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RESEARCH ARTICLE

Gynaecological oncology

User experience of wearing comfort of reusable versus disposable surgical gowns and environmental perspectives: A cross-sectional survey

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Abstract

Objective: To determine the user experience of wearing comfort of reusable sterile surgical gowns and compare these gowns with conventional disposable surgical gowns.

Design: Cross-sectional survey.

Setting: An academic hospital in the Netherlands.

Population: Gynaecologists, surgeons, residents and operating room assistants (n=80).

Methods: Quantitative and qualitative data were obtained via a written questionnaire. Participants provided subjective comments and scored the reusable gown on each individual topic with a score from 1 to 5 (1 = unsatisfactory, 2 = moderate, 3 = good, 4 = very good, 5 = excellent) and compared the reusable gown with the conventional disposable alternative (better, equal or worse).

Main outcome measures: Wearing comfort: ventilation and temperature regulation, fit and length, functionality, barrier function and ease of use.

Results: The results of the overall scores of the reusable gown are scored as 'very good' (mean 4.3, SD ± 0.5) by its users. Regarding comparison of the gowns, more than 79% (lowest score 79%, highest score 95%) of the participants scored the reusable gown equal or higher on six of seven topics. The topic 'ease of use' was scored equal or higher by 59% of the participants. Subjective comments provided information on possible improvements.

Conclusions: The findings of this study demonstrate that there is professional acceptance regarding the utilisation of reusable surgical gowns. To facilitate broader adoption, it is imperative to foster collaboration among suppliers and healthcare institutions. The reusable surgical gown is an environmentally sustainable, safe and comfortable alternative in the operating room.

KEY WORDS

climate change, comfort, operating room, surgery, surgical gowns, sustainability, user experience

1 | INTRODUCTION

Climate change is currently one of the biggest threats to ecosystems as well as to human society and health.¹ Consequently, it is crucial we make substantial changes to

our behaviour. As healthcare professionals we have a responsibility to enhance human health, which is at odds with the fact that healthcare accounts for 4.4% of global greenhouse gas (GHG) emissions.² Recently, different countries have agreed to work towards climate-resilient healthcare

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and to commit to a sustainable healthcare sector.³ This should also be reflected in our daily practices, without harming patient safety and with guaranteed quality.

Surgery contributes substantially to the environmental impact of healthcare by being a significant source of emissions and waste.⁴ This waste consists mainly of disposable items, such as blue wraps, and single-use devices, gloves, surgical drapes and surgical gowns.⁵ Globally, over 300 million major surgeries are performed per annum,⁶ which leads to a substantial amount of surgical gowns being used. Despite the fact that the industry is a commercially driven entity, we cannot ignore the environmental burden we are creating with the production and waste of disposable gowns in the healthcare sector.

The life cycle environmental impact of gowns and other textiles used in the operating room (OR) have been assessed multiple times.^{7–10} Vozzola et al.⁷ showed that employing disposable sterile surgical gowns results in a threefold increase in GHG-emissions compared with the use of reusables. With regard to the quality and patient safety of sterile surgical gowns, McQuerry et al.¹¹ showed that reusable gowns appear to protect better than disposables, even after several washes.

Initially in the 1960s there was resistance to wearing disposable gowns due to their paper-like material and stiffness.¹² As a result, the industry improved quality and comfort with newer materials, which drastically increased the amount of disposable gowns used.¹² However, in the pursuit of environmental sustainability, the healthcare sector should consider shifting towards reusable gowns. Comfort has always been an important aspect for users of surgical gowns over the years.^{13,14} However, current literature shows that reusable gowns may have a disadvantage in terms of wearing comfort.¹⁵ The last user-comparative effectiveness study comparing reusable and disposable gowns among surgeons dates from 2010.¹⁶ Newer reusable surgical gowns have since been developed but have not been broadly employed.

