Original Article

Comparison of the cleaning and drying performance of different instrument tray designs and accessories

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All authors confirm that there is no conflict of interest according to the guidelines of the International Committee of Medical Journal editors (ICMJE).

Abstract

Following a previous comparison of wire-mesh trays (baskets) and perforated sheet metal trays (*Central Service* 4/2018) [1], the present study now investigated in addition the performance of a new perforated sheet metal tray with a corrugated design and also explored any changes resulting from the use of two different silicone mats or from reprocessing with a fitted tray lid.

To that effect, the drying properties of loads with 50 standard instruments and different drying times, with and without rinse aid, were compared on the basis of weight difference.

The cleaning performance was investigated in two different processes using a system consisting of process challenge devices (PCDs) and a camera (Helimatic Performance Qualification), based on detachable box locks.

Keywords
- surgical instruments
- reprocessing
- instrument trays
- cleaning
- drying

It was shown that there were no significant differences in the drying and cleaning performance between the tray designs. Silicone mesh mats did not adversely affect the cleaning or drying results, whereas the burled silicone mat and a fitted tray lid greatly increased the residual moisture. Cleaning was hampered only when using the tray with fitted lid.

The drying performance was primarily influenced by the drying time and position in the chamber. Under the test conditions, the use of a rinse aid shortened the drying time by 5–10 min.

The conclusion drawn is that a compromise must always be reached between the process outcome and instrument protection. Our study provides additional insights into this.

- Perforated sheet metal trays (bars or corrugated design) can be used without any adverse effect on drying or cleaning.
- Overall, drying and cleaning are highly dependent on the system and process control. These should always be checked and optimized as a first troubleshooting step.
- Silicone mesh mats, of the design investigated here, did not result in any difference in the cleaning and drying performance and may be routinely used (if desired).
- The burled silicone mat tested adversely impact only the drying performance. The mats should therefore be used specifically for delicate, fine instruments.
- The same applies to trays with fitted lid which have a negative impact on drying and cleaning.
- Rinse aids shorten the drying time by around 5 min in all setups.

Another common observation in everyday practice was instrument stains mirroring the tray structure, as seen after cleaning or sterilization. These differ in accordance with the tray design but should be addressed by optimizing the media quality.

Background

Wire trays serve as a general design benchmark for instrument trays (baskets). While it is said that other designs, e.g. perforated sheet metal, offer better instrument protection (less interlocking or slipping of instruments through openings), their drying and cleaning performance has been the topic of controversial debate. An initial study into this has already been carried out by the present authors (*Central Service* 4/2018) [1].

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Another critical factor in the case of sheet metal trays was frequent sliding of instruments within the tray. To prevent this happening, a sheet metal tray with a three-dimensional corrugated-design structure was developed. This design should facilitate instrument "packing" (positioning); that was also investigated here (but not the packing performance).

For enhanced protection of, in particular fine, instruments, silicone mats and/or trays with a lid are commonly used. This also raises the possibility of impaired cleaning and drying performance. The extent to which rinse aids could improve the drying performance was also investigated.

EN ISO 15883-1 calls for complete drying as far as possible as this also facilitates instrument handling. Besides, residual moisture can cause contact corrosion. To date, no direct comparison of these properties has been conducted. The Quality Task Group of the German Society of Sterile Supply (DGSV) published a guideline in *Central Service* on this topic [2]. However, that only listed, but did not test or quantify, the pros and cons noted.

Aim

The aim of this publication was to test the cleaning and drying performance of different tray designs and accessories with the aforementioned configurations under standardized conditions and with different process parameters. It aimed to quantify differences so as to compare the process parameters underpinning good performance.

Materials and Methods

The test trays were wire-mesh trays (mesh width 4 mm, bar width 1 mm) and sheet metal trays in corrugated design (AESCULAP Aicon®), all measuring 485 mm x 250 mm and manufactured by Aesculap, Tuttlingen (Fig. 1+2).

The accessories used were two silicone mats, one in mesh design (Fig. 3, blue), the other in classic burled design (Fig. 4 yellow) as well as a lid in bar design (mesh width 4.5 mm, bar width 1 mm).

