Monitoring the quality of the endoscopic reprocessing technique by a nurse in gastroenterology

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Abstract:

Introduction: Gastrointestinal endoscopy is an effective and safe method designed for screening, diagnosing, and treating digestive tract diseases. However, nosocomial infections are a serious problem. Therefore, many countries are revising guidelines for the reprocessing of endoscopes, with the goal of preventing nosocomial infections. It is crucial for endoscope reprocessing to be conducted in accordance with the latest recommendations.
Objective: To monitor the quality of endoscope decontamination by nurses and compare the quality of the endoscope decontamination after automatic and manual reprocessing through indicator tests. Based on the results, recommendations will be proposed for routine reprocessing control by nurses in practice.

Methodology: The research took place from January to September 2022 in the Department of Gastroenterology at the Faculty Hospital in Trnava. The quality of manual and automatic reprocessing was compared using 1,108 rapid indicator tests. This was routine testing of endoscopes using rapid tests to detect protein and blood residues. Gastroscopes, colonoscopes, and duodenoscopes were tested. In total, 277 control procedures were performed by nurses after the manual and automatic reprocessing of endoscopes. The results were assessed using the T-test and Chi-square test.
Results: The rapid tests showed 31.8% (with manual) compared to 15.5% (with automatic) contamination after endoscope reprocessing. In the case of manual reprocessing, there were 58 (42%) positive protein tests and 5 (7%) positive blood tests out of all the reprocessed endoscopes. With automatic reprocessing, there were 41 (28%) positive protein tests and 1 (0.7%) positive blood test out of all the reprocessed endoscopes. The average time for carrying out reprocessing with quality control of disinfection was 31.8 ±10.2 min compared to 29.9 ±10.0 min without control.
Conclusion: We demonstrated the justification for the implementation of rapid tests after endoscope reprocessing. We proposed a pilot set of recommendations for practice for routine reprocessing control by nurses that are tailored to the needs of a tertiary care facility. We attempted to create a basis for other facilities in Slovakia where endoscope reprocessing is carried out.

Conflict of interest - We are not aware of any conflict of interest concerning the work presented.

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Introduction

The first generation of flexible endoscopes was introduced into practice about 50 years ago, and it triggered a revolution in the clinical practice of gastroenterology. They significantly improved diagnostics, and endoscopic screening prevented many cancer-related deaths. National and international endoscopic societies supported the employment of nurses, research, and proposed guidelines to support internal auditing and quality assurance in the proper handling of endoscopes. Advances in instrument design and the production of new accessories improved endoscopic techniques and their capabilities while increasing patient comfort and safety. The risk of infections associated with the use of endoscopes is never zero, and with the increase in the number of endoscopic procedures, nosocomial infections began to appear. Therefore, endoscopic societies introduced very high-quality protocols and guidelines for endoscope disinfection to minimize the risks of infectious agent transmission (Axon, 2020). An increasingly serious problem in healthcare facilities is the growth of nosocomial infections with multidrug-resistant strains. Standards for the reprocessing of flexible endoscopes in gastroenterology should be regularly updated by a group of experts working in the field, including nurses, microbiologists, infection prevention and control specialists, and other relevant professionals. The goal is to maintain high-quality reprocessing to minimize the risk of infection transmission based on findings and the

subsequent development of professional guidelines for endoscope decontamination practices in specific workplaces.

We are witnessing a constant increase in endoscopic and surgical procedures, and therefore, also the risk of infectious complications, which are associated with the potential transmission of infectious agents. The constant increase in diseases and examinations leads us into an era of quantity. It is essential to use all the available options to ensure patient health. In recent years, disposable medical devices have become preferred in healthcare practices. The use of disposable medical devices offers clear advantages, a trend that has also been embraced in endoscopy. Disposable devices facilitate and speed up work. In some countries, disposable endoscopes are already firmly established in clinical practice, basically a given. However, the current situation regarding the climate is alarming. We are destroying our ecosystem with irresponsible and indifferent human behavior, consumerism, and the burning of disposable instruments. Endoscopy is also a major contributor to this. The production of waste, namely plastics, increases greenhouse gases (Rodríguez De Santiago et al., 2022). Endoscopic examinations carry a certain risk of infection transmission, but with thorough endoscope disinfection carried out by professional specialized staff, the risk of transmission to patients, staff, and the workplace can be significantly reduced.

The problem with biofilm formation inside or on the surface of an endoscope may stem from the following: repeated exposure of the instrument to microorganisms (mechanical transfer during the handling of the endoscope), insufficient cleaning procedures from various unclassified causes, and ultimately the modernization of the technical execution of the instruments and their structural complexity. Therefore, a nurse's role requires a comprehensive understanding of the entire reprocessing process, including mechanical cleaning, disinfection, drying, and the proper storage of endoscopes.

Methods

Currently, there is a lack of data on the transmission of nosocomial infections through endoscopic instruments from endoscopy centers in Slovakia. Information about the epidemiological situation and the activities of epidemiology departments in the Slovak Republic from 2010 - 2019 report an average positivity of tested instruments as being 18% (9 out of 50 tested) (Annual Epidemiological Reports, 2020). However, they do not provide further information about what infections were involved and where the highest risks were. Therefore, it is essential to obtain this information and develop further procedures to prevent infection transmission. In Slovakia, the most recent professional guidelines on performing endoscope decontamination were issued in a bulletin published in 2000. On July 1, 2000, the Ministry of Health of the Slovak Republic, through the Chief Hygienist, issued "professional guidance on performing endoscope decontamination" effective from September 1, 2000. This guidance was issued according to §19 letters h) and i) of the NS SR Act No. 277/1994 Coll. on the protection of human health as amended by Act NR No. 290/1996 Coll. to prevent and limit the spread of communicable diseases. This guidance was supplemented on May 15, 2021, by two standards that were our motivation for research. However, these standards were not derived from verified data or practical experience. They are more of a theoretical framework, and to this day these standards have not been implemented. Workplaces often struggle independently and use European standards to manage their facilities.

Organization and realization

The organization and realization of the research took place at the Gastroenterology Outpatient Clinic of the Faculty Hospital Trnava, which is the final provider of institutional healthcare for the catchment area of the Trnava region. Approximately 25,000 patients are hospitalized annually in FN Trnava in 638 beds, and roughly 2,380 invasive procedures are performed on an outpatient basis.