Additionally, based on previous surveys of service users, it is evident that the general public leans towards environmentally friendly options when the results are comparable or the cost difference is minor.^{17,18} As a result, one could infer that these items hold significance, as service users would probably be supportive for transitioning to reusable surgical gowns when there is no negative effect on performance, meaning that professional acceptability is most important. For this reason, a study will be conducted to gain insight into the comfort of the current generation of gowns. The aim of our study is to determine the user experience of wearing comfort of reusable gowns and show whether there is a preference for reusable or disposable surgical gowns.

2 | METHODS

2.1 | Study design, participants and setting

This cross-sectional survey was conducted to determine the user experience of wearing comfort of reusable sterile surgical gowns and compare it to conventional disposable

surgical gowns. Participants included gynaecologists, surgeons, residents and operating room nurses. Quantitative and qualitative data were obtained via a written questionnaire. Reusable sterile surgical gowns were used over a 4-week period at the Leiden University Medical Centre (LUMC), Leiden, the Netherlands. The reusable gowns were leased and transported to the hospital by the same supplier who provided the rental of linen and work clothing (CleanLease B.V.). For logistic reasons it was decided to test only one size (L: large) of the reusable sterile surgical gown. The sterile reusable surgical gown packages were delivered to the hospital and were packed per one or two pieces in reusable packages.

We used 'Standard Performance' 500-g sterile reusable surgical gowns (99% polyester filament and 1% carbon graft), the material meeting the international standards for surgical gowns (NEN-EN 13795-1). The wearing comfort of the reusable gown was compared with the Mölnlycke 'Universal Standard Performance (63000622)' disposable sterile surgical gown (consisting of polypropylene, polyester and nylon). Figure 1 shows both reusable and disposable surgical gowns.

2.2 | Data instrument and collection

Different topics were identified to evaluate and determine the user experience regarding wearing comfort. They were determined in collaboration with the supplier and submitted for assessment by a number of operating room employees. After consensus, they were implemented in the questionnaire. For more detailed information about the questionnaire see Appendix S1.

The topics included in the questionnaire were: (1) ventilation and temperature regulation, (2) fit and length, (3) functionality standing at the operating table (functionality was defined as: suppleness, closing of the cuffs and weight), (4) functionality sitting at the operating table, (5) functionality walking in the OR, (6) barrier function and (7) ease of use. In addition, subjective comments were collected from participants, allowing them to provide written feedback in the comment section.

Over the course of 4 weeks, questionnaires were distributed to participants in the OR. After wearing the gowns, participants were asked directly to complete the paper-based questionnaire. Each participant had the opportunity to participate once.

2.3 | Data analysis

The participants scored the reusable gown individually on each topic with a score from 1 to 5 (1 = unsatisfactory, 2 = moderate, 3 = good, 4 = very good, 5 = excellent) and compared the reusable gown with the conventional disposable alternative (better, equal or worse). Data analysis was conducted using IBM SPSS STATISTICS 25. Data supporting this study are included within the article.



FIGURE 1 Reusable and disposable sterile surgical gowns. (A) Reusable surgical gown. (B) Disposable surgical gown.

TABLE 1 The distribution of answered questions between the different topics. Some questions were not applicable for all participants and were therefore not answered.

	A: Score reusable gown, <i>n</i> = 80		B: Score reusable compared with disposable gown, <i>n</i> = 80	
	Total scored	Total blanks	Total scored	Total blanks
1. Ventilation and temperature regulation	<i>n</i> = 80	<i>n</i> = 0	<i>n</i> = 72	<i>n</i> = 8
2. Fit and length	<i>n</i> = 80	<i>n</i> = 0	<i>n</i> = 72	<i>n</i> = 8
3. Functionality standing at the operating table	<i>n</i> = 76	<i>n</i> = 4	<i>n</i> = 68	<i>n</i> = 12
4. Functionality sitting at the operating table	<i>n</i> = 44	<i>n</i> = 36	<i>n</i> = 39	<i>n</i> = 41
5. Functionality walking in the operating room (OR)	<i>n</i> = 77	<i>n</i> = 3	<i>n</i> = 70	<i>n</i> = 10
6. Barrier function	<i>n</i> = 49	<i>n</i> = 31	<i>n</i> = 46	<i>n</i> = 34
7. Ease of use	<i>n</i> = 78	<i>n</i> = 2	<i>n</i> = 70	<i>n</i> = 10

Note: (A) individual scores of reusable gowns per topic; (B) scores of reusable gowns compared to disposable gowns per topic; *n*, number of participants.