Testing was divided into "cleaning "and "drying" sections. To test the drying performance each tray was loaded with 50 standard instruments. The loading configuration was based on

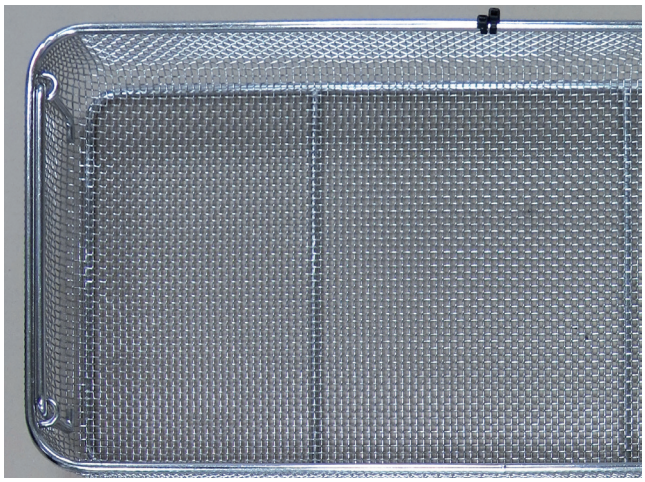


Fig. 1: Wire (mesh) test tray(mesh width 5 mm, wire diameter 0.5 mm)

Fig. 2: AESCULAP Aicon® sheet metal tray in corrugated design (mesh width 4.5 mm, 1 mm bars)

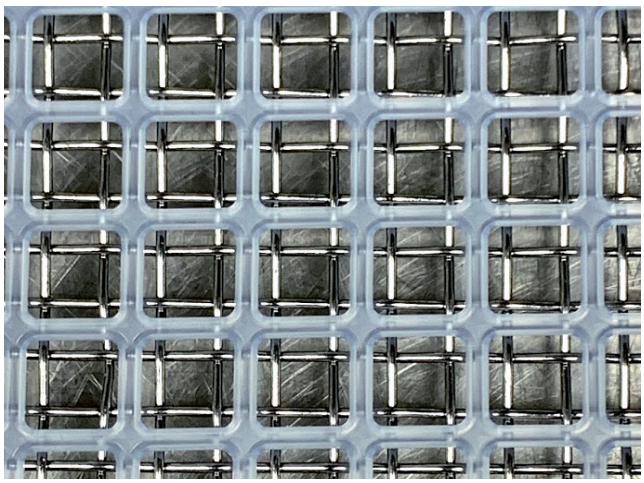


Fig. 3: Mesh mat, mesh width 8 mm, bar 2 mm

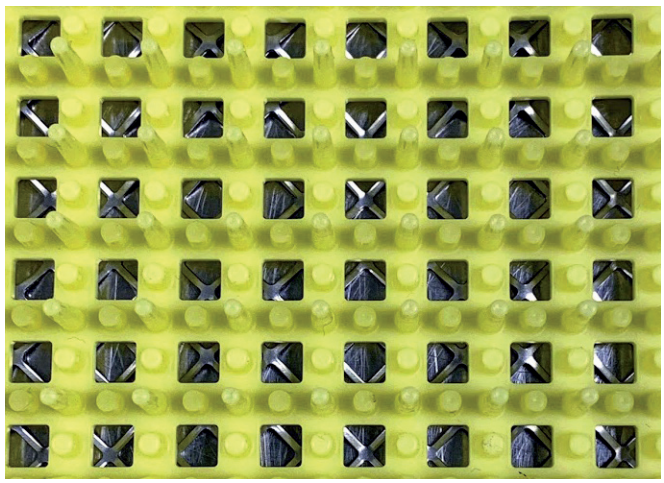


Fig. 4: Burled mat, holes with 5 mm edge length, bar width 5 mm

Fig. 5: Loaded tray for measurement of dryness

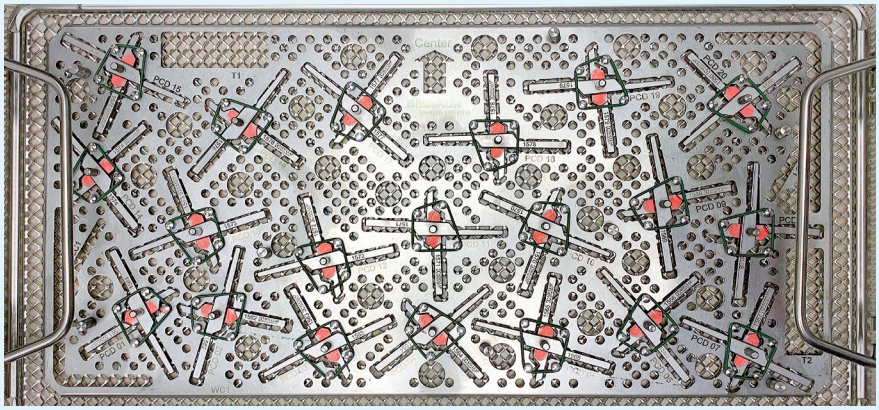


Fig. 6: Sheet metal tray with metal template (level 2 +3), for spray shadowing (without PCDs)

