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To cite this Article: Aholaakko, Teija-Kaisa & Metsälä, Eija (2015) Aseptic practice recommendations for circulating operating theatre nurses. *British Journal of Nursing* 24(13), 670-678.

URL: <http://bib.fi/h8bpDw/global>

A TOOL FOR INTRA-OPERATIVE ASEPTIC PRACTICE ASSESSMENT AMONG
CIRCULATING OPERATING THEATRE NURSES

ABSTRACT

Aseptic practices prevent microbial exposure to a surgical wound, operating theatre environment, and personnel. The circulating nurse assists the operating theatre personnel and supervises aseptic practices preventing surgical site infections. In the absence of analytical tools, few studies exist on intra-operative nursing-related aseptic practices. This study introduces a tool to assess the role of the circulating nurse towards aseptic practices. We used international recommendations and research findings to construct a 20-item self-report instrument with a demonstrated reliability across the scale. We structured the scale based on the establishment, maintenance, and disestablishment of a sterile operating field. We tested the tool among operating theatre and day-surgery nurses, and compared the differences in the mean acceptance rates of aseptic practice recommendations based on background characteristics. College-level nurses and nurses with 15 years or more work experience accepted the recommendations at higher levels than bachelor's-level nurses and nurses with less work experience. Continual assessment of the evidence base and comprehensive evaluation represent important components in further developing the tool. A reasonable number of items covering clinical practice are necessary for assessing the effectiveness and cost-effectiveness of aseptic practices and a larger response rate is needed to validate the tool in future.

KEY WORDS: infection control, infection prevention, antisepsis, asepsis, aseptic technique, surgery, operating theatre

INTRODUCTION

In the European Union (EU), approximately 4 million patients acquire health care–associated infections each year. The most frequent infections include urinary tract infections, respiratory infections, post-operative infections, and blood stream infections. Approximately 20% to 30% of these may be prevented through intensive hygiene and infection control programmes. Effective infection prevention is globally defined as one of the key components of safe patient care (EU Council, 2009; WHO, 2009; APIC, 2012; ECDC, 2015).

The EU Council (2009) encouraged the development of a specific approach to promote safe practices, ensure the development of skills, and make guidelines and recommendations available at the national and regional levels. These represent globally applied standards and recommendations for operating theatre teams in order to achieve the optimal level of technical and aseptic practices (AORN, 2013).

However, no direct evidence exists that these recommendations (except those for hand hygiene) reduce surgical site infections in patients (Slade, 2014). Developing the content and conceptual structure of these recommendations represent important steps ensuring that they better address all phases of surgical procedures. Once developed, critically assessing, increasing the evidence base, and measuring the effectiveness and cost-effectiveness of aseptic practices become possible.

This study aims to develop an assessment tool for intra-operative aseptic practices, with the objective of studying intra-operative aseptic practices performed

by circulating nurses. The research questions included: 1) What recommendations did nurses accept from the aseptic practices scale for circulating nurses during the establishment, maintenance, and disestablishment of the sterile field? 2) Did the developed scale, 'Aseptic Practices among Circulating Nurses', reliably measure acceptance of the roles of circulating nurses in the aseptic practice recommendations? 3) And, were any differences detected in nurses' acceptance of aseptic practice recommendations between hospitals, working environments, education levels, work experience in a surgical unit in general, and work experience in the current position?

BACKGROUND

Since 1995, international recommendations for aseptic practices have been applied and locally validated in the surgical departments of one university hospital in Finland (Aholakko, 2011; Aholakko et al, 2013). Similar to findings by Fung-Kee-Fung et al (2009), challenges in their application include establishing trust among health professionals and health institutions; collecting accurate, complete, and relevant data; clinical leadership; securing institutional commitments; and establishing infrastructure and methodological support for quality management. The results of this intervention showed no improvements, but others found an increase in surgical site infection rates after breast surgery (Aholakko et al, 2013). In addition, Tame (2013) reported negative results including no behavioural changes, but finding an increased confidence and assertiveness after continuous perioperative education. In a study by Sinkowitz-Cochran et al (2012), the nursing staff became better engaged and possessed greater knowledge about infection prevention than other health-care

workers. In another study by Sessa et al. (2011), infection prevention knowledge was significantly higher among nurses with a higher level of education.

