Keywords
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Testing the suitability of different types of dip slides for rapid self-control of processed endoscopes

Summary

Background and objective: Due to the sometimes insufficient reprocessing of endoscopes the usual four to six month time interval between monitorings may be too long to allow rapid detection of potential flaws. Hence our aim was to examine whether dip slides, which are normally used in other areas for detecting microorganisms, can also be used as a rapid self-control method for processed endoscopes.

Methods: We selected 19 commercially available dip slides and examined the rinse solutions of non-reprocessed gastroscopes and colonoscopes. The samples were diluted and examined using dip slides and additionally plated on Tryptic Soy Agar and Endo Agar serving as reference media.

Results: 1. The median of almost all dip slides showed lower bacterial counts than both the reference media. 2. The median and the single values of dip slides no. 5 (Petrifilm AC) and no. 13 (Petrifilm Enterobac CP) showed results closest to both reference media. 3. All dip slides yielded higher bacterial counts for colonoscopes than for gastroscopes compared to TSA, but they did not yield the results compared to the TSA median value. 4. Related to Endo-Agar, dip slides yielded comparable results to the reference medium in colonoscopes.

Conclusions: Dip slides should not be viewed as a substitute for routine laboratory analyses. In spite of their imprecision in terms of the bacterial counts detected, several of the examined dip slides can be recommended for screening of the endoscope reprocessing results, especially swellable dip slides with a low detection limit. Moreover, any bacterial growth detected by means of dip slides with a low detection limit generates an immediate call for action.

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Introduction

The reprocessing of endoscopes is still a complicated procedure, and deficiencies are frequently seen in practice. In 2002 the Committee for Hospital Hygiene and Infection Prevention at the Robert Koch-Institute, Berlin (Germany), issued recommendations entitled “Hygienic Requirements for Reprocessing of Flexible Endoscopes and Accessory Endoscopic Devices” [1]. These recommendations stipulate that reprocessed endoscopes undergo periodical hygienic/microbiological testing in all endoscopic units of both hospitals and medical practices, including periodical testing by experienced laboratories every three to six months. However, such tests are frequently not performed in practice [2]. Yet, the study conducted by Tunuguntla and Sullivan in the United States in 2004 as well as other studies show that it is indispensable to verify the reprocessing quality [3].

Currently, there are no self-control methods for monitoring reprocessing results available which endoscopists can use as quality control tools to detect potential shortcomings in between periodical laboratory analyses. Thus we examined whether dip slides constitute suitable tools for testing endoscope rinse fluids. Dip slides are mainly used in the food industry to detect bacterial contamination as has been described in numerous publications [4, 5, 6, 7, 8, 9]. In addition, dip slides are used in the cosmetics and pharmaceutical industry as well as for urine testing [10]. In another study, the usage of Petrifilm® for microbiological testing of drinking water was examined [11].

If proven suitable for endoscopes testing, dip slides may constitute a rapid and easy-to-use tool at the disposal of endoscopy staff. Dip slides should not be viewed as a substitute for routine labora-

tory analyses; rather they may provide endoscopists with an additional and rapid self-control tool. Dip slides cannot be expected to yield accurate bacterial counts. However, in order to be suitable in practice, their lower detection limits should meet the requirements of the Robert Koch-Institute. The microorganisms detected need not be differentiated in the first place, as the primary goal is to determine whether microorganisms are present at all. If deemed necessary, differentiation can be performed in a microbiological laboratory at a later stage.

We selected 19 dip slides for our study. Dip slides differ depending on the swellable properties of their culture media and with regard to their detection limits. Also, it is important to know which spectrum of microorganisms each dip slide can detect. Preferably, dip slides should be able to detect total viable counts inclusive of stressed microorganisms as well as Enterobacteriaceae and/or coliform bacteria. In contrast, yeasts and moulds are less relevant for endoscope-related infections, except for bronchoscopy. Bacterial growth on the examined dip slides was compared with bacterial growth on two reference culture media: Tryptic Soy Agar (for determination of the total bacterial count) and Endo Agar (for determination of Enterobacteriaceae).