The research was carried out from January 2022 to September 2022 in cooperation with the staff of the Department of Hospital Hygiene and Epidemiology FN Trnava. Our sample of respondents reflects the number of on-site rapid indicator tests conducted to detect the presence

of protein residues or blood in patients undergoing endoscopic examination in gastroenterology at FN Trnava. The result of an on-site rapid test is available within 15 seconds. If a rapid test was repeatedly positive despite repeated reprocessing, ATP testing was then conducted. The endoscopic device to be tested must first be decontaminated, either manually or automatically. Automatic decontamination involves the use of both manual decontamination and decontamination in an automatic disinfector. In the event of a positive indicator test result, the ATP method was carried out, i.e., testing for residual adenosine triphosphates to detect the presence of microorganisms. The method is based on the fact that when ATP reacts with d-luciferin, light energy is produced, which is then quantitatively measured by a luminometer in relative light units. ATP detection was measured after the completion of the decontamination process using a portable luminometer (3M Clean-TraceTM). Protein detection was determined by a Resi test, and blood detection was carried out using HemoCheck-S. Repeated routine testing of positive indicator tests either confirmed or refuted staff errors in reprocessing. The ATP method yielded a positive result in one case following a change in the disinfection protocol after switching from glutaraldehyde preparations to peracetic acid-based ones. The elimination of the issue was confirmed after the switch. Another case of ATP occurred at the very beginning of the project itself, when the technique was verified and calibrated on a non-reprocessed endoscope. Due to the low sample size, we did not statistically process this method. In principle, the basic steps of the reprocessing description were based on valid legislation. After examining the patient, the endoscope was reprocessed by the nurse at the endoscopy workplace according to the current standards of the Ministry of Health of the Slovak Republic for the manual and automatic reprocessing of instruments. After both manual and automatic reprocessing, quality control tests using indicator tests were performed, and the quality of each reprocessing performed by the nurse was evaluated and compared. According to amendments to the law, the task of a nurse is to verify the quality of the reprocessing (and thereby eliminate the risk of infection transmission) by carrying out an indicator test after performing both manual and automatic reprocessing. Our set consisted of 1,108 indicator tests. We focused on selected types of endoscopes (colonoscope, duodenoscope, gastroscope), as they have been the most commonly used in clinical practice for a long time, and the method of disinfection used (manual vs. automatic reprocessing). If the selected "on site" tests yielded positive results, a higher level quantitative test was performed, specifically the ATP bioluminescence method using a luminometer. This was always conducted in the presence of a staff member of the Department of Hospital Hygiene and Epidemiology FN Trnava. If the ATP sample was positive, corrective measures were taken and immediate re-education of the staff took place to improve the effectiveness of the decontamination and disinfection process. In addition to the primary goal of verifying the reprocessing quality using rapid tests, the secondary objectives were to assess the total time required for thorough endoscope decontamination by the nurse and to use indicator tests to evaluate the entire decontamination process.

Objective

The Slovak Republic ranks among the countries with the highest incidence of colorectal cancer. 3.8% of deaths stem from rectum and colon cancer, and approximately 1.6% from pancreatic cancer (OECD, 2021). Through screening and early detection, the alarming numbers of colorectal cancer incidence can be actively prevented. Endoscopy plays an indispensable role in modern healthcare. Our objective is to contribute to the proper functioning of endoscopic facilities in Slovakia and to promote the overall health of the Slovak population.

The main objective of the work is to monitor the effectiveness of endoscopic equipment decontamination performed by nurses in gastroenterological outpatient practices. The results will be used to analyze the factors regarding the adjustment and testing of endoscopic devices, ultimately contributing to the development of a practical standard for nursing practice in Slovak endoscopic facilities. Our goal is to assess the practical feasibility of implementing the

new recommendations issued by the Ministry of Health of the Slovak Republic for nurses regarding the routine disinfection control of medical devices and to compare different methods of detecting contamination. We will develop proposals and recommendations for practice on the routine control of reprocessing in gastroenterological outpatient clinics in Slovak healthcare facilities. At the same time, various aspects and impacts of reprocessing quality control in practice will be analyzed.

The sample selection criteria were set as follows: endoscopes used in examinations of patients at the gastroenterology outpatient clinic of the University Hospital Trnava. The research was carried out in cooperation with the Department of Hospital Hygiene and Epidemiology of the University Hospital Trnava. Resi tests were used to detect residual proteins and Hemo-Check-S tests were used to detect residual blood. If a result was positive, we proceeded with the ATP method. The endoscopes were decontaminated using manual and automatic processes. The tested endoscopes were 3 colonoscopes, 3 duodenoscopes, and 3 gastroscopes. Additionally, we processed and analyzed the time unit (the duration of the test itself and the total reprocessing time).

Statistical Methods

Statistical tests were carried out in the R Project 4.1.3 program, and a significance level of $p < 0.005$ was chosen. If at least one indicator test was positive, the decontamination process was assessed as unsatisfactory. We graphically represented the comparison of time using box plots. The Student's T-test was used to compare the two mean values. The Chi-square test of independence was used to compare categorical variables.