Studies about surgical practices demonstrate that awareness of role-related social order represents an important aspect of operating theatre culture, at times hampering the implementation of recommendations (Nestel & Kidd, 2006; Aholaakko, 2011; Tame, 2013). Disregarded recommendations (Adams et al, 2011; Aholaakko, 2011), individual knowledge (Gillespie et al, 2008; Tame, 2012), skill-based intra-operative incidents (Angelillo et al, 1999), or errors (Flin et al, 2006; Jeffs et al, 2008; Smith, 2010) persist. Previous studies (Timmons & Tanner, 2003; McGarvey et al, 2004; Gillespie et al, 2008; Richardson-Tench, 2008; Sinkowitz-Cochran et al, 2012; Yang et al, 2012) showed that the role and influence of nurses are essential to operating theatre practices. In one study, the adherence of operating theatre personnel to aseptic practice recommendations varied and circulating nurses found such variation stressful (Aholaakko, 2011). The development of well-structured recommendations with a sound evidence base may improve not only infection status among surgical patients, but also the well-being of operating theatre team members.

METHODOLOGY

'Aseptic Practices among Circulating Nurses' Scale

We developed the 'Aseptic Practices among Circulating Nurses' scale, a self-report instrument. We then completed a cross-sectional descriptive study to measure the acceptance of aseptic practice recommendations in 2013. Using a four-point scale, 1 referred to strong disagreement while 4 represented strong agreement. We constructed positive and negative multi-item statements rather than single-item rankings in order to avoid distorted results and improve the reliability. We coded

items using a four-point score so that higher numbers represented stronger agreement with the recommendations.

We first created the data collection instrument in early 2000. In an initial study, we pre-tested a hard-copy questionnaire among 22 operating theatre personnel unaffiliated with the study group in the project hospital district in 2000. In total, 17 nurses and physicians responded, assessing statements as easy to answer and the statement contents as valid. Based on their feedback, we improved and clarified the wording of some statements. We then used the revised instrument among registered operating theatre personnel from two hospitals in 2000 and 2001. In 2001, 106 of 234 (45%) questionnaires were returned.

In 2013, we updated the initial assessment tool and created an online questionnaire using some statements from the initial survey based on previous recommendations (AORN, 1999). In addition, we formulated questions according to AORN recommendations (2013). The instrument used in the present study comprised 20 statements. Due to variations in the evidence base and the structure of the conceptual model (Figure 1), a separate tool for measuring hand hygiene will be created.

Data collection

We distributed online surveys between October and November 2013 to nurses from the operating theatre units of two university hospitals. From a total of 242 nurses, 73 (31%) responded. From hospital 1, 16 (27%) operating theatre nurses and 10 (21%) day surgery nurses responded after receiving two online reminders and a reminder from nursing managers. From hospital 2, response rates reached 33 of 95 (31%) and

12 of 40 (30%), respectively. Two respondents did not identify their place of work and their questionnaires were not completed. Missing values were not replaced; due to the low response rate, valid responses were analysed as a single study group.

Among all respondents, 45% held a bachelor's-level nursing degree, while 55% were senior nurses who previously received a college-level degree in nursing. All but three undergraduate bachelor's-level nurses were registered. These three represented graduating students awaiting official registration upon completion of their practical placements. Among all respondents, 45% worked in operating theatre units in general for 15 years or more. In terms of their current positions, 40% of our respondents worked in their current unit for less than 5 years, while 21% worked in their current units for more than 15 years.

The ethical board of the university hospital district and the heads of medicine and nursing departments approved and accepted this study. Nurses were informed of the study during staff meetings and via email as part of the questionnaire. Informed consent forms were returned with the completed questionnaires.

Data analysis

In total, we used 20 recommendations (none for hand hygiene) to describe the aseptic practices from the circulating nurses' points of view. First, we completed descriptive statistics to introduce the acceptability of recommendations. Second, we counted summation variables according to the phases of specific operations. We aimed to construct a clinically relevant and reliable scale with three sub-scales: establishment of a sterile field; maintenance of a sterile field; and disestablishment of a sterile field. We chose meaningful constructions with possibly high alpha (α) values. We tested the scale by analysing the acceptance of recommendations according to

the respondents' background characteristics. We used Mann-Whitney U-tests to explore the differences between ranked mean values for skewed data. For all analyses, we considered results yielding $p < 0.05$ as statistically significant.

RESULTS

We constructed the 'Aseptic Practice among Circulating Nurses' scale, with an overall reliability of $\alpha = 0.782$. Table 1 and the sub-scale reliability analyses below show the acceptability of the recommendations and the characteristics for the summated variables. As a final step, we introduce the differences in acceptance based on background characteristics.