Materials and Methods

Samples

Samples were obtained from 50 colonoscopes and 65 gastroscopes at four different locations in Berlin: Three hospitals and one medical practice. Following patient use and prerinsing each endoscope biopsy channel was flushed with 50 ml physiological saline solution 0.9 %. In order to achieve sample homogeneity, the eluates of 5 gastroscopes and 5 colonoscopes were pooled. Thus a total of 10 colonoscope samples and 13 gastroscope samples were obtained. The samples were further processed in a laboratory within 2 to 5 hours after sampling. The colonoscope samples were diluted at 10^{-6} and the gastroscope samples at 10^{-5}. Of these serial dilutions only the three last dilution steps were examined.

Reference culture media

Tryptic Soy Agar (Oxoid, Wesel/Germany) for detection of total bacterial counts and Endo Agar (Becton Dickinson, Heidelberg/Germany) for selective detection of Enterobacteriaceae were used as reference culture media. A volume of 0.1 ml from the three last dilution steps of each sample was plated in duplicate onto these culture media and incubated at 36 ± 1°C for 48 h. The plates were read after 24 h and 48 h. The results were interpreted on the basis of the 24-hour-readings since bacterial counts did not change after a 24 hour period. The lower detection limit of the reference media was set to be at 6 colony-forming units (cfu) per plate and the upper detection limit at 300 cfu per plate.

Dip slides

We selected 19 dipslides of different composition from various manufacturers (see Table 1). Dipslides DS 8 and DS 9 proved identical and were subsequently termed DS 9. The last three dilution steps of each sample were examined using each dip slide. Incubation was carried out following the manufacturers' instructions (see Table 1). All dip slides were read and the results interpreted after 24 hours, since bacterial counts did not show significant changes after the expiration of this period and growth of yeasts and moulds was not taken into account. Moreover, the dipslide results were intended to be comparable with those of the reference culture media.

Dip slides differ in their detection limits and in the swellable properties of their culture media. Detection limit ranges are listed in Table 1. In order to ensure better comparability the upper detection limit was consistently set at 300 cfu per plate, even though this was not in accordance with the manufacturer's instructions.

Non-swellable dip slides (DS 1, DS 2, DS 4, DS 7, DS 10, DS 11, DS 12, DS 15, DS 17, DS 18, and DS 19) are coated with culture media on both sides to enable detection of differing microbial spectra. Results are evaluated using charts that illustrate bacterial growth on dipslides: Microbial growth on the examined dip slides is compared with these illustrations.

Dip slides with swellable properties are coated with culture media on one side only. According to the manufacturers, dip slides DS 3, DS 5, DS 6, and DS 9 mainly detect total viable counts, whereas dip slides DS 13, DS 14, and DS 16 primarily detect Enterobacteriaceae and/or coliform bacteria.

Growth results obtained with dip slides whose culture media have swellable properties are interpreted by direct enumeration of colony-forming units or by comparison with charts illustrating bacterial growth.

Fluid absorption

The volume of absorbable fluid was examined for each dip slide using physiological saline solution 0.9 % according to the manufacturer's instructions.

Each type of dip slide was weighed three times in its original state prior to and after specified absorption of physiological saline solution 0.9 % in order to determine its absorption capacity. The weight difference, expressed in grams, was calculated, and one gram of solution was assumed to correspond to a volume of one milliliter.

Analysis and statistics

Values below and above the specified limits of detection were disregarded. Bacterial counts of the respective dilution steps were extrapolated to baseline counts in cfu/ml in order to allow comparison of measurement values. Upon comparison with the dipslide values the reference values obtained with TSA and Endo Agar were defined as 100 % (shown as reference line in the following figures).

Results

Bioburden of endoscopes

Preliminary tests were conducted to determine the microbial load of reprocessed endoscopes. However, bacterial counts in endoscopes reprocessed at the four study locations were too low to allow proper evaluation of the dip slides. Thus we used non-reprocessed endoscopes directly after patient use. Due to the pooling of endoscope rinse fluids from five devices respectively the required homogeneity of bacterial counts was achieved.

The average bacterial load at baseline was 7.8×10^6 cfu/ml on TSA (3.6×10^6 cfu/ml on Endo Agar) in the examined gastroscopes and 8.6×10^6 cfu/ml on TSA (8.1×10^6 cfu/ml on Endo Agar) in colonoscopes.