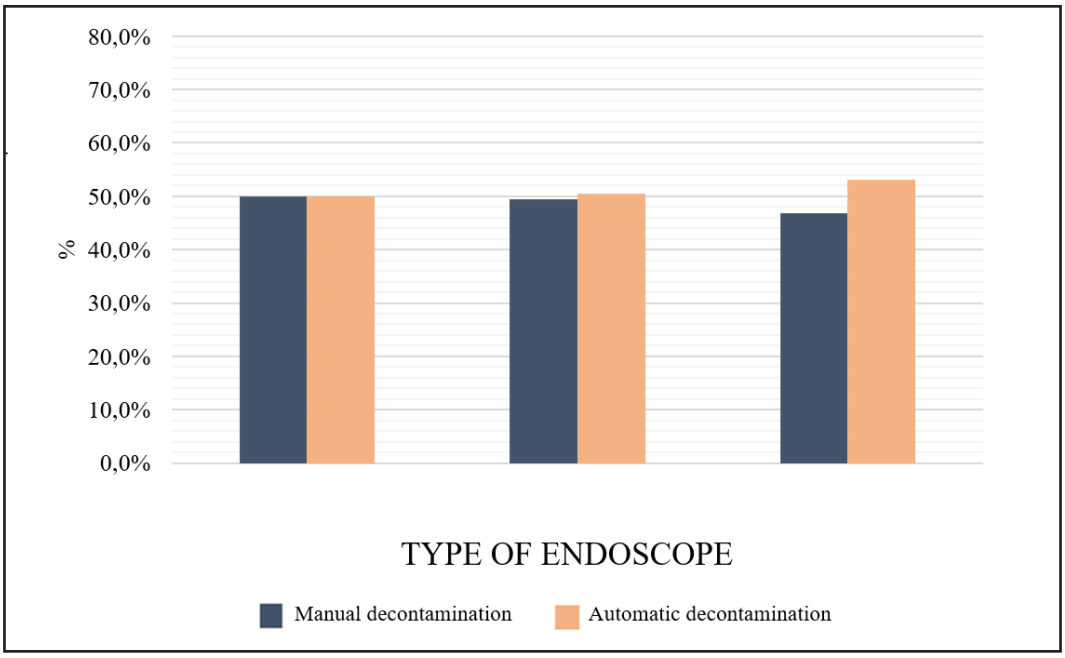
Research Results

During the research period, a total of 277 decontamination checks of endoscopic instruments were performed using 1,108 indicator tests. The tests were designed to detect residues of proteins and blood in the internal channels and outer casing of the endoscope. Testing was done after the manual and automatic decontamination of the endoscopic instruments. We divided the sampling sites for indicator tests into external and internal sections. In the external testing, we took a swab from the casing of the endoscope, the screws, and the distal end of the endoscope. The internal parts consisted of the suction and working channel and the distal end of the working channel. A different kind of testing was done with duodenoscopes, as a swab was also taken from the elevator wire channel. There were 88 (31.8%) checks on colonoscopes, 93 (33.6%) checks on gastroscopes, and 96 (34.7%) checks on duodenoscopes. According to the method of decontamination, 135 (48.7%) checks were performed purely after manual decontamination, and 142 (51.3%) checks were performed after automatic endoscope reprocessing.

The results of the control of the endoscopic reprocessing technique performed by manual decontamination

A total of 135 endoscopes were tested using indicator tests (540 tests) after being decontaminated and disinfected by the manual technique, of which 65 tests (48.1%) were positive. Out of 44 tested colonoscopes, 19 indicator tests (43.2%) were positive. The most common positive tests were for the presence of proteins in the working channel of the colonoscope, with 12 cases (27.3%). Out of the total number of 46 gastroscopes tested after manual reprocessing, 25 tests (54.3%) were positive. Similarly, the most common positive tests were for the presence of proteins in the working channel of the gastroscope, with 15 cases (32.6%). The manual reprocessing technique was performed on 45 duodenoscopes, of which 21 (46.7%) tested positive. Again, the most frequent positive tests were for the presence of proteins in the internal part of the duodenoscope channels, with 12 cases (26.7%). The results include values for endoscopes that were repeatedly tested following the detection of positive results during routine testing, specifically during the transition from glutaraldehyde preparations to Persteril.

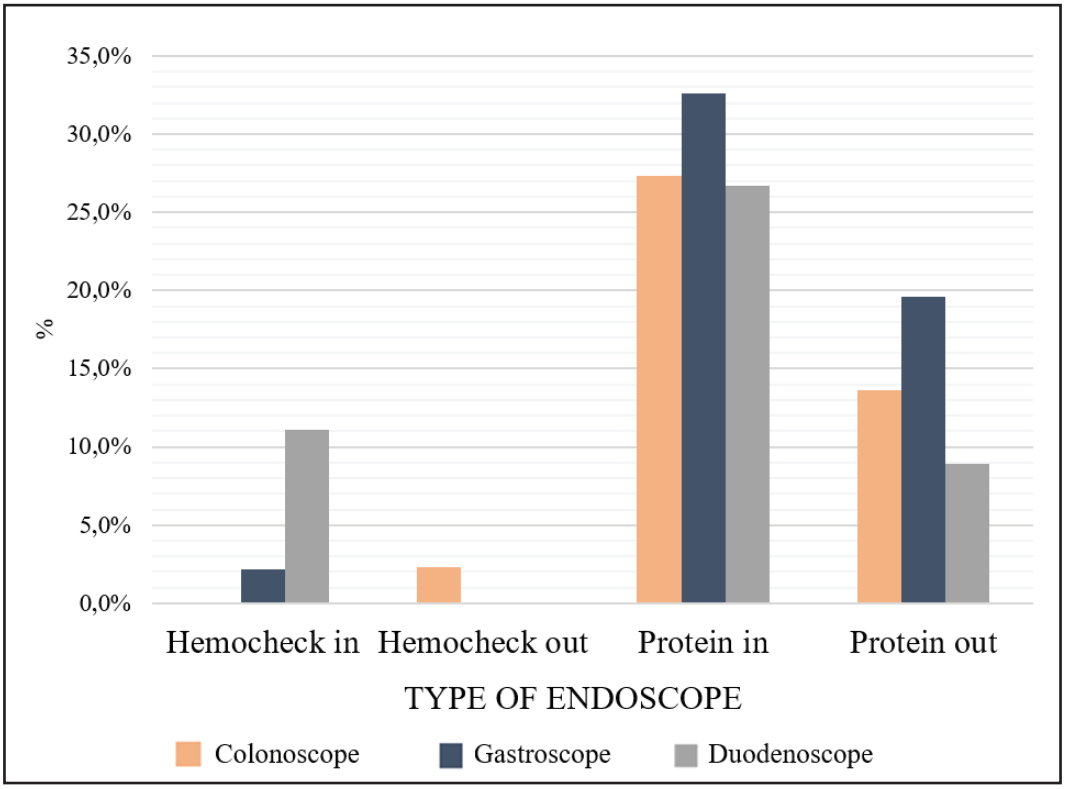
Graph 1 The number of performed inspections according to the type of endoscope and method of decontamination



Results of the inspection of reprocessing endoscopic techniques performed by manual decontamination

A total of 135 endoscopes were decontaminated using the manual technique, with 540 indicator tests conducted. Of these, 65 tests (48.1%) yielded positive results. Out of the 44 tested colonoscopes, 19 indicator tests (43.2%) were positive. The most frequent positive tests were due to the presence of proteins found in the inner part of the colonoscope, with 12 cases (27.3%). Out of the 46 gastroscopes tested after manual reprocessing, 25 tests (54.3%) were positive. The most frequent positive test results were due to the presence of proteins found in the inner part of the gastroscope, with 15 cases (32.6%). The manual reprocessing technique was performed on 45 duodenoscopes, of which 21 (46.7%) tested positive. Again, the most frequent positive tests were for the presence of proteins found in the inner part of the duodenoscope, with 12 cases (26.7%).

Graph 2 The number of positive controls after conducting manual decontamination according to the type of endoscope.

