Summary

Impact of transportation environment on contaminated instruments before reprocessing: A study challenging reprocessing practices

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Background and rationale

The transportation and temporary storage of contaminated surgical instruments between the operating theatre and the Central Sterile Services Department (CSSD) is an important but relatively underexplored part of the reprocessing chain. Once an instrument has been used, prompt and appropriate handling is necessary to prevent drying of biological contamination, maintain cleaning efficacy and protect instrument integrity.

International recommendations are inconsistent regarding whether contaminated instruments should be transported under moist or dry conditions. The World Health Organization (WHO), for example, recommends maintaining moisture during transportation from the operating theatre to the CSSD[1]. The rationale is that keeping contamination moist may prevent blood and other organic material from drying onto the instrument surface and thereby facilitate subsequent cleaning. Other guidelines and practices favour dry transportation, particularly because moisture may contribute to corrosion and deterioration of metallic surgical instruments[2-6].

This creates an important practical dilemma. Moisture could theoretically improve cleaning by preventing organic material from drying, while prolonged exposure to moisture may accelerate corrosion and compromise instrument integrity and lifespan.

This study investigated whether transporting contaminated surgical instruments under moist versus dry conditions influenced two outcomes after reprocessing:

- **Residual protein contamination**, as an indicator of cleaning efficacy
- **Surface integrity**, particularly corrosion and related damage

The study was conducted at Aarhus University Hospital in Denmark to provide evidence relevant to transportation and reprocessing practices.

Aim of the study

The overall aim was to determine whether the transportation environment, moist versus dry, affects the cleanliness and material integrity of reusable surgical instruments after standardised reprocessing.

More specifically, the study investigated whether:

- Moist transportation resulted in lower residual protein levels than dry transportation

- Moist transportation increased corrosion compared with dry transportation
- Different types of surface damage were associated with the transportation environment
- Some instrument types were particularly susceptible to corrosion

The underlying practical question was:

Does keeping contaminated instruments moist actually improve cleaning outcomes, and if so, is this potential benefit achieved at the cost of increased corrosion?

This is relevant because transportation conditions form part of the overall reprocessing chain and may influence both patient safety and long-term instrument preservation.

Study design and methods

The study was conducted at Aarhus University Hospital, Denmark, using surgical instruments transported under two different environmental conditions: moist and dry.

Transportation conditions

For the moist condition, instruments were kept moist using sterile water-soaked towels. Instruments in the comparison group were transported under dry conditions.

All instruments subsequently underwent a standardised reprocessing procedure, allowing the researchers to assess the effect of transportation conditions rather than differences in subsequent reprocessing.

Assessment of residual protein

Cleaning efficacy was assessed using the bicinchoninic acid (BCA) protein assay[7]. Residual protein was used as an indicator of remaining organic contamination.

A total of 173 instruments were analysed:

- 89 transported under dry conditions
- 84 transported under moist conditions

Mean residual protein levels were compared between the groups.

Assessment of corrosion and surface integrity

A total of 880 instruments were assessed:

- 530 transported under dry conditions
- 350 transported under moist conditions

Instruments were visually inspected for:

- Corrosion associated with fretting
- Corrosion without fretting
- Pitting
- Staining

The researchers also examined whether corrosion differed according to instrument type. Statistical significance was set at $p < 0.05$.

Main findings

Transportation environment did not affect residual protein levels

Moist transportation did not result in lower residual protein levels:

Transportation condition	Mean residual protein
Dry	27.7 µg/instrument
Moist	26.9 µg/instrument

The difference was not statistically significant ($p = 0.56$).

Eight instruments exceeded the predefined threshold of 75 µg residual protein[4].

Thus, under the conditions investigated, moist transportation using sterile water did not demonstrate a measurable advantage in residual protein removal. This does not mean that moisture can never influence cleaning, but rather that no detectable improvement was demonstrated under the conditions of this study.

Moist transportation was associated with more corrosion

The most interesting finding concerned instrument surface integrity. Significantly more corrosion was observed among instruments transported under moist conditions.

- Fretting corrosion: $p < 0.001$
- Corrosion without fretting: $p = 0.05$
- Pitting: $p = 0.29$
- Staining: $p = 0.98$

The findings therefore suggest that the primary effect of the transportation environment was not on measured cleaning efficacy but on material integrity.

Transportation conditions are often discussed primarily in relation to preventing drying of contamination. These findings suggest that their potential consequences for instrument corrosion and longevity may deserve greater attention.

Corrosion was also not distributed equally across instruments. Scissors showed the highest susceptibility to corrosion, with a significant difference between instrument types ($p < 0.001$), regardless of transportation environment.

This highlights the importance of considering instrument-specific vulnerability, as characteristics such as construction, joints, moving components, surface characteristics and material composition may influence susceptibility to corrosion.

Interpretation of the findings

Under the conditions investigated, the transportation environment appeared to have a greater impact on instrument surface integrity than on measured cleaning efficacy. Residual protein levels were comparable between moist and dry transportation, whereas corrosion was significantly more prevalent following moist transportation[8-9]. This may be particularly relevant for complex instruments, which can be more susceptible to corrosion[10].

The results challenge the assumption that moist transportation is inherently preferable because it prevents organic material from drying[11-13]. Rather, they indicate a potential trade-off: moisture may prevent drying of contamination but simultaneously increase corrosion risk. Conversely, dry transportation may reduce corrosion risk, although concerns remain regarding the potential drying of organic material.

Importantly, the anticipated cleaning benefit of moist transportation was not demonstrated through residual protein measurements. This raises an important question for future research: if moist transportation does not demonstrably improve cleaning efficacy but may increase corrosion, what is the evidence base for continuing to recommend moist transportation?

The findings therefore contribute to the broader discussion of whether current transportation practices should be reconsidered and whether dry transportation combined with timely reprocessing may be appropriate in some settings.

Clinical and practical implications

The findings highlight transportation as an integral part of the reprocessing chain, with implications for both cleaning and instrument preservation.

The lack of a measurable cleaning benefit from moist transportation, combined with increased corrosion, suggests that current transportation practices may warrant reconsideration. Particular attention should be given to corrosion-prone instruments, such as scissors, due to potential consequences for functionality, longevity and replacement costs.

Overall, the study supports evidence-based guidance on transportation conditions, considering cleaning efficacy, instrument preservation, sustainability and patient safety.

Key message for practice

The transportation environment is not a neutral step in reprocessing. Under the conditions investigated, moist transportation did not improve measured residual protein levels but was associated with increased corrosion. The study does not establish that dry transportation is universally superior. The choice between moist and dry transportation should therefore be evidence-based and context-specific, rather than based on the assumption that keeping instruments moist is inherently safer or more effective.

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