Dip slides

Fluid absorption

Upon weighing the dip slides prior and after specified absorption of physiological saline solution 0.9 % it was noted that swellable dipslides were able to absorb about 1 ml, whereas non-swellable dip slides absorbed about 0.1 ml of fluid on average.

Table 1: Properties and origin of the examined dipslides. Highlighted in deeper blue: dipslides with swellable properties, highlighted in brighter blue: non-swellable Dipslides; Ps. aeruginosa = Pseudomonas aeruginosa; MOs = microorganisms.

Dip slide No.	Product	Manufacturer	Type	Incubation		Range	Microorganisms detected
				Temperature (° C)	Time (d)	cfu / ml	
1	Hycheck Desinfektionskontrolle	BD-Difco	Dipslide	36 +/- 1	2	$10^3 – 10^6$	total viable count, stressed MOs
2	Hycheck Gesamtkeimzahl	BD-Difco	Dipslide	36 +/- 1	2	$10^3 – 10^6$	total viable count
3	Millipore HPC	Millipore	Dipslide	36 +/- 1	2	11 – 300	total aerobe count including stressed MOs
4	Easicult Combi	Orion	Dipslide	30 +/- 1	7	$10^3 – 10^6$	total aerobe count, yeasts, fungi
5	Petrifilm AC	3M	Petrifilm	36 +/- 1	2	15 – 250	total aerobe count
6	Millipore Total Count	Millipore	Dipslide	36 +/- 1	2	11 – 300	total aerobe count
7	Envirocheck Contact DC	Merck	Dipslide	36 +/- 1	2	$10^3 – 10^7$	total viable count, bacteria, yeasts, fungi, stressed MOs
9	Drycult TPC	Orion	Dipslide	36 +/- 1	2	$1 – 10^5$	total viable count
10	Urotube 2s	Becton Dickinson	Dipslide	36 +/- 1	2	$10^3 – 10^6$	total viable count, bacteria, yeasts, Enterobacteriaceae
11	Dip-Slide Cled/MacConkey/Cetrimid	Oxoid	Dipslide	36 +/- 1	7	$10 – 10^6$	total viable count, Enterobacteriaceae, selective für *P. aeruginosa*
12	Hycon GK-A/C	Biotest	Dipslide	30 +/- 1	7	$10^2 – 10^5$	total viable count, coliform bacteria
13	Petrifilm Enterobac CP	3M	Petrifilm	36 +/- 1	2	15 – 100	Enterobacteriaceae
14	Millipore Coli Count	Millipore	Dipslide	36 +/- 1	2	11 – 300	coliform bacteria
15	Hycheck Enterobacteriaceae	BD-Difco	Dipslide	36 +/- 1	2	$10^3 – 10^6$	total viable coun, Enterobacteriaceae
16	Petrifilm CC	3M	Petrifilm	36 +/- 1	2	15 – 150	coliform bacteria
17	Hycon GK-A/HS	Biotest	Dipslide	30 +/- 1	7	$10^2 – 10^5$	total viable count, yeasts, fungi
18	Dip-Slide TS/Malzextrakt CA	Oxoid	Dipslide	30 +/- 1	7	$10 – 10^6$	total viable count, yeasts, fungi
19	Dip-Slide Combi	Bode	Dipslide	30 +/- 1	2	$10^2 – 10^7$	total aerobe count, yeasts, fungi

Limit of detection

For dip slides DS 1, DS 2, DS 4, DS 7, DS 10, DS 12, DS 15, DS 17, and DS 19 manufacturers state detection limits of 100 and 1000 cfu/ml. These specifications were confirmed upon comparison with the values obtained with our reference test media. However, a detection limit of 100 cfu/ml is too high for the purpose of this study, so that we disregarded the corresponding results.

For dip slides DS 3, DS 5, DS 6, DS 9, DS 11, DS 13, DS 14, DS 16, and DS 18 manufacturers state detection limits of 1, 10, 11, and 15 cfu/ml (Tab. 1). Since the counts obtained with the non-swellable dip slides DS 11 and DS 18 were lower than those obtained with swellable di slides despite a stated detection limit of 10 cfu/ml, the corresponding results were disregarded, all the more as the accuracy of the interpretation method was insufficient.