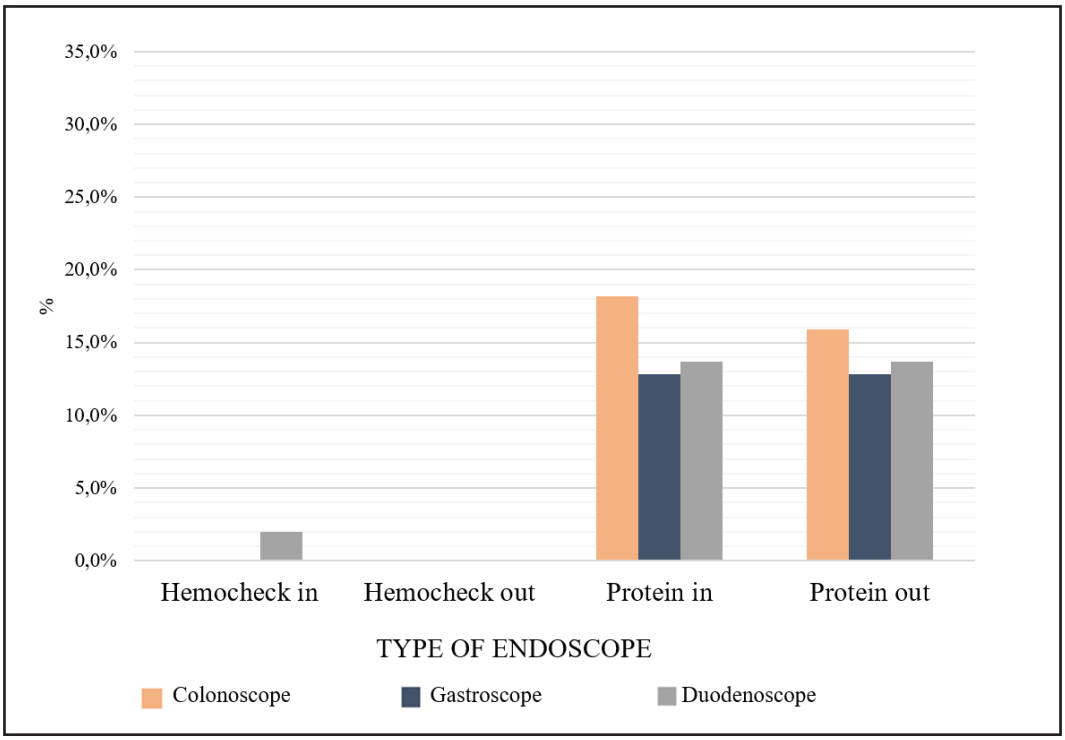


Results of the inspection of reprocessing endoscopic techniques performed by automatic decontamination

A total of 568 tests were performed automatically and 142 endoscopes were inspected. Out of the total number of 44 tested colonoscopes, 15 (34.1%) tests were positive. The most frequent positive tests were due to the presence of proteins. In the case of colonoscopes, all the performed tests were negative for the presence of blood. Out of 47 tested gastroscopes, a total of 12 tests (25.5%) were positive. The most common errors were detected in the control for the presence of proteins detected on the exterior and interior of the gastroscope, with 6 cases (12.8%). Tests for the presence of blood were negative for gastroscopes decontaminated using the automatic technique. The 51 tested duodenoscopes yielded 15 (29.4%) positive tests. The most frequent reasons for the positive tests were the presence of proteins detected on both the exterior and interior of the duodenoscope, with 7 cases (13.7%). Only one duodenoscope was positive for the presence of blood, as indicated by indicator tests, on the exterior part of the duodenoscope.

It is necessary to mention, however, that the positivity of the rapid test itself does not mean gross inaccuracy or failure of the disinfection process. The tests are semi-quantitative "rapid tests" and are intended to capture the presence of possible biological (whether protein or blood) contamination on the endoscope after reprocessing. To detect the infectivity of the endoscope for the patient, we would have to use methods for culturing microbial colonization, which are carried out in collaboration with the department of hygiene and epidemiology of the institutional facility (founder) or regional public health offices, which would not be within our competence.

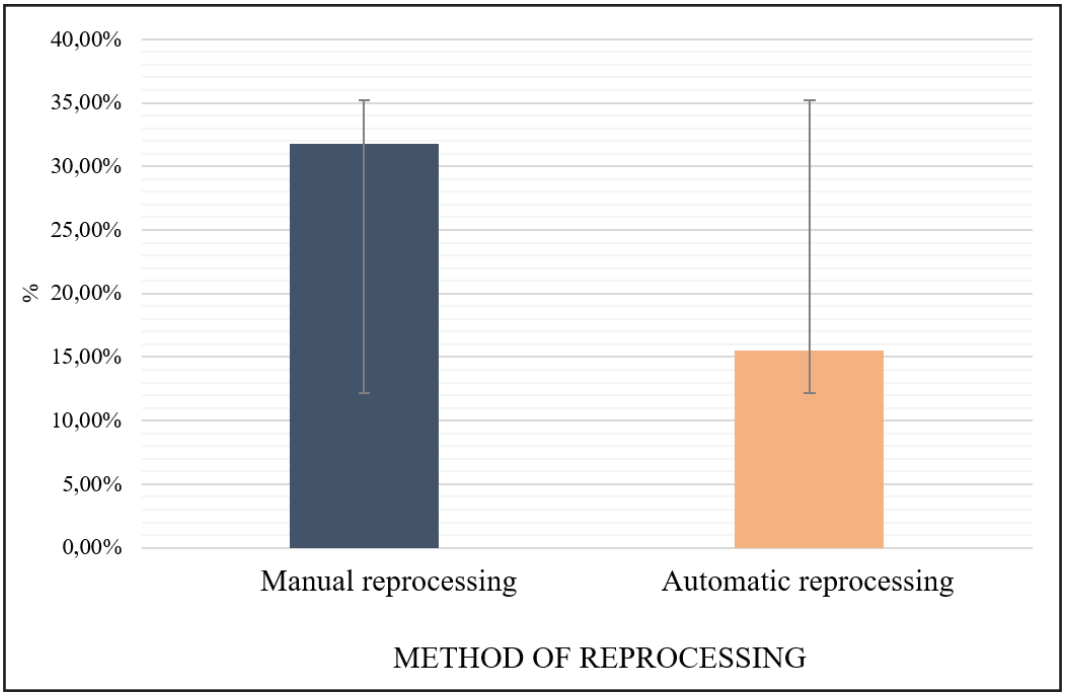
Graph 3 The number of positive controls after performing automatic decontamination according to the type of endoscope.



Comparison of the quality of endoscopic decontamination techniques after performing manual and automatic reprocessing

Out of the total number of 135 checks carried out after manually reprocessing endoscopic equipment, 43 (31.8%) endoscopes tested positive. With automatic reprocessing, 22 endoscopes (15.5%) out of a total of 142 tested positive. Statistical research shows that there is a statistically significant difference between the occurrence of errors in the reprocessing of endoscopic techniques according to the method of decontamination (p=0.0021).