the *Red Brochure* (a reprocessing guide issued by the Instrument Preparation Working Group [AKI]) [3], with all jointed instruments opened to 90° and evenly distributed in horizontal layers on the trays. The weight of a loaded tray was 3 kg±300g.

In all cases, one wire and one sheet metal tray were placed side by side in a Belimed WD290 washer-disinfector (WD).

The drying temperature was varied in the first test series and then in the second series set to a standard temperature of 120°C, resulting in chamber temperatures of between 40°C and 70°C (measured with EBRO EBI 10 TP231 thermologger in the geometrical centre of the chamber). The temperature was also determined on the basis of the WD air outlet setting and by means of the negative pressure of the exhaust air system from the chamber. That meant that even machines of similar design could produce different drying performances depending on the installation. Rinse aids (B. Braun Helimatic Rinse) were used additionally. The pre- and post-cy-

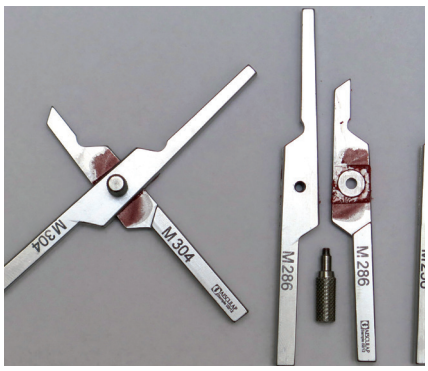


Fig. 7A: PCDs

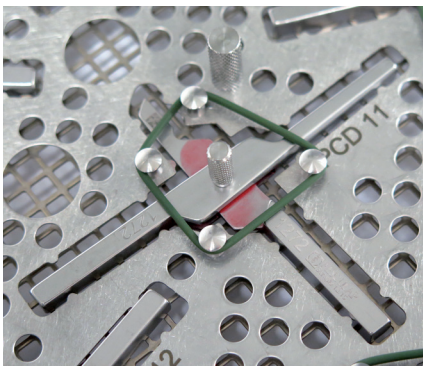


Fig. 7B: PCDs in template (see Fig. 6)