Comparison of dip slides with reference culture media

In comparison with TSA the examined dip slides yield median values below the 100 % reference line (fig. 1). The median of dip slide DS 5 comes closest to the reference line (85,8 %), followed by the median of dip slide DS 13 (71,2 %).

However, higher median values are obtained with all examined dip slides in comparison with Endo Agar than with TSA. The median of dip slide DS 5 exceeds (113,8 %) the reference line, again followed by the median of dip slide DS 13 (92,3 %). The 75th percentile exceeds the reference line in 6 out of 7 dipslides.

Dip slides DS 3, DS 5, DS 6, and DS 9, which according to manufacturers' instructions can detect total viable counts, show lower microbial counts by comparison with TSA, since most of the values lie below the 100 % reference line. However, when compared with Endo Agar, these dip slides produce higher microbial counts than in comparison with TSA, i. e. they detect higher counts than the reference medium Endo Agar. The values of the 75th percentile of DS 5 and DS 6 clearly exceeded the reference line.

Dip slides DS 13, DS 14, and DS 16, which according to manufacturers' instructions can detect Enterobacteriaceae and/or coliform bacteria, also show lower counts when compared to TSA than in comparison with Endo Agar, and their median values lie below the 100 % reference line. Median values do not reach the Endo Agar reference line; however, the values of the 75th percentile clearly exceed the reference line.

Comparison of the dipslides with TSA and Endo-Agar, itemized by colonoscope and gastroscope

The results were analyzed separately and itemized by sample origin (colonoscope or gastroscope). With samples from both colonoscopes and gastroscopes all dip slides produced lower microbial counts than the reference medium TSA (see Fig. 2). Colonoscope samples gave median values ranging from 49.6 % (DS 14) to 88.9 % (DS 5), thus clearly exceeding median values in gastroscope samples. In gastroscope samples median values ranged from 0.4 % (DS 16) to 8.2 % (DS 9), with the exception of DS 5 (51.2 %)

Compared to Endo Agar dip slides also showed higher bacterial counts in colonoscopes than in gastroscopes (Fig. 3). In colonoscope samples median values of the dip slides ranged from 64.3 % (DS 6) to 107.7 % (DS 5). Dipslide DS 5 detected higher cfu counts than the other dip slides and even in comparison with the reference medium Endo Agar. The gastroscope sample results are of limited significance since the number of evaluable results was too low. Hence although we do present gastroscope results here, we do not take them into consideration in our analyses.

Discussion

The reprocessing of flexible endoscopes includes various procedural steps (cleaning, disinfection) and parameters (time, temperature, dosage, etc.) and can be accomplished both manually and automatically. Reprocessing in fully automated endoscope washer-disinfectors (WD) shall be validated or standardized in accordance with prEN 15883-1 [12], whereas manual reprocessing is hardly standardizable and validable. Manual reprocessing is performed more frequently in medical practices than in hospitals due to high acquisition and maintenance costs for WD. For example, in the Frankfurt/Main area (Germany) 39 % of all medical practices reprocess their endoscopes manually, compared with only 7 % of all hospitals [13]. In Berlin, 49 % of all medical practices reprocess their endoscopes manually [14].

In comparison with manual reprocessing the quality of automated reprocessing is considerably higher. In the HYGEA study conducted in Bavaria, Germany, reprocessing results were deemed unsatisfactory in 49 % of all manually reprocessed endoscopes, versus 14 % of automatically reprocessed endoscopes [2]. Nevertheless in principle flexible endoscopes can be reprocessed both automatically and manually with satisfactory effectiveness in terms of hygiene.