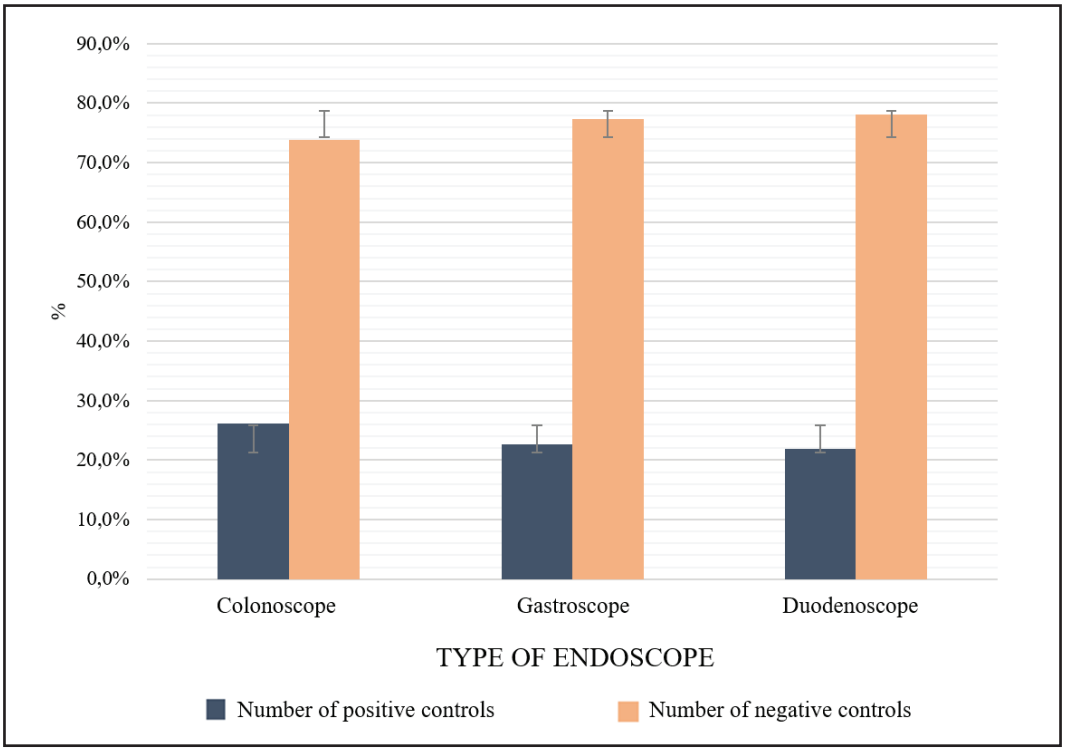
Graph 4 A comparison of the detected errors in manual and hand reprocessing



Comparison of the quality of decontamination of endoscopic equipment after performing manual and automatic reprocessing according to the type of endoscopic equipment

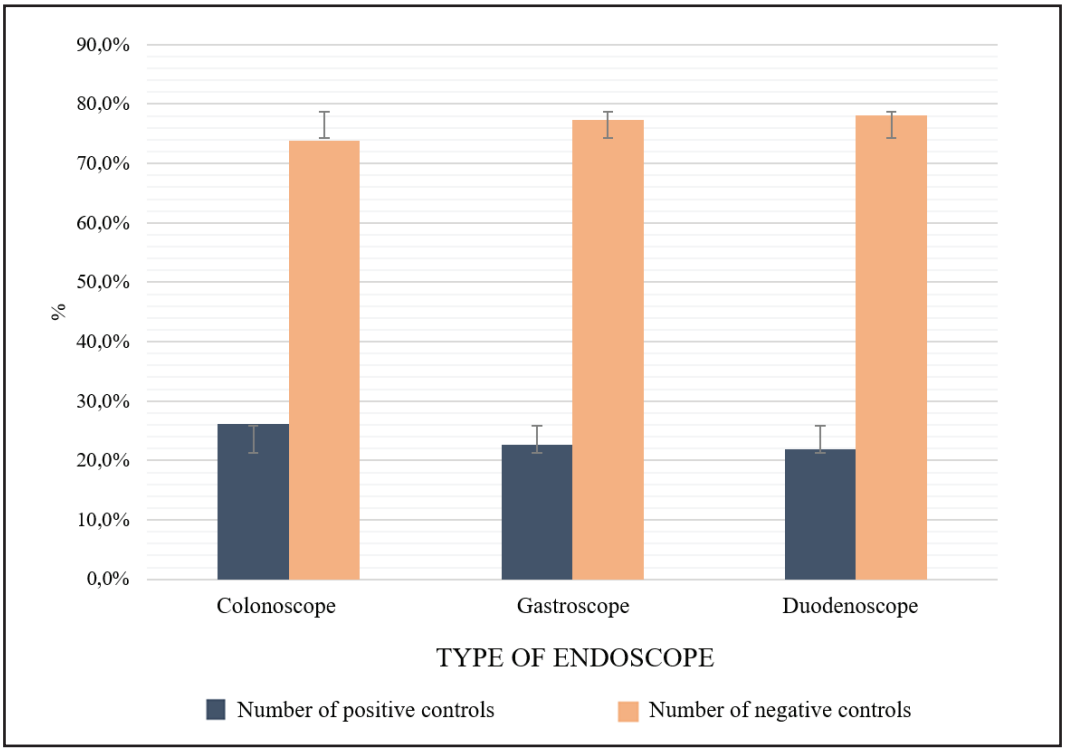
From the total number of 277 endoscopic equipment checks, 96 duodenoscopes were tested for the presence of proteins and blood, out of which 21 (21.9%) tested positive. After reprocessing, a total of 88 colonoscopes were tested, with positive results detected in 23 of them (26.1%). 93 gastroscopes were checked in total, and positive results were detected in 21 of them (22.6%).

Graph 5 A comparison of the number of endoscopes that tested positive after reprocessing according to the type of endoscope



In statistical testing, we verified whether there is a statistically significant difference in the number of detected errors according to the individual type of endoscope. This relationship was not statistically confirmed; there is no significant difference in the number of detected errors after reprocessing according to the type of endoscope (p=0.769).