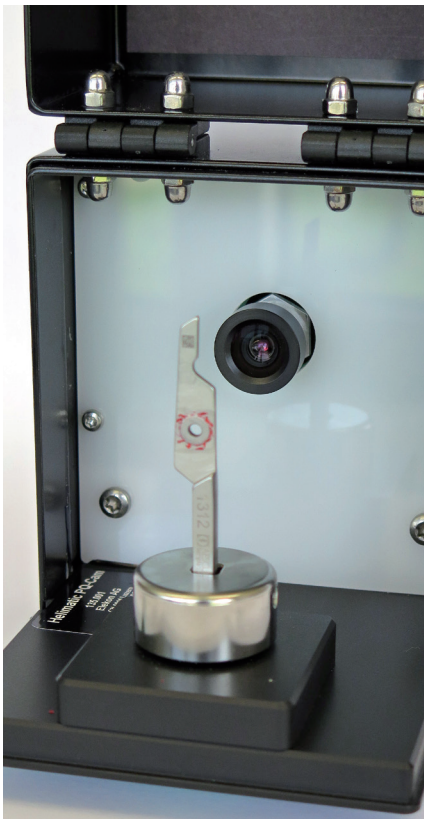


Fig. 7C: Camera system

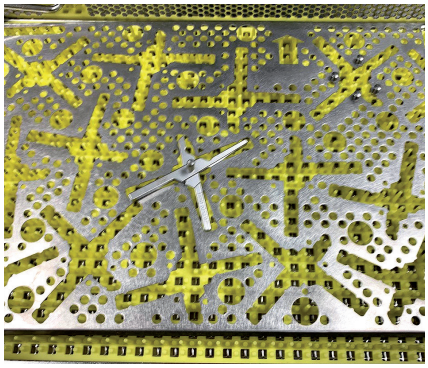


Fig. 7D: Cleaning with yellow silicone mat

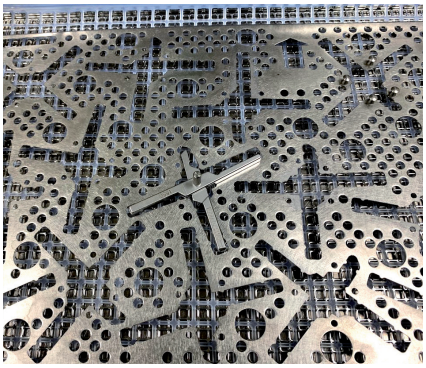


Fig. 7E: Cleaning with blue silicone mat

cle weight difference is a measure of the drying performance. The results were compared as absolute values and influence factors.

The cleaning performance was evaluated with the HPQ system (Helimatic Performance Qualification) in two processes using different holding times. The HPQ model consisted of a template with 20 soiled PCDs, with detachable box locks and a camera using software to optically quantify the residual contamination. The PCDs were each contaminated with 100 µl Browne Test Soil and dried for 1 h at 55°C. Twenty PCDs were reproducibly positioned in a special template on each tray. After cleaning, the residual red colour on the inside was measured in mm^2 with the HPQ camera system. That value was somewhat proportional to the amount of residual protein on the PCDs in areas with low to moderate residual contamination [4].

Results

The drying results revealed that the chamber temperature was essentially a function of the drying time and less so of the temperature setting. The values obtained without rinse aid demonstrated that 15–20 min were needed to achieve well-dried loads, whereas when using rinse aid similar results were obtained in 10–15 min. No major differences were observed between any of the tray designs tested (Graphic 1).

The same picture was seen on using rinse aid. The use of rinse aid markedly reduced residual moisture variance. Again, the tray design did not exert any influence on the drying performance.

In the following the residual moisture values measured when using the AESCULAP Aicon® trays alone were compared with those obtained when using the various accessories. The accessories had a major impact. A fitted lid adversely and significantly impacted the drying performance (corresponding to around 5 min drying time), with increased scattering effect. That was even more pronounced in the case of the yellow burled mats, whereas the blue (mesh) silicone mat had virtually no effect (Graphic 2).

The situation improved accordingly on using rinse aid (this reduced drying times by more than 5 min; the variance decreased sharply).

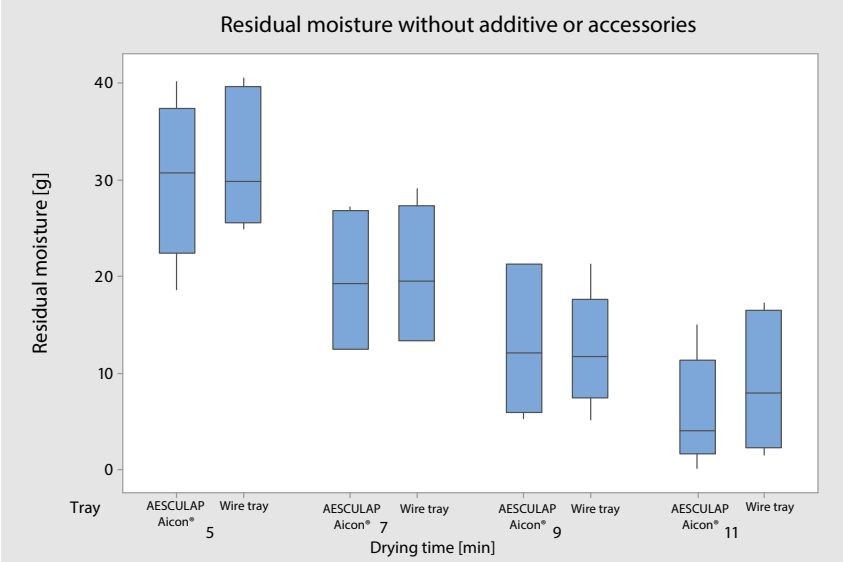
Direct comparison demonstrated that there was almost no difference in the cleaning performance between the tray designs. These tests showed that the process parameters (cleaning time, etc.) and the position in the chamber had a major impact. As in the drying experiments, the magnitude of influence exerted by the use of a lid and silicone mats on the cleaning results (tested in AESCULAP Aicon® tray) was also investigated.