The flexible endoscope reprocessing procedure should include microbiological tests to allow detection and elimination of potential shortcomings. The Robert Koch-Institute, Germany, recommends that these microbiological tests be carried out every three to six months in all flexible endoscopes available [1]. Within the "Agreement on the Quality of Colonoscopy" (Qualitätsvereinbarung zur Koloskopie) the German National Association of statutory health insurance physicians (Kassenärztliche Bundesvereinigung) requires microbiological testing of flexible endoscopes every six months by acknowledged laboratories as a prerequisite for a physician to be entitled to perform and invoice colonoscopies [15]. These laboratory controls, while relatively costly, allow detection of microorganisms which may be present in endoscopes. However, such half-yearly controls do not always detect flaws like damaged endoscope channels that prepare the ground for microbial contamination. So far the problem-oriented endoscopist does not have a rapid and easy self-control method at his disposal for monitoring the reprocessing result. No experiences exist regarding the suitability of dip slide culture systems for testing rinse fluids of endoscopes [1]. Hence, in our study we examined whether dip slides constitute a tool for quality control which may be used in addition to the officially recommended microbiological laboratory tests.

Sampling: colonoscopes and gastroscopes

For sampling we initially planned to use endoscopes already reprocessed as these were likely to be heavily contaminated. In

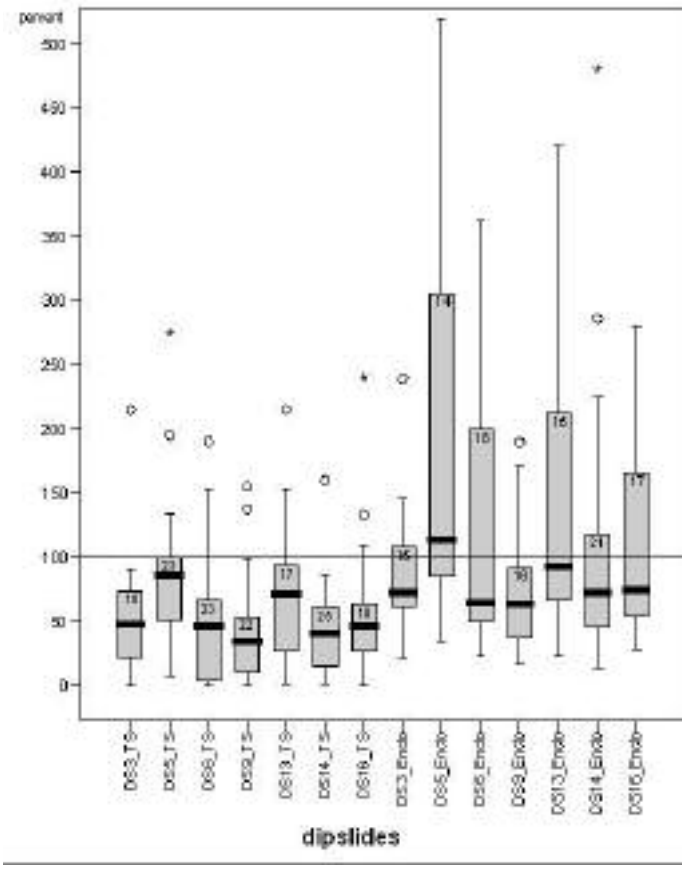

Figure 1: Results of dipslides expressed as percentage of reference media TSA and Endo Agar (represented as 100 % reference line). The number of evaluable dipslides is shown in the respective box plots. Box plot: Line in the box = median value, box = 25 % to 75 % of values, maximal and minimal value = values have the distance of 1,5-box length from the box, circles = outlier values have the distance between 1,5 and 3 box length from the box, stars = extreme values have the distance of more than 3 box length from the box.