3 | RESULTS

At the end of the 4-week period, 80 independent responses were obtained. Table 1 shows the distribution of answered questions between the topics. The scores per topic were calculated for the total number of participants who completed the question on the relevant topic.

3.1 | Individual scores of reusable sterile surgical gowns

Table 2 shows the scores for the reusable surgical gown. The reusable sterile surgical gown scored higher than 4 (range 1–5) on six of the seven topics. The topic ‘functionality’, both standing and sitting at the operating table, scored

TABLE 2 Individual scores per topic of the reusable sterile surgical gown.

	1 Insufficient (%)	2 Moderate (%)	3 Good (%)	4 Very good (%)	5 Excellent (%)	Total blanks (%)	Mean \pm SD	n
1. Ventilation and temperature regulation	1 (1)	5 (6)	17 (21)	24 (30)	33 (41)	0 (0)	4 \pm 1.0	80
2. Fit and length	1 (1)	6 (8)	9 (11)	24 (30)	40 (50)	0 (0)	4.2 \pm 1.0	80
3. Functionality standing at the operating table	0 (0)	0 (0)	4 (5)	19 (24)	53 (66)	4 (5)	4.6 \pm 0.6	80
4. Functionality sitting at the operating table	0 (0)	0 (0)	2 (3)	13 (16)	29 (36)	36 (45)	4.6 \pm 0.6	80
5. Functionality walking in the OR	0 (0)	2 (3)	6 (8)	23 (29)	46 (58)	3 (4)	4.5 \pm 0.8	80
6. Barrier function	0 (0)	0 (0)	12 (15)	14 (18)	23 (29)	31 (39)	4.2 \pm 0.8	80
7. Ease of use	2 (3)	8 (10)	17 (21)	21 (26)	30 (38)	2 (3)	3.9 \pm 1.1	80

Note: n, total number of participants.

Abbreviation: SD, standard deviation.