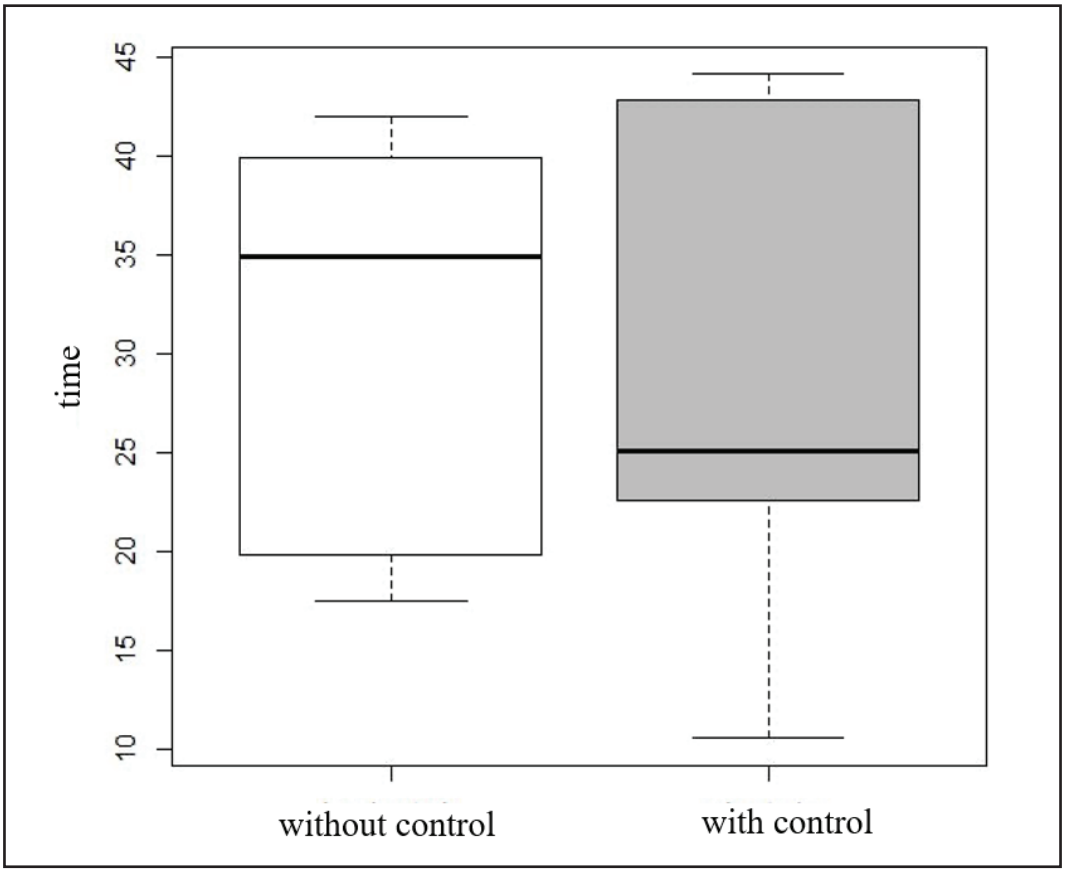
Graph 6 The results of endoscope reprocessing controls according to metho



Average time required to carry out endoscopic technique reprocessing

The average time required to perform endoscopic technique reprocessing without a control check was 29.9 ± 10.0 minutes. Reprocessing, during which the quality control of the decontamination of the endoscopic technique was also performed, lasted on average 31.8 ± 10.2 minutes (p=0.0218). Statistical testing shows that there is a statistically significant difference in the time of decontamination of endoscopic technology depending on whether the decontamination was performed with the quality control of decontamination using indicator tests and without control.

Graph 7 A comparison of endoscope decontamination time without and with testing by indicator tests



Graph 7, presented in a box plot, shows the comparison of the time required to perform reprocessing with the quality control of decontamination and without control, based on quartiles.

Discussion

This study emphasizes the primary objective of verifying the accuracy of the reprocessing procedure, which was statistically validated. Rapid tests showed a 31.8% positivity rate during manual reprocessing compared to 15.5% contamination of the endoscopes that underwent automatic reprocessing. Manual decontamination was conducted in 135 cases of endoscope cleaning, and 43 endoscopes tested positive. This represents a percentage expression of 31.8%. In contrast, the rate of positive rapid tests was reduced by half when decontamination was performed using an automatic reprocessor. This value represents higher rates of endoscope positivity testing compared with automatic reprocessing, where we detected positivity in 22 endoscopes, totaling 15.5%. **The results demonstrated the existence of a connection between the occurrence of errors in automatic versus manual decontamination, as identified by rapid tests.** Rapid tests are discussed with regard to their application in routine testing or contamination monitoring. For proving infectivity, it is necessary to carry out a cultivation examination in collaboration with the department of hygiene and epidemiology. Certain individual tests were positive due to human error, time factors, or complications of the patient's epidemiologic state. However, it should be noted that the positivity of the protein test itself does not mean gross inaccuracy or a failure

of the disinfection process. This is because the mentioned tests are semi-quantitative "rapid tests" and are meant to detect the presence of potential biological (either protein or blood) contamination on the endoscope after reprocessing. It was proven that with a second reprocessing, the rapid test yielded a negative result.

In decontamination, manual cleaning is a key component. The author Wo (2021) compared mechanical, or manual, decontamination with high-level disinfection using an automatic endoscope reprocessor. He describes sufficient and proper decontamination as difficult to achieve due to the technical complexity and the possibility of human error. The risk of contamination associated with different decontamination methods was assessed by detecting the presence of proteins and carbohydrates, thereby confirming endoscope contamination. The sample consisted of 48 examinations conducted with duodenoscopes. Out of those, 21 endoscopes were manually cleaned according to the given standards under the supervision of hygiene workers, and 27 were cleaned with HLD. Contamination was proven after manual cleaning in 4 out of 21 cases (19%). As this study concludes, manual cleaning has pitfalls and is more prone to error. HLD appears to be an automated cleaning technology that is suitable as an alternative to replace manual cleaning (Wo et al., 2021).

In 2019, study results on cleaning, disinfection, and high-level disinfection were processed. It is possible that only discussions on this topic occurred during this period in Slovakia. Slovak standards are not supplemented with these new recommendations. Rutala et al. (2019) recommend employing high-level disinfection or, alternatively, single-use sterile endoscopes—particularly for procedures involving duodenoscopes.

In 2020, Mark et al. addressed the issue of duodenoscope decontamination using HLD. Endoscopes were cleaned according to recommended practices and standards for automatic decontamination. A total of 140 cleanings were performed on 280 samples. This extensive study highlights the importance of obtaining information about decontamination as an option for further decisions regarding the fate of endoscopes. It was found that HLD is not always effective at eliminating contamination. For contaminated duodenoscopes, it is beneficial to reprocess the duodenoscope through three decontamination cycles using HLD as the type of decontamination (Mark et al., 2020).

In Brazil, they analyzed the cleaning process of 22 endoscopes, including gastroscopes, colonoscopes, and duodenoscopes. The analysis consisted of 60 samples that were used to determine the cleaning effectiveness of the endoscopes. The cleaning results revealed significant gaps in the cleaning and thorough removal of heavy contaminants from the endoscopes. The author provides an overview of the error rates, highlighting that by preventing these errors, the retention of proteins or blood in endoscopes can be avoided, even after automatic or mechanical reprocessing (de Oliveira, Madureira, 2022).