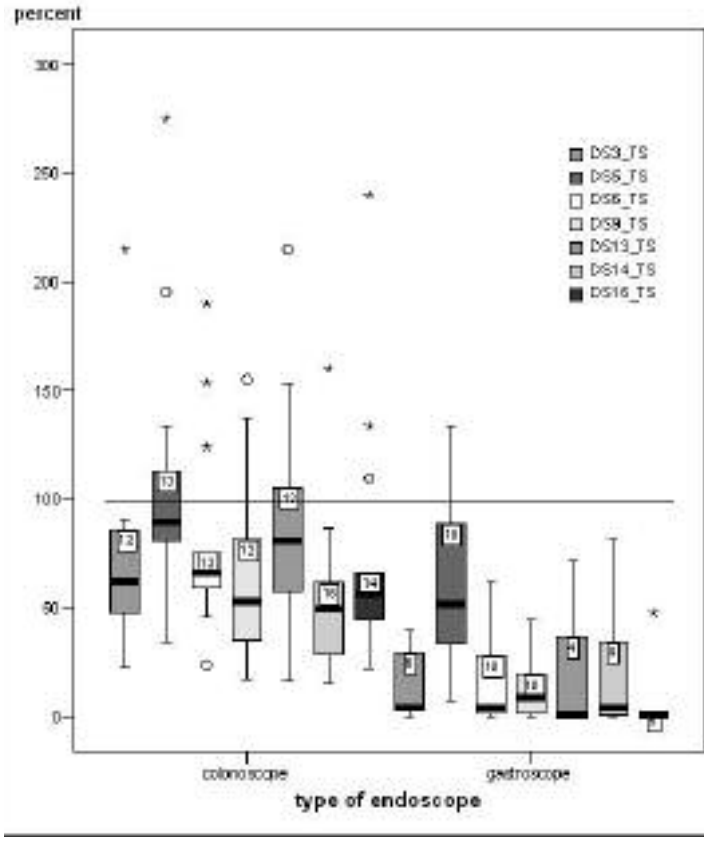

Figure 2: Results of dipslides expressed as percentage of reference medium TSA, (represented as 100 % reference line), itemized by sample origin. The number of evaluable dipslides is shown in the respective box plots. Explanation of box plot see figure 1.

the HYGEA study 49 % of endoscope reprocessing results in the first study phase and 39 % in the second study phase were deemed unsatisfactory [2]. In Berlin the dissatisfaction rate was 25 %, with dissatisfaction dropping from 48 % in the first examination series to 16,7 % in the sixth examination series [14].

Thus we first carried out preliminary tests of rinse fluids of endoscopes that had already been reprocessed. Samples were collected without advance notice at various locations in Berlin, on different days of the week, within differing periods of time and from randomly selected WDs. The results showed consistently low microbial loads (approximately 1 cfu per milliliter of rinse fluid)[16]. In order to obtain the bacterial counts required for this study, we therefore used non-reprocessed endoscopes directly after patient use. As expected, non-reprocessed endoscopes had high microbial loads, with colonoscopes displaying slightly higher microbial baseline loads than gastroscopes (arithmetic mean values of 8.6×10^6 cfu/ml and a total of $4,3 \times 10^8$ per suction channel in used colonoscopes versus 7.8×10^6 cfu/ml and a total of $3,9 \times 10^8$ per suction channel in used gastroscopes). Comparable cfu counts in colonoscopes were found in other studies: Vesley et al. found microbial loads of 8.4 $\log_{10}$ (1.5×10^8) per suction channel in colonoscopes and 6.7 $\log_{10}$ ($1. 7 \times 10^6$) per suction channel in gastroscopes [17]. Chu et al. detected microbial loads of 7×10^9 cfu per colonoscope suction channel, and Alfa et al. found 8.46 $\log_{10}$ (1.46×10^8) cfu per colonoscope suction channel [18, 19].

Hygiene recommendations

Various guideline values for viable counts found in endoscope rinse fluids have been proposed. The Robert Koch-Institute recommends a maximum bacterial count of 20 cfu per 20 ml rinse fluid. However, the authors of the HYGEA study as well as the German National Association of statutory health insurance physicians stipulate a maximum of 10 cfu per 1 ml rinse fluid. In any case, the following microorganisms shall never be detected: *E. coli*, other Enterobacteriaceae, enterococci, *Pseudomonas aeruginosa*, *Pseudomonas spp.*, other non-fermenters as well as microbes like *Staphylococcus aureus* relevant in terms of hygiene.

The guidelines of the Association of Professionals in Infection Control and Epidemiology (APIC) define the absence of any growth of vegetative bacteria as criterion for acceptability [20]. No criteria are mentioned in the guidelines of the European Society of Gastrointestinal Endoscopy [21]. The guidelines of the French Society of Digestive Endoscopy (SFDE) call for criteria to be established: "Furthermore, priorities must be established for the detection of bacteria and identification of the preponderant colony or colonies together with the appropriate culture medium" [22].