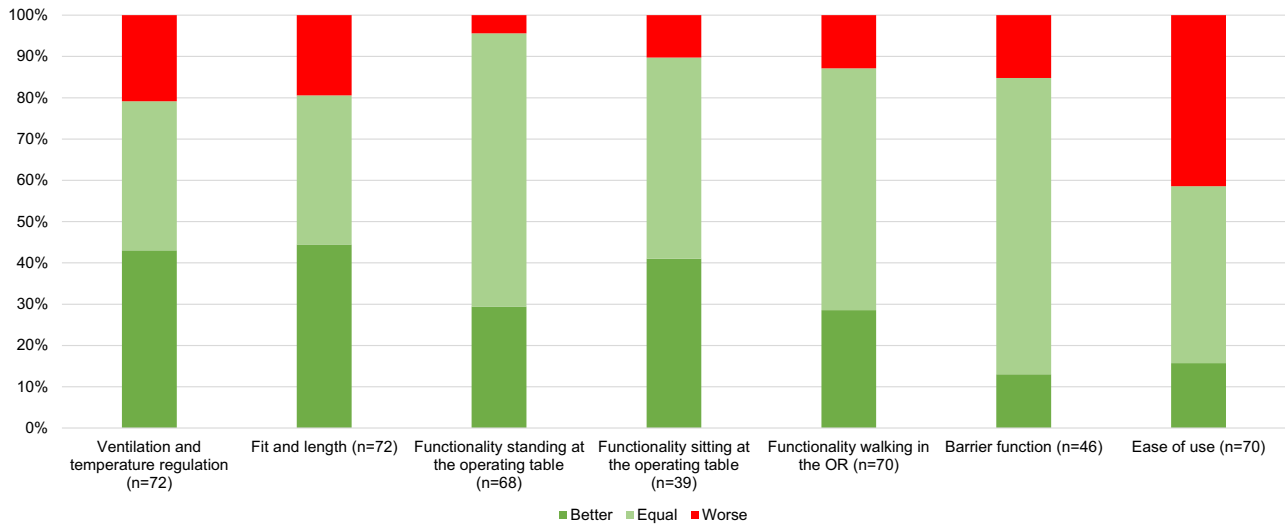


FIGURE 2 Reusable sterile surgical gown compared with the standard disposable sterile surgical gown. The participants compared the reusable gown with the conventional disposable alternative (better, equal or worse). The figure shows the scores of total number of participants who scored (in %). n, number of participants; OR, operating room.

equal and highest with 4.6 (SD \pm 0.6). The topic 'ease of use' scored lowest with 3.9 (SD \pm 1.1). The average result of the overall score on wearing comfort of the reusable gown is 4.3 (SD \pm 0.5). Based on these individual scores, the users scored the reusable sterile surgical gowns as 'very good'.

3.2 | Scores for reusable versus standard disposable sterile surgical gowns

3.2.1 | Ventilation, temperature regulation and fit

The participants compared the reusable sterile surgical gown with the standard disposable gown, as shown in Figure 2. Of

the participants, 31 scored the 'ventilation and temperature regulation' of the reusable surgical gown as 'better' than that of the standard disposable surgical gown, 26 as 'equal' and 15 as 'worse' (total n = 72). In addition, the 'fit and length' of the reusable gown was perceived as 'better' by 32 participants, 'equal' by 26 and 'worse' by 14 participants (total n = 72) in comparison with the disposable gown.

3.2.2 | Functionality, barrier function and ease of use

Functionality was defined as suppleness, closing of the cuffs and weight. The 'functionality of the reusable surgical gown standing at the operating table' scored 'better' than

the disposable gown by 20 participants, 'equal' by 45 and 'worse' by 3 (total $n=68$). With regard to sitting at the operating table, 16 of the participants scored the reusable gown as 'better', 19 as 'equal' and 4 as 'worse' (total $n=39$). The functionality of the reusable gown while walking in the OR was scored by 20 participants as 'better', 41 as 'equal' and 9 as 'worse' (total $n=70$). The barrier function of the reusable surgical gown was experienced as 'better' by 6 participants, 'equal' by 33 and 'worse' by 7 (total $n=46$). Finally, the ease of use was perceived as 'better' by 11 participants, 'equal' by 30 and 'worse' by 29 (total $n=70$) than the standard disposable sterile surgical gown.

3.3 | Subjective comments

Of the participants, 35 participants provided multiple subjective comments. Participants indicated that in terms of ventilation, the reusable surgical gown had 'more breathability' ($n=3$) than the disposable variant. Furthermore, with regard to the fit of the reusable gown, participants provided positive comments such as 'the neck closure is much better' ($n=1$) and 'the gown does not pull up when sitting' ($n=1$). However, other comments regarding fit were also provided, such as 'too long/big for my height' ($n=4$), 'short sleeves' ($n=5$), 'cuffs could be tighter/cuffs too thick' ($n=3$), 'sleeves are harder to find' ($n=2$), 'neck cuff too high' ($n=1$) and 'heavy gown' ($n=2$). Regarding ventilation and temperature regulation, participants commented that the reusable gown was 'warmer compared than disposable' ($n=2$), and some participants 'prefer disposable' ($n=3$). Regarding ease of use, comments such as 'difficult to take off' ($n=10$) stood out. However, such comments were nuanced several times with the comment that, for example, this difficulty will become easier after 'habituation with the use of the reusable gown' ($n=4$). In other comments, it is stated by the participants that the reusable gown is a 'fine gown' ($n=3$), 'positively nostalgic' ($n=1$) and it is indicated to 'go back to reusable' ($n=1$).

4 | DISCUSSION

4.1 | Main findings

The user experience of wearing comfort of reusable sterile surgical gowns was scored as 'very good' by their users. In addition, the majority of the participants scored the reusable sterile surgical gown as 'equal or better' on all discussed topics regarding the user experience of wearing comfort when compared with the conventional disposable sterile surgical gown.