Our research did not find a correlation between the selection of endoscopes and the error rates in disinfection, specifically among endoscopes (gastroscopes, colonoscopes, and duodenoscopes). This hypothesis was not supported by our study. However, its conclusions are significant for clinical practice. It is largely derived from other studies with larger sample sizes that indicate duodenoscopes are more prone to disinfection failures compared to standard endoscopes. One of the studies talks about a sample that tested 309 duodenoscopes and 63 other endoscopes for comparison. The authors demonstrated the presence of contamination after reprocessing in 54 duodenoscopes and 9 endoscopes. In this case, the length of use of the duodenoscope (the age of the endoscope) was not associated with the contamination risk. The result is an increased risk of contamination for patients undergoing examination with a duodenoscope, particularly during ERCP, with 66% at risk of microbial transmission, as outlined in this study (Rauwers et al., 2020).

In 1993, one American company estimated the rate of infection associated with endoscopy at 1 case per 1.8 million procedures. In 2013, a new estimate was made on the rate of infection transmission during endoscopic procedures. Over the years, world organizations have monitored and conducted various studies to find the actual data.

The author talks about substantial evidence and results. High-level disinfection (HLD) alone cannot remove all contamination from duodenoscopes, and this is due to the presence of biofilm on the duodenoscope. The risk is estimated to be present in up to 10% of all procedures, or 1 in 1,765 ERCP procedures. Therefore, it is essential to continuously strive to improve the cleaning and inspection process in cooperation with relevant departments, such as hygiene, microbiology, etc. (McCafferty et al., 2018).

Duodenoscopes with a removable distal cap were compared to those with a solid, non-removable distal cap to assess the presence of bacterial infection after HLD processing, followed by testing using the ATP method. They identified the presence of bacteria in the two different types of duodenoscopes. It was confirmed that in the sample of 54 duodenoscopes with a removable distal cap there is a lower risk of the presence of bacteria compared to the solid distal end of a duodenoscope. The removable part of the duodenoscope represented a 37% presence of the risk of bacteria, and for the non-removable part, there was a 95% risk. The removable end provided easier access to the cleaning brush from Albaran's bridge, which led to effective cleaning of the endoscope and reduced the risk of the presence of bacteria (Ridtitid et al., 2020). I n examining the time required to perform endoscope control checks using indicator tests after automatic reprocessing, whether mechanical or not, we made the following assumption: we assumed a correlation between time consumption and the performance of endoscope control during reprocessing, with and without control. The average time required to reprocess endoscopic equipment without conducting indicator tests was 29.9 ± 10.0 minutes. Reprocessing, during which a quality control of the decontamination of the endoscopic technique was also performed, lasted on average 31.8 ± 10.2 minutes (p=0.0218). **After obtaining the time data, statistical testing displayed a statistically significant correlation in the decontamination time of endoscopic equipment depending on whether the decontamination was carried out with quality control of decontamination using indicator tests or without control.**

Many global recommendations, such the one from the World Association of Endoscopy Nurses, had already developed a recommendation for reprocessing testing in 2007 (Loquai et al., 2008). Many other places and facilities have adopted these recommendations into practice. The importance of detecting contamination after endoscope reprocessing in the workplace was confirmed through our research, where we repeatedly identified positive tests, thus preventing recontamination. Causes can be human factors, time, routines, and other factors that limit proper decontamination. The method of testing individual endoscopes once a week proved to be a sufficient method for detecting blood and proteins inside the channels on the surface of endoscopes. Our objective was to examine the correlation between time consumption and the implementation of endoscope reprocessing tests to inform practical recommendations and estimate the additional time this process would require in endoscopic facilities.

The time required for endoscope decontamination is divided into the time for manual processing, mechanical decontamination, and the time needed for automatic reprocessing. Unfortunately, current European guidelines lack clearly defined and uniform standards for testing endoscopes following reprocessing. It suggests the necessity of routine endoscope testing or doing so after each use. However, the interval between endoscope testing should be no longer than three months. In 18 out of 20 countries, automatic disinfectors are used, and endoscope testing is carried out in 12 out of 20 states. Many of these countries recommended testing within three months (Loquai et al., 2008).

Researchers who analyzed the time healthcare workers spent on endoscope processing developed a workflow that not only measures the time required for endoscope reprocessing but also identifies issues related to human factors and ergonomics. The sample of respondents consisted of 341 individuals. 69 of them performed manual processing and manual cleaning of endoscopes in under 10 minutes on average. Approximately 16-30 minutes were dedicated to automatic reprocessing. The respondents described time pressure during cleaning and the need to work faster (Sivek, 2022).

Conclusion

In addition to providing nursing care to patients, gastroenterology units require nurses to properly reprocess endoscopes. Reprocessing involves more than just cleaning; each step must be meticulously executed and followed by thorough verification of endoscope cleanliness through appropriate testing. Indicator tests, used to verify the presence or absence of endoscope contamination, also function as a quality control measure for nurses. However, consistent and effective use of these tests can only be ensured through standardized guidelines for all nurses working in gastroenterology units across Slovakia.

After processing our results, we found different results can be expected based on the type of endoscope reprocessing. The subject of our study were tested endoscopes that were cleaned after patient examination. The nurses reprocessed them, and then the endoscopes were tested for the presence of blood and proteins. Based on our findings, we recommend the implementation of indicator tests in gastroenterology facilities, as their use has proven effective for quality control during reprocessing. We also recommend carrying out controls, which are not time-consuming for nurses or healthcare facilities. However, we are still talking about routine testing and monitoring for contamination. For proving infectiousness, a culture examination is necessary in cooperation with the department of hygiene and epidemiology. We recommend using an automatic reprocessing process for endoscopes in workplaces, regardless of the type of endoscope. The duodenoscope, due to its construction, is a more complex endoscope. Therefore, it is essential to be vigilant in the first phase of cleaning and to comply with all recommendations to ensure the proper operation of gastroenterological facilities.

We have informed certified nurses, nurses, and practical nurses about the results. The information included how to manually clean the endoscope itself. During reprocessing, the pre-cleaning phase is the most important step, as solid particles that remain in the channels of the endoscope can infect the endoscope in all subsequent reprocessing phases. Automatic endoscope reprocessing methods are preferred over manual methods, as they reduce staff workload and demonstrate superior outcomes in quality control for high-level disinfection. After reprocessing, indicator tests should be utilized to test for blood and protein. Testing with indicator tests should be performed by a certified nurse who is trained in the form, type, and method of testing. The entire reprocessing process should be thoroughly documented, including the result of the indicator test. Newly hired staff should be trained on effective reprocessing and its importance, and the regular retraining of nurses and staff performing endoscope reprocessing should be carried out every 2 years. It is important to point out the benefits of using automatic reprocessing, using automatic disinfectors, and testing with indicator tests to nurses.