Dip slides

In principle, dip slides are suitable for rapid testing of fluids and can be handled even by an inexperienced person. Compared to laboratory analyses, dip slides are considerably cheaper and offer the advantage of being usable any time. The costs for one dip slide range from one to four Euros depending on the manufacturer, whereas costs for laboratory analyses range from 69 from 95 Euro (KV Brandenburg, Berlin, Germany) [23]. However, according to manufacturers' instructions dip slides shall be disposed of by immersion in a disinfectant solution, by autoclaving or by incineration. So far no dip slides specifically designed for testing rinse fluids from reprocessed endoscopes are available, and no dip slides have been recommended by manufacturers to this end.

In our study, the majority of the selected dip slides equipped with non-swellable culture media have detection limits above 100 cfu/ml. They were evaluated at baseline and their declared limits of detection were confirmed. However, in view of the recommended guideline values they are not suitable for the detection of microorganisms in rinse water samples of reprocessed endoscopes. Non-swellable dip slides are evaluated using charts that illustrate bacterial growth on dip slides, i. e. colony-forming units are not counted individually, but their number is estimated by comparison with these charts. Yet, the patterns represented on these charts do not reflect true cfu counts, but rather approximations, e. g. 10^5 or 10^6 cfu/ml, meaning that direct cfu counting is not possible. This method of evalu-

ation also applies to dip slides DS 11 (Dip-Slide CLED/MacConkey/Cetrimide) and DS 18 (Dip-Slide TS/malt extract CA/Oxoid), whose lower limit of detection is 10 cfu/ml. Hence in spite of their detection accuracy dip slides DS 11 and DS 18 were not taken into account.

Swellable dip slides with lower detection limits of 1, 10, 11, or 15 cfu/ml are more accurate and thus more suitable for screening the endoscope reprocessing quality than non-swellable dipslides. Evaluation can be done both by counting of colony-forming units and by estimating the bacterial count through comparison with sample charts.

The upper limit of detection was set at 300 cfu for all dip slides in order to ensure comparability of the examined dip slides among one another and with the reference culture media. According to manufacturers dip slides DS 5, DS 13 and DS 16 had upper detection limits below 300 cfu. We nevertheless included these dip slides into the data evaluation due to their high accuracy in detecting low cfu counts. Otherwise this would result in the loss of relevant data and hamper statistical analyses.

Reference culture media

In order to ensure detectability of all microorganisms mentioned above, we selected two reference culture media. TSA for was chosen for determination of the total bacterial count, and Endo Agar which contains a lactose indicator served as reference culture medium for detection of Enterobacteriaceae, *Pseudomonas spp.* and other non-fermenters. Limits of detection were set at 6 cfu per plate (lower detection limit) and 300 cfu per plate (upper detection limit).

Comparison of dip slides versus reference culture media

More than 50 % of the bacterial counts obtained with dipslides were lower than those obtained with both TSA and Endo Agar. The only exception was dipslide DS 5: More than 50 % of the bacterial counts obtained with DS 5 were higher than those obtained with Endo-Agar. We therefore concluded that in general dipslides produce lower bacterial counts than the reference media.

However, it should be noted that endoscopes that proved contaminated despite reprocessing were not available in sufficient number. Hence we used endoscopes displaying a bioburden resulting from patient use, i. e. endoscopes with heavy microbial contamination. Despite serial dilutions several dip slides were non-countable due to high cfu counts. This was seen more frequently than dipslides exhibiting no microbial growth despite presence of microorganisms in the samples. More favorable results would be obtained if non-countable values were taken into account in the evaluation, as shown in the doctoral thesis in process by Gerstenberger [16]. Thus we conclude that microorganisms present in the endoscope will indeed be revealed by dip slides. However, the opposite conclusion can not be drawn: The absence of any growth on dip slides does not prove that the examined endoscopes does not contain microorganisms.

Several differences between the examined dip slides and reference culture media can be noted: In comparison with TSA all examined dip slides produce lower cfu counts than in comparison with Endo Agar. This may suggest that dip slides detect Enterobacteriaceae better than total bacterial counts. No difference was seen between dip slides that according to manufacturers were designed for determination of total bacterial counts and dip slides designed for determination of Enterobacteriaceae or coliform bacteria.