4.2 | Interpretation

Since the end of the previous century, a significant portion of high-income countries have implemented disposable surgical

gowns and drapes as the standard within the OR. This shift is attributed to better performance results of non-woven disposable fabrics.^{19,20} Meanwhile, in low- and middle-income countries, the prevalence of reusable fabrics remains more common. In contrast to the past, current evidence demonstrates that reusable gowns are of high quality.¹¹ Moreover, the processes of cleaning and sterilisation have advanced sufficiently to ensure safety in their reuse. However, it is important to note that these observations primarily apply to high-income countries. In numerous low- and middle-income regions, the use of reusable gowns persists, but potential shortcomings in the cleaning and sterilisation protocols must be acknowledged. These considerations are pivotal to ensure safety while contemplating a shift to reusable alternatives.

Considering both environmental and human health aspects, the reusable surgical gown emerges as the superior choice. Existing literature suggests that the wearing comfort of reusable gowns is perceived as a disadvantage, often resulting in a preference for disposable surgical gowns.¹⁵ However, this study adds knowledge about the user experience of wearing comfort of reusable sterile surgical gowns in the OR. The findings aim to inform and educate OR personnel who currently rely on disposable surgical gowns and may not be fully convinced of the positive user experience provided by reusable gowns. The results can serve as supportive evidence for making informed decisions regarding the selection of surgical gowns in the OR, promoting a well-considered approach.

4.3 | Clinical implications

Transitioning to reusable surgical gowns would result in a reduction of environmental impact, contributing to the achievement of climate goals aimed at mitigating the healthcare sector's impact.^{7,8} The biggest contributor to this impact is the manufacturing process of the disposable gowns: the manufacturing process of 1000 disposables is approximately ten times more polluting in terms of CO₂-equivalents in comparison with using reusable surgical gowns 1000 times (1495 kg versus 143 kg CO₂-equivalents).⁷ For the reusable surgical gowns the washing and sterilisation process has the greatest environmental impact. It is important to note that this impact is lower than the environmental impact of manufacturing disposable gowns. However, this impact is expected to decrease further with the increasing use of renewable energy and the development of more efficient machines for cleaning and sterilisation.

Furthermore, the shift towards reusables will entail different costs in comparison with disposable surgical gowns. The cost of reusable surgical gowns varies enormously among hospitals. A recent business case conducted in the Netherlands examined the cost difference between reusable and disposable isolation gowns.²¹ In that analysis, both financial implications and social considerations were taken into account. The price is among other things contingent on the quantity purchased and nowadays both reusable surgical and isolation gowns are more expensive than disposables. In general, if implemented on a larger scale, costs

would decrease. The study for isolation gowns shows that if implemented on a larger scale, the difference could narrow down to just 0.02 eurocents per gown use.²¹ Should these isolation gowns be reused more frequently (from 80 to 100 times), their cost could be even lower than that of disposables. Moreover, reusable gowns yield social benefits, whereas disposables result in social costs. Although the initial price of a disposable isolation gown is lower, it sustains 40 eurocents in social costs due to energy consumption and CO₂ emissions. Conversely, the reusable isolation gown generates 17 eurocents in social benefits by creating job opportunities. Therefore, to promote widespread adoption of reusable gowns, it is crucial to encourage cooperation among suppliers and healthcare institutions, enabling a reduction in financial expenses.

In terms of supply chain stability, opting for reusables emerges as the more favourable decision. This shift would decrease our reliance on foreign sources and enhance supply chain dependability. Consequently, fewer raw materials are required in the production of reusable gowns, resulting in reduced resource consumption. Additionally, instead of incinerating the gown after it needs to be disposed of, the material can be recycled. This method promotes a circular economy in which the materials from used gowns are recycled and utilised to produce new gowns, reducing waste and minimising the need for additional raw materials. Consequently, this approach would lead to a reduction in environmental impact while maintaining proper protection in the OR.