Aseptic practices to establish a sterile field

First, we coded a 10-item (10/20) summated variable for the 'Establishment of a Sterile Field' sub-scale. We found a better reliability ($\alpha = 0.605$, mean = 3.77, SD = 0.232, min = 3.00, max= 4.00) than a previous study from 2001 using a five-item scale ($\alpha = 0.564$). All but one of the recommendations were rated as highly acceptable with a mean value of 3.61, with six recommendations receiving a mean value of 3.86 or higher. One of the recommendations focused on the selection of sterile items, while nine recommendations focused on the aseptic technique when establishing a sterile field. Acceptance of the recommendation 'Create the sterile field less than an hour before the operation' received a lower acceptability than other recommendations (mean = 3.23). Removing this item would increase the reliability of the scale overall; however, given its relevancy in clinical practice, we did not remove it from our analysis.

When testing the scale, we found statistically significant differences in the acceptance of recommendations according to the respondents' education, general work experience, and time spent working in the current operating theatre. Senior nurses with a college-level education ($n = 38$) accepted the recommendations to a higher degree (mean = 3.84, SD = 0.201) than nurses with a bachelor's degree ($n = 30$, mean = 3.69, SD = 0.309), a statistically significant difference ($p = 0.045$). Acceptance was significantly higher ($p = 0.023$) among nurses with 15 years or more work experience in a general surgical unit ($n = 32$, mean = 3.84, SD = 0.242) than among nurses with less work experience ($n = 36$, mean = 3.72, SD = 0.270). We also found a significantly higher ($p = 0.011$) acceptance of recommendations among nurses with 5 years or more time spent in their current position ($n = 42$, mean = 3.84, SD = 0.227) than among nurses with less than 5 years work experience in their current surgical unit ($n = 26$, mean = 3.68, SD = 0.289).

Aseptic practices for maintaining a sterile field

Second, we constructed a sub-scale for the 'Maintenance of a Sterile Field' using a summated variable for seven (7/20) recommendations. We found a moderate reliability for the sub-scale ($\alpha = 0.639$, mean = 3.58, SD = 0.362, min = 2.29, max = 4.00). The reliability here was higher than the reliability of an eight-item scale from 2001 ($\alpha = 0.620$). We found high acceptance for recommendations on constantly supervising the sterile field, keeping doors closed, and limiting the number of persons in the operating theatre. We found less acceptance for the recommendation on limiting conversations during surgery.

Only differences in the acceptance of recommendations between nurses with 15 years or more work experience in the current operating theatre ($n = 14$, mean =

3.76, SD = 0.272) and nurses who have worked for a shorter time in the current operating theatre (n = 52, mean = 3.53, SD = 0.370) were statistically significant (p = 0.018).

Aseptic practices for disestablishing sterile field

Third, we constructed a sub-scale for the 'Disestablishment of the Sterile Field' using three (3/20) recommendations. We found a moderate reliability for the scale (α = 0.617, mean = 3.90, SD = 0.232, min = 2.67, max = 4.00). In 2001, only one recommendation focused on the disestablishment of the sterile field. In this study, we found a high level of acceptance for all three recommendations, with mean values of more than 3.8. These recommendations focussed on the prevention of blood-borne infections and protecting the wound until it closes. Removing the item 'No disestablishment of the sterile field during wound closure' (mean = 3.83) would increase the overall reliability of the scale; however, we did not remove the item from our analysis given its clinical relevancy.

In our analysis, we found a significantly higher (p = 0.017) acceptance of the scale recommendations among senior nurses with a college-level education (n = 37, mean = 3.96, SD = 0.105) than among nurses with a bachelor's degree (n = 29, mean = 3.83, SD = 0.317). Nurses with 15 years or more general operating department work experience (n = 30, mean = 3.97, SD = 0.108) accepted the recommendations at a higher rate than nurses with less work experience (n = 36, mean = 3.85, SD = 0.292), a statistically significant difference (p = 0.039).

DISCUSSION

This study aimed to assess the role of circulating nurses in intra-operative aseptic practices. Local recommendations were updated according to international recommendations (AORN, 2013) and studied among day surgery and operating theatre nurses. A previous qualitative study in a project operating theatre highlighted the necessity of developing the tool given the stress associated with performing aseptic practices. Another study aimed to identify the risk factors for surgical site infections (Aholaakko et al, 2013) through a review of records from more than 1000 breast surgery patients. Virtually no evaluative documentation of nursing-related aseptic practices was found. Given this, we found it necessary to begin constructing tools for the assessment of intra-operative aseptic practices. In the costly work of operating theatre teams, relevant, reliable, and valid tools to perform and assess clinical performance are essential. This paper introduces a tool that may serve as the starting point in developing performance, assessment, effectiveness, and cost-effectiveness measurement of aseptic practices within a sterile operating field in order to protect the surgical patient, personnel, and environment. Through this tool, it may be possible to enhance constructive communication and to increase the engagement of circulating nurses and the entire operating theatre team facilitating multi-disciplinary improvements in aseptic practices (Nestel & Kidd, 2006; Gillespie et al, 2008; Aholaakko, 2011; Sinkowitz-Cochran et al, 2012; Tame, 2013).