To identify the effect of a lid, the cleaning results with 4 min holding time were compared and showed significantly poorer results for reprocessing with a lid (Graphic 3). While the impact of a longer holding time was not investigated, it can be estimated that around a 5 min longer cleaning time would be needed to achieve results on a par with those obtained without a lid.

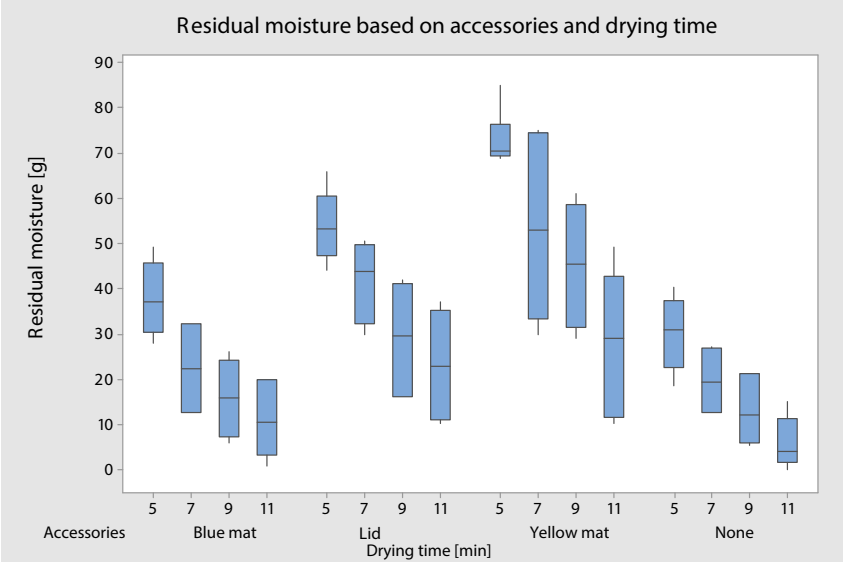
The use of burled mats did not significantly change the cleaning results (Graphic 4). That is thought to be due to the greater distance between the PCDs and tray, which assured better water access.

Discussion

Like the findings in 2018, the test results here revealed that the tray design did not impact the outcome. In 2018



Graphic 1: Example illustrating residual moisture in the AESCULAP Aicon® and wire trays when used without additive and accessories