4.4 | Research implications

This study confirms great contentment among the participants' user experience regarding wearing comfort. Nonetheless, due to our study being limited to one type and one size of reusable surgical gown compared with one type of disposable gown, many variations could also be analysed. To reduce the environmental impact, it is worth considering the feasibility of using recycled materials for both disposable and reusable gowns. However, following the 10R model of circularity,²² which prioritises reducing the use of raw materials and thereby the environmental impact, the preference lies in reuse rather than recycling. As mentioned earlier, it is possible to use reusable gowns and recycle them at the end of their life cycle if the quality of the fabric still meets requirements.

Although the results from this study are positive, the survey has also identified areas that require attention. The subjective comments gathered indicate that there is room for improvement in terms of the wearing comfort of the current reusable gowns. For instance, over 40% of respondents found reusable gowns less easy to use. This issue should be resolved when considering the broader adoption of reusable surgical gowns in the clinical setting. It is thus worth exploring alternative gown designs. Nevertheless, to gain a comprehensive understanding, new research should encompass wearing comfort, quality and environmental impact as key factors. According to the 10R

model of circularity, the best option is to 'refuse' the use of a surgical gown altogether. Exploring alternatives where particularly a 'sterile' surgical gown may not be necessary should also be considered. This is especially relevant in the context of minimally invasive surgery, where there is less tissue disruption and less exposure to pathogens. Here, the risk of infection is very low and the need for a 'sterile' surgical gown could potentially be re-evaluated.²³

Lastly, Vozzola et al.⁷ have shown that the manufacturing phase and the washing of surgical gowns contribute greatly to the environmental impact. The phases of the life cycle that contribute most to the environmental impact are referred to as environmental hotspots. These environmental hotspots can be assessed to see whether they can be improved for further use of reusable surgical gowns, in favour of the environment.

4.5 | Strengths and limitations

Our study has several strengths. First of all, this study collected both qualitative and quantitative data on the wearing comfort of the surgical gowns. The latter provides an easy way of comparing data, while the qualitative data provides information on possible improvements. Furthermore, gynaecologists as well as surgeons and OR nurses completed the questionnaire, which provides a good representation of the actual users in the OR. However, a limitation of the study was that only one size of the surgical gown was used, which consequently may have led to lower scores regarding the topic 'fit and length' due to the variation in body size between users. We note, however, that reusable gowns are available in different sizes, which will help to overcome this problem.

5 | CONCLUSION

As reusable surgical gowns provide adequate protection and their environmental impact is less than that of disposable gowns, lack of comfort cannot be an indication to discourage the use of the reusable gown. Our data show great satisfaction concerning the reusable gown. Considering the environment and the health of the population, reusable surgical gowns are therefore a suitable option in the OR. In addition to the wearing comfort, adequate protection, quality, environmental impact and costs are important factors. The cost per use depends on factors such as supplier, purchase volume, price agreements and scarcity in the supply chain. We expect that when the reusable gown is used on a large scale, the costs per use will decrease, which will lead to an even more interesting choice for the reusable sterile surgical gown. Furthermore, the healthcare sector has become reliant on disposables and the potential for disruptions in the production process creates vulnerability in supply. Reusables seem to be a safe option for a stable supply chain,²⁴ while at the same time using fewer raw materials. The combination of lower environmental impact and

good quality with adequate protection, provides reasons to switch to the reusable surgical gown. In this current climate crisis, the disposable surgical gown should no longer be used in the OR.

AUTHOR CONTRIBUTIONS

Study conception and design: SvdL, AvdE. Data collection: SvdL, HF, AvdE. Analysis and interpretation of results: KvN, AvdE, FWJ. Draft manuscript preparation: KvN, HF, SvdL, FWJ, AvdE. All authors reviewed the results and approved the final version of the paper.

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CONFLICT OF INTEREST STATEMENT

None declared.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS APPROVAL STATEMENT

Approval of the Institutional Review Board (IRB) was not mandatory as the questionnaire did not meet the criteria according to the Medical Research Human Subjects Act.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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