Reliability of the 'Aseptic Practices among Circulating Nurses' scale

Precise and comprehensive scales accepted by clinical professionals are essential in measuring the performance and assessment of intra-operative aseptic practices. During the development of the assessment criteria, discussions must address the influence of statistical tools used to complete the focus of the evaluation. In the

assessment of aseptic practice recommendations, this equates with aiming to reach only high reliability values. Thus, numerous clinically relevant assessment criteria may be lost.

In this study, we found a satisfactory reliability for the constructed scale ($\alpha = 0.782$). Despite the limitations, the results of this study may serve as a starting point for the further development and validation of assessing the role of the circulating nurse in aseptic practices. The reliability values for the three sub-scales varied, indicating partial premature acceptance of international recommendations. In particular, the sub-scale for the disestablishment of a sterile field may require critical review. Furthermore, a reasonable number of items (and respondents) are needed for future analysis.

The aseptic practice recommendations

The evidence-based aseptic practice recommendations warrant consideration through the actions, skills, and concepts of the nursing profession (Niiniluoto, 1993; 1996). As technical norms, they provide goals for practical action, express professional expertise, and facilitate efficiency in practice. Recommendations cannot always be deduced from general theory alone, but may be supported 'from below'. According to Niiniluoto (1993), the conditions regarding technical norms demand that they hold social relevance in factual situations, they should be at least potentially acceptable among some social groups, they contain evaluative and normative terms, and their relationship to the value system varies from the positivistic ideal. They only become binding among those who accept the premise of their conditional value.

Differences in the acceptance of the recommendations in scale testing

In this study, we found no differences in the acceptance of aseptic practice recommendations between project hospitals or between operating theatre and day surgery nurses. This may indicate solid organisational and professional support for the role of circulating nurses in aseptic practice recommendations (Fung-Kee-Fung et al, 2009). Instead, we found differences in the acceptance of recommendations between nurses with a previous college-level education and nurses with a contemporary bachelor's-level education. Nurses with a bachelor's degree reported less acceptance of recommendations for establishing and disestablishing sterile fields than nurses with a college-level education. The difference was not statistically significant for recommendations related to maintaining a sterile field. This may indicate a lack of relevant research or personal knowledge. It may be that acceptance among nurses with a bachelor's degree suffers because they critically reflected upon the knowledge base of the recommendations. These results did not support the results of Sessa et al (2011) indicating that a higher level of knowledge was associated with a higher level of education. In addition, Sinkowitz-Cochran et al (2012) reported that more knowledge was associated with a high engagement with clinical recommendations. Thus, it may be that the knowledge base towards independent clinical decision-making among nurses with a bachelor's degree remains weaker in situations where relevant research does not exist. When maintaining a sterile field, such nurses may also accept clinical reasoning when receiving collegial support from senior nurses who rely on traditional practices.

Initially, interpretation of the lack of differences in recommendation acceptance levels comparing nurses with 5 years or more general work experience in surgical departments to nurses with less than 5 years work experience proved difficult. We found differences within recommendations for the establishment of a sterile field

between nurses with less than 5 years and nurses with 5 years or more work experience in the current setting. Sinkowitz-Cochran et al (2012) found better self-reported hygiene performance and high staff engagement was related to recommendations and hospital leadership. It may be that the development of capabilities in aseptic practices takes longer than general expectations and requires the engagement of the operating theatre culture and staff. The development of expertise may begin with the establishment of a sterile field and extend to expertise in the maintenance and disestablishment of a sterile field. These latter two stages may require longer and more extensive work experience and a greater understanding of aseptic practices than establishing a sterile field.

High acceptance of recommendations among nurses with longer work experience supports this interpretation. We found a higher acceptance of the recommendations for maintaining a sterile field among nurses with 15 years or more work experience in their current unit than among nurses with less work experience. In addition, acceptance of recommendations for the establishment and disestablishment of a sterile field was higher among nurses with 15 years or more general work experience than among nurses with less work experience. It may be that managing demanding intra-operative aseptic practices like an expert requires time. An explanation for this may exist in the operating theatre culture. Senior nurses may possess more confidence and assertiveness to create and express solid opinions related to adhering to the recommendations in a multi-disciplinary team (Gillespie et al, 2008; Tame, 2013).