Gastroenterology departments should be equipped with all the necessary resources to ensure high-quality endoscope reprocessing in compliance with established hygienic and microbiological standards. After regular revisions, maintenance, and new endoscopic equipment installations, it is necessary to carry out testing with indicator tests before using the technology. Using indicator tests to check for proteins and blood residues should be carried out for all types of endoscopes on average once a week when using automatic disinfectors, and this is sufficient for regular endoscopies. Testing should be conducted on all types of endoscopes after each use when manual reprocessing is employed. For high-risk or clearly infectious patients, an indicator test should be performed following every examination. Despite our findings, based on the results of other studies, we strongly recommend heightened supervision during the reprocessing of duodenoscopes, particularly at the Albaran bridge, which has been identified as a potential risk site.

We recommend fostering interdisciplinary collaboration to conduct endoscope testing using indicator tests during repeated corrective actions and instances of positive results. In such cases, the hospital hygiene and epidemiology department should be consulted. Additionally, the ATP method and microbiological testing should be employed when relevant. It is essential to es-

tablish conditions that facilitate the adoption of adjusted recommendations in collaboration with the hygiene and epidemiology departments.

Thanks to the results of this work, the findings of other authors, and our practical experience of working nurses in gastroenterology, I believe that this information will be beneficial for all workplaces and for practice. Effective collaboration between gastroenterology clinics, alongside the professionalism of the staff, is a critical factor in ensuring patient satisfaction within these healthcare facilities.

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References

1. AXON A T R (2020) Fifty years of digestive endoscopy: Successes, setbacks, solutions and the future. *Digestive Endoscopy*, 32(3), 290–297. https://doi.org/10.1111/den.13593.
2. DE OLIVEIRA A C, MADUREIRA R A DA S (2022) Cleaning of in-hospital flexible endoscopes: Limitations and challenges. *Revista Latino-Americana de Enfermagem*, 30. https://doi.org/10.1590/1518-8345.5969.3684.
3. LOQUAI C, SCHLUTER B, KLOTGEN H W, LUGER T A, GRABBE S, NASHAN D (2008) Autoimmuninduktion durch pegyliertes Interferon−alpha−2b in Korrelation zur Überlebenszeit bei Mittel− und Hochrisikomelanompatienten. *Akt. Dermatol*., 34(5), 170–174. https://doi.org/10.1055/s.
4. MARK J A, UNDERBERG K, KRAMER R E (2020) Results of duodenoscope culture and quarantine after manufacturer-recommended cleaning process. *Gastrointestinal Endoscopy,* 91(6), 1328–1333. https://doi.org/10.1016/j.gie.2019.12.050.
5. MCCAFFERTY C E, AGHAJANI M J, ABI-HANNA D, GOSBELL I B, JENSEN S O (2018) An update on gastrointestinal endoscopy-associated infections and their contributing factors 11 Medical and Health Sciences 1108 Medical Microbiology. *Annals of Clinical Microbiology and Antimicrobials*, 17(1), 1–6. https://doi.org/10.1186/s12941-018-0289-2.
6. OECD (2021) State of Health in the EU · Slovensko · Country Health profile. 2021. Retrieved from https://health.ec.europa.eu/system/files/2022- 01/2021_chp_sk_slovak.pdf.
7. RAUWERS A W, VOOR IN ’T HOLT A F, BUIJS J G, DE GROOT W, HANSEN B E, BRUNO M J, VOS M C (2018) High prevalence rate of digestive tract bacteria in duodenoscopes: A nationwide study. *Gut*, 67(9), 1637–1645. https://doi.org/10.1136/gutjnl-2017-315082.
8. RAUWERS A W, VOOR IN ‘T HOLT A F, BUIJS J G, DE GROOT W, ERLER N S, BRUNO M J, VOS M C (2020) Nationwide risk analysis of duodenoscope and linear echoendoscope contamination. *Gastrointestinal Endoscopy*, 92(3), 681- 691.e1. https://doi.org/10.1016/j.gie.2020.05.030.
9. RIDTITID W, PAKVISAL P, CHATSUWAN T J, KERR S, TIANKANON K, PIYACHATURAWAT P, … RERKNIMITR R (2020) A newly designed duodenoscope with detachable distal cap significantly reduces organic residue contamination after reprocessing. *Endoscopy*, 52(9), 754–760. https://doi.org/10.1055/a-1145-3562.
10. RODRIGUEZ DE SANTIAGO E, DINIS-RIBEIRO M, POHL H, AGRAWAL D, ARVANITAKIS M, BADDELEY R, … MESSMANN H (2022) Reducing the environmental footprint of gastrointestinal endoscopy: European Society of Gastrointestinal Endoscopy (ESGE) and European Society of Gastroenterology and Endoscopy Nurses and Associates (ESGENA) Position Statement. *Endoscopy*, 54(8), 797–826. https://doi.org/10.1055/a-1859-3726.
11. RUTALA W A, KANAMORI H, SICKBERT-BENNETT E E, WEBER D J (2019) What’s new in reprocessing endoscopes:

Are we going to ensure "the needs of the patient come first" by shifting from disinfection to sterilization? *American Journal of Infection Control*, 47, A62–A66. https://doi.org/10.1016/j.ajic.2019.01.017.

12. SIVEK AD, DAVIS J, TREMOULET P, SMITH M, LAVANCHY C, SPARNON E, KOMMALA D (2022) Healthcare worker feedback on duodenoscope reprocessing workflow and ergonomics. *Am J Infect Control*. 2022 Sep;50(9):1038-1048. doi: 10.1016/j.ajic.2022.01.012. Epub 2022 Jan 30. PMID: 35108583.
13. PUBLIC HEALTH AUTHORITY OF THE SLOVAK REPUBLIC (2020). Annual Epidemiological Reports.
14. WO J, JAMES-STEVENSON T, STAINKO S, AL-HADDAD M (2021) Am J Gastroenterol Abstracts ACCEPTED : INTERVENTIONAL ENDOSCOPY Copyright © 2021 by The American College of Gastroenterology . Unauthorized reproduction of this article is prohibited . Abstracts Copyright © 2021 by *The American College of Gastroenterolog*, 116 (October), 464–465.

Abbreviations

ATP - Adenosine triphosphate residue testing
ERCP - Endoscopic Retrograde Cholangiopancreatography
HLD - High-level disinfection
FN - University Hospital
FNTT - University Hospital Trnava