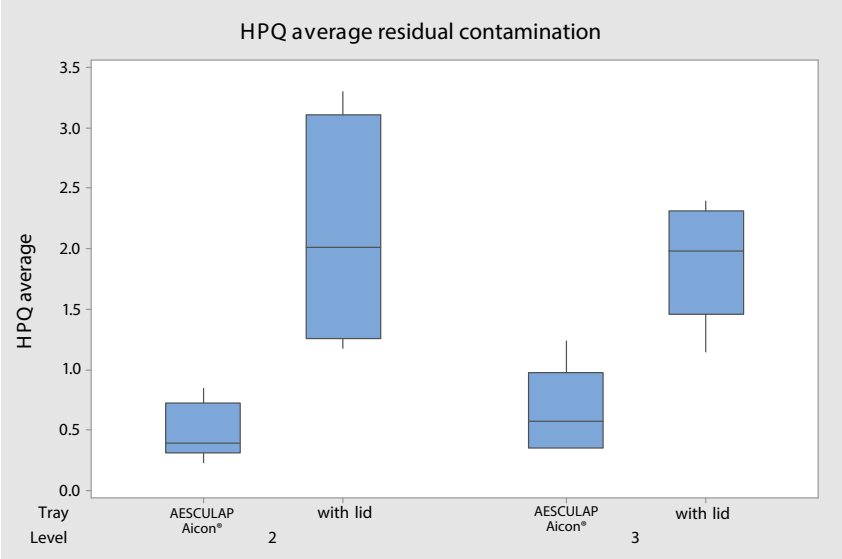


Graphic 2: Residual moisture based on accessories and drying time

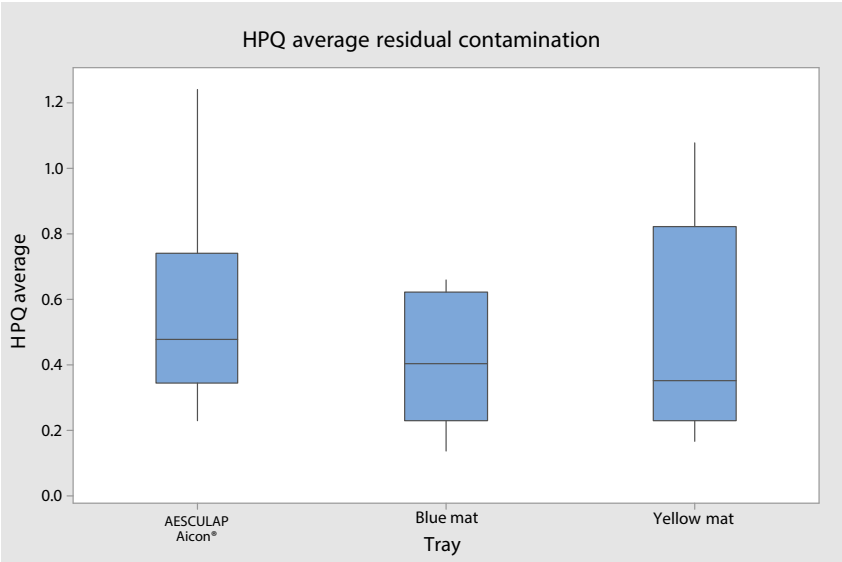
wire trays were compared with perforated sheet metal trays, while in the current study wire trays were compared with sheet metal trays in corrugated design (that was intended to reduce instrument sliding within the tray). Sheet metal trays should provide better instrument protection (less slippage and interlocking) with no adverse impact on cleaning or drying. The results reported here refer exclusively to the geometries tested, other designs may produce different results.

The drying performance was influenced mainly by the drying time and less so by the temperature of the incoming air. Other important factors were the chamber temperature reached, the air flow rate and air humidity. These factors differ not only between the various machine models but also in accordance with the individual installation (exhaust air, etc.), hence, effective parameter settings cannot simply be applied to other situations. The drying performance was also influenced by the weight and composition of the load (synthetic materials, in particular, were much more difficult to dry than metal).

The use of a rinse aid was found to reduce the drying time by around 5 min for the metal load used here.



Graphic 3: HPQ average (mm²) based on level and use of a lid



Graphic 4: HPQ average (mm²) after using silicone mats

Trays with lid and/or silicone mats are commonly used, especially for delicate and fine instruments. The blue mesh mat, in the design used here, did not produce poorer cleaning or drying results.

The yellow silicone mat in burl design demonstrated poorer drying performance (around 6–7 min longer drying time), but achieved similar cleaning results.

The use of a lid adversely and significantly impacted both the drying and cleaning results. The use of an additive in the final rinse step led to significantly less improvement in drying performance than that observed in other setups.

Drying stains were seen at contact points (mesh, etc.) in all setups after cleaning in the WD or following sterilization. But these were caused by inappropriate water or steam quality, leaving residues after drying at the contact point interfaces. That phenomenon must be addressed by optimizing the media quality. The use of an additive in the final rinse step after cleaning in the WD can also be helpful.

Overall, the following conclusions can be drawn from the findings:

- The perforated sheet metal trays tested (bars (JF/JG article series) or corrugated design (JJ article series)) may be used without any negative impact on the drying or cleaning performance.
- Overall, drying and cleaning are greatly dependent on the system and process control. These should be checked and optimized as a first troubleshooting step.
- Silicone mesh mats, of the design investigated, do not result in any difference in the cleaning and drying performance and may be routinely used (if desired), e.g. for better instrument protection during transport by road.
- The burled silicone mat tested adversely impact only the drying performance. To compensate for that, the drying time must be prolonged by more than 5 min. The burled silicone mats should therefore be used specifically, for example, for delicate, fine instruments that do not make stringent demands on the cleaning performance.
- The same applies to trays with fitted lid which has a negative impact on drying and cleaning. If such lids

are to be routinely used (e.g. in soft packaging), it is advisable to clean and disinfect them separately for standard instruments.

- Rinse aids shorten the drying time in all setups by around 5 min. Their pros and cons should be weighed up (expenditure, risk of stains).

However, it must be noted that all conclusions are based on a single (albeit very realistic) model.

The results demonstrate that the long handed-down "truth" claiming that sheet metal trays are more difficult to clean and dry has been refuted in these comparative tests. The test results provide tangible evidence of their benefits in routine RUMED practices.

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