Upon itemization of results into sample origin (gastroscope or colonoscope) with dipslides in comparison with TSA expected significantly higher microbial counts are found in colonoscopes than in gastroscopes, with dip slides not achieving the cfu counts obtained with TSA. Compared to Endo Agar most dip slides produce similar cfu counts in colonoscopes, with dip slide DS 5 detecting even higher bacterial counts than Endo Agar.

Upon comparison with Endo Agar the dip slide results obtained with gastroscope samples could not be interpreted by taking the upper and lower detection limits into account. However, we found that higher cfu counts are detectable in colonoscope than in gastroscope samples in relation to both reference culture media.

In colonoscope samples dip slide results approximated or exceeded those of Endo Agar, the reference culture medium for detection of Enterobacteriaceae. This can be attributed to qualitative and quantitative differences in the bioburden present at baseline, since higher counts of intestinal bacteria were found on colonoscopes than on gastroscopes, suggesting that the examined dip slides detect microorganisms present in rinse fluids of colonoscopes better than in rinse fluids of gastroscopes.

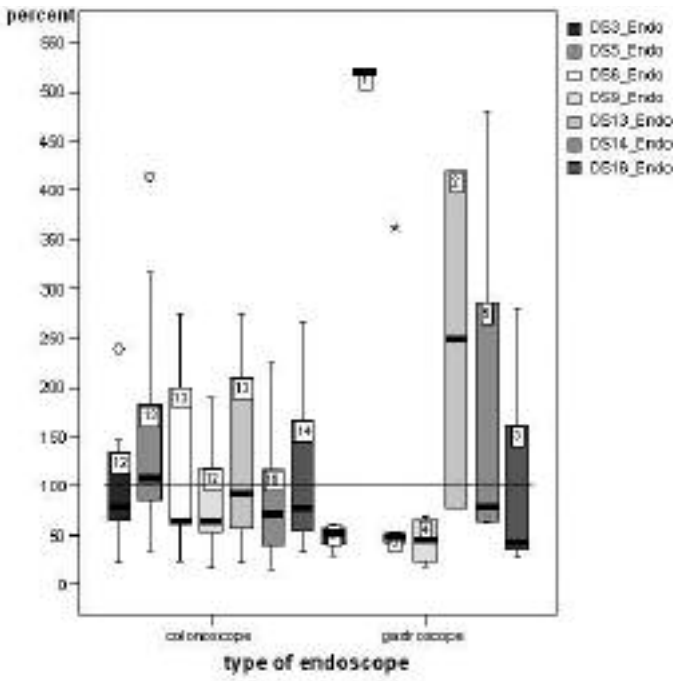

Figure 3: Results of dipslides expressed as percentage of reference medium Endo Agar (represented as 100 % reference line), itemized by sample origin. The number of evaluable dipslides is shown in the respective box plots. Explanation of box plot see figure 1.

Conclusion

Although most dip slide results did not achieve cfu counts comparable to those of the chosen reference culture media, swellable dip slides with a low detection limit (DS 3, DS 5, DS 6, DS 9, DS 14, DS 16) can still be recommended for screening of the quality of endoscope reprocessing. The use of these dip slides should not be viewed as a substitute for routine laboratory analyses, but rather as a tool for the endoscopist to evaluate the reprocessing result. In this way reprocessing flaws can be identified and managed without delay, and patients are never put at risk. For example, microorganisms which colonize defective devices will be detected by dip slides if present in sufficient numbers. Thus any microbial growth detected by one of the recommended dip slides clearly generates an immediate call for action.

In view of constant developments with respect to the quality control of endoscope reprocessing results, and given that dipslides still show various shortcomings, manufacturers of laboratory systems are appealed for developing innovative dip slides with improved sensitivity designed for examination of endoscope rinse fluid.

Nevertheless the recommended dip slides evaluated in this study are cost-effective and readily available on the market and allow detection of potential problems without delay. Endoscopists can use them as an additional self-control tool.

Acknowledgement

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