated by endoscope accessories, this might be very important aspect exceeding diagnostic contribution. As far as structural aspect of endoscopic disinfection,
Correct cleaning of the elevator mechanism was essential in endoscopy disinfection. Fixed distal ends demand more accuracy during pre-cleaning because the narrow lumen behind the elevator is difficult to access with routine cleaning brushes. Special brushes are needed but these should not cause any damage. Therefore, it is of utmost importance to follow the manufacturer’s recommendations. Even though automated reprocessing is performed, a thorough manual pre-cleaning is essential in the process of satisfactory disinfection. In the review of the papers published in PubMed, the transmission risk of microorganisms due to contaminated endoscopes was very low when the endoscope reprocessing was performed according to the current reprocessing guidelines. All staffs in endoscopic suite should be aware of the latest reprocessing guidelines and also need to prepare for the emerging of resistant pathogens to the current disinfection practices. Lastly, adequate training of endoscopic staff is one of the most crucial points to achieve the highest quality control standards in digestive endoscopy. In addition to afore-mentioned CRE risk, though there were only two reports of nosocomial outbreaks due to Klebsiella spp. but seven additional outbreaks of this kind have been reported within the last 4 years, signifying that many of such outbreaks have been missed in the past because this pathogen belongs to the physiological gut flora and ignorance. There is enough risk that we may only be seeing the tip of the iceberg as far as endoscopy disinfection is concerned. Also several PubMed publication relevant to endoscopy disinfection deal with the limitation about the cleaning of luminal endoscopes. Taken together, PubMed search emphasizes that with the emergence of highly resistant carbapenemase-producing strains, CRE, more adherence to infection control guidelines should be continued. Also, limited action of several decontamination procedures and the lack of convincing quality control methods to warrant the cleanliness of channels between patients lead to pay more attentions to prevent the risk of cross-infection of unnoticed harmful microorganisms or to get rid of unidentified molecules during endoscopy procedures.

**Awareness of disinfection dealt in clinical endoscopy**

After the inauguration of “Clinical Endoscopy” as an English journal in 2011, the journal published several reviews and original articles on the subject of “Disinfection of endoscopy and accessories”. As our journal aims to promote the exchange of the up-to-date clinical scientific information, disinfection and reprocessing is one of the main topics of interest. In detail, in a special issue of Clinical Endoscopy on the 48th Seminar of KSGE held in 2013, two review articles summarized the presentation on the topic of gastrointestinal endoscope
reprocessing. KSGE established endoscope cleaning and disinfection guidelines in 1995 and the first revision was made in 2009 and the second one in 2012. Lee et al. discussed the endoscopic reprocessing steps and their required equipment proposed in the second revised guidelines because endoscope contacts mucosa of upper gastrointestinal tract and is considered as semi-critical equipment. Although complete sterilization was impossible due to complex structure of endoscope, it requires high-level disinfection. The required steps for reprocessing are pre-cleaning, cleaning, disinfection, rinsing, and drying. Necessary materials and procedures that should be followed were described in detail for each step. Compliance for the established reprocessing guidelines is most important to prevent possible pathogen transmission during endoscopy. To increase compliance, efforts have focused on developing disinfectants and automated endoscope reprocessors, which are introduced to replace manual reprocessing steps and it can provide effective disinfection and reduce exposure to hazardous chemicals. Personnel who are in charge of endoscope reprocessing should be well-trained for entire procedure and regular monitoring is essential for quality assurance.

Disinfection is the main step of reprocessing to eliminate the potential human pathogens such as bacteria, viruses, fungi, or mycobacterium. In this journal, a review of disinfectants currently available in Korea and approved by U.S. Food and Drug Administration for endoscopic reprocessing was published by “disinfectant management committee of the Korean Society of Gastrointestinal Endoscopy”. Disinfectants including glutaraldehyde (GA), orthophtaldehyde (OPA), peradetic acid (PAA)/ hydrogen peroxide (HPO), and electrolyzed acid water (EAW) in terms of chemical characteristics, disinfection potency, advantages, and limitations were discussed. Most of the listed disinfectants are suitable for endoscope reprocessing if the instructions recommended by the product manufactures are strictly kept. Thus, each endoscopy unit can choose a specific disinfectant according to the facility and the working environmental conditions. There are still ongoing demands on the new disinfectant or combination of existing ones that will have improved efficacy and safety. Kim et al reported in this journal that efficacy of combination of polyhexamethylenebiguanide hydrochloride-alkyldimethylbenzylammonium chloride (PHMB-DBAC) was comparable to that of OPA by showing that culture positive rates at the tip of endoscope and the working channels were not significantly different between two disinfectants. Reprocessing time was shorter and total cost was much lower in PHMB-DBAC use.

Recently, Park et al. reported the results of survey on the endoscope reprocessing practices in Korea in comparison with those performed in 2002 and 2004. This survey report showed the significant improvement in following recommended reprocessing process around 98.9% compared with those result from the previous
surveys, 27% and 50%, respectively. Automatic reprocessing was 100% in the participating secondary or tertiary teaching hospitals. However, there was still room for improvement in reprocessing procedures. The most common deviation from the guidelines, which was reported in 56% of responders, was the transportation of soiled endoscope after procedure to the reprocessing room in sealed container. The non-compliance rates were followed by the leaking test in 16.2% and by the keeping the exposure time and temperature in 12.6%. The study showed significant improvement in compliance to recommendations for reprocessing during last decade but these encouraging results need be validated by a study including primary clinics which actively participate in gastric cancer screening program sponsored by the Korean government. One of the important aspects in preventing endoscope-related infection prevention was that the reuse in disposable accessories, reported in 35.7% in previous study,\textsuperscript{17} which is not generally acceptable because of the fragility of the devices at sterilization process.\textsuperscript{18} Recent publication in this journal showed the less cost in using disposable biopsy forceps compared to that of reusable forceps, which includes both purchase cost and sterilization cost.\textsuperscript{19} Disposable forceps and reusable forceps showed comparable excellent performance in obtaining adequate biopsy samples. In response to the efforts of Disinfection Management Committee of The KSGE and Clinical Endoscopy journal to raise the awareness on this issue, disposable biopsy forceps are recently listed as a reimbursed item from August 2015 by Korean National Health Insurance Service. Although reusable forceps are also allowed to use, but strict disinfection/sterilization process should be followed as guidelines suggest and detailed documentations are prerequisite. Recycling of a disposable forceps after sterilization is not allowed in any circumstances.\textsuperscript{14}

**SCI JOURNALS EMPHASIZING THE IMPORTANCE OF ENDOSCOPIC DISINFECTION**

It cannot be emphasized too much that high level disinfection of the gastrointestinal endoscope is so important. There have been many SCI journals which emphasized high level disinfection of the gastrointestinal endoscope. Especially, many papers were produced since outbreak of CRE in 2013. Ubhayawardana DL \textit{et al.}\textsuperscript{20} reported residual bio burden in reprocessed duodenoscopes used for ERCP in 2013. They tested 102 samples obtained from two different duodenoscopes for bacterial growth. Three samples were obtained each time; one swab from the tip before and another after manual disinfection. The third sample was collected by irrigation of the working channel with saline after manual disinfection. After manual disinfection, culture-positive rates were 20 % and 9 % for the samples collected from the tip and the working channel of the duodenoscopes, respectively. This
paper concluded that there is a high culture-positive rate after reprocessing of the duodenoscopes using the manual disinfection procedure, in spite of rigid adherence to the protocol for disinfection. Muscarella LF\textsuperscript{21} published the risk of transmission of CRE during GI endoscopy in World J Gastrointest Endosc in 2014. This review concentrated on an outbreak of CRE in 2013 following the ERCP performed at hospital in Chicago. This review reported that GI endoscopy is an important risk factor for the transmission of CRE having been associated with the morbidity and mortality of patients after ERCP. The author concluded that contaminated GI endoscopes, particularly duodenoscopes during ERCP, had been related with outbreaks of CRE which induced the morbidity and mortality of patients. They also recommended the intensified training and monitoring of reprocessing procedures to confirm the proper cleaning and brushing of GI endoscopes, especially the forceps elevator located at the distal tip of the duodenoscopes. Recently, Chiu KW \textit{et al}.\textsuperscript{22} published the high level disinfection of the gastrointestinal endoscope reprocessing in World Journal of Experimental Medicine. This review article included disinfection classification, manual washing and automatic endoscopic reprocessing method. The authors emphasized that close adherence to the current guideline is the most important because the GI endoscopy is linked with outbreaks related with the incomplete reprocessing during high level disinfection, concluding that quality control is the most important among all aspects of procedural cares including the efficiency of the GI endoscopy unit and reprocessing room, as well as the endoscopy procedure.

\textbf{CONCLUSIONS}

It can’t be emphasized too much that high level disinfection of the GI endoscope is very important. The GI endoscopy is an important risk factor for the transmission of CRE and other microorganisms, having been recently associated with the morbidity and mortality of patients after ERCP. The close adherence to current guidelines is necessary because the GI endoscope is related with more outbreaks linked to inadequate reprocessing during high level disinfection. KSGE established GI endoscope cleaning and disinfection guidelines in 1995. The first revision was made in 2009 and the second one in 2012. KSGE will continue to emphasize endoscopy disinfection and develop more advanced GI endoscope cleaning and disinfection guidelines in the future, in which Clinical Endoscopy and related journals can’t be too careful in sharing the way of endoscopy disinfection.
REFERENCES