Limitations of the study

Our results are not generalizable, but should be used in the local development of aseptic practices. The small sample size and the absence of medical staff in the data collection limit the transferability and comparability of our findings to earlier results. Due to the low overall response rate in 2013, further testing of the acceptance of the recommendations and the scale reliability proved necessary. In early 2000 when development of the recommendations began, we applied both factor analysis and principal components analysis aiming to create relevant and valid scales. None of the analyses managed to reduce the variables to logical and practically meaningful factors. Finally, the survey items did not properly cover clinical performance.

Recommendations for clinical practice, education, and future research

By using relevant, valid, and reliable tools in the assessment of intra-operative aseptic practices, continuously improving the outcomes of surgery and the capabilities of the operating theatre nurses become possible. The evidence-based recommendations serve as technical norms for clinical and educational practices among operating theatre nurses and students (Niiniluoto, 1996). These are key to reducing the number of surgical site infections, improving patient and occupational safety, and decreasing work-related stress (Espin & Lingard, 2001; Aholaakko, 2011; Sinkowitz-Cochran et al, 2012; Tame, 2013).

Sound methodological support is essential in the evidence-based development of intra-operative aseptic practices and multi-disciplinary quality management. Testing concepts and the assessment criteria for aseptic practices more carefully in order to construct stable models for different professional roles and phases of operation are necessary. Our results may serve as a starting point for the further development of aseptic practices, which are nursing-specific and multi-disciplinary

interventions, and may facilitate improvements to patient safety and operating theatre culture. Future research should focus on studying the aseptic practice-related cultures and outcomes. Similar recommendations and practices should also be developed for demanding facilities such as angiography in the field of radiography.

CONCLUSIONS

In the development of assessment criteria for intra-operative aseptic practices, precise and comprehensive scales of both acceptance among clinical professionals and the use of scientific methods are essential. This study demonstrated the reliability of the constructed 'Aseptic Practices among Circulating Nurses' scale, which may serve as a starting point for the further development and validation of assessing the role of the circulating nurse in aseptic practices.

Our study found statistically significant differences in the acceptance of recommendations for circulating nurses according to education and general and current work experience in operating theatre units. The work of a circulating nurse includes responsibilities such as aseptic practices facilitating teamwork in a sterile operating field. Traditionally, attention focused on the establishment and maintenance of a sterile field. In future, it is important to develop recommendations covering the entire process, including the disestablishment of a sterile field. To develop evidence-based intra-operative aseptic practices, future research should further study such topics from varying perspectives.

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Table 1. The 'Aseptic Practices among Circulating Nurses' Scale

	Mean (SD)*	Cronbach's α reliability coefficient	α if item deleted
'Aseptic Practices among Circulating Nurses' scale	3.44	0.782	
Establishment of a Sterile Field sub-scale	3.77	0.605	
Sterile indicators inspected before use ^a	3.95 (0.278)		0.532
Indicator gloves taken for risk operations ^a	3.95 (0.213)		0.519
Not using a sterile item after expiration date	3.94 (0.244)		0.536
Integrity of package inspected	3.89 (0.403)		0.541
Fluid transparency inspected before use ^a	3.89 (0.362)		0.435
Not using a damp sterile package*	3.86 (0.467)		0.513
Not using an opened sterile package*	3.73 (0.623)		0.551
Fluids and medicines decanted near use ^a	3.67 (0.714)		0.371
Filter needle used with liquids ^a	3.61 (0.748)		0.550
Sterile field created less than an hour before operation ^a	3.23 (1.046)		0.663
Maintenance of Sterile Field sub-scale	3.58	0.639	
Sterile field constantly supervised ^a	3.85 (0.404)		0.589
Doors kept closed during operation	3.80 (0.403)		0.622
Number of persons in operating theatre limited during operation	3.75 (0.501)		0.600
Defects in aseptic practices documented	3.71 (0.744)		0.623
Unscrubbed person not moving between two sterile fields	3.66 (0.594)		0.572
Circulating nurse stayed in operating theatre during operation*	3.26 (0.776)		0.638

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Intra-operative conversation is aseptically important*	3.00 (0.901)		0.564
Disestablishment of Sterile Field sub-scale	3.90	0.617	
Gloves used during disestablishment of the sterile field ^a	3.97 (0.173)		0.388
Bloody gloves not removed outside operating theatre* ^a	3.91 (0.290)		0.578
Not disestablishing sterile field during wound closure* ^a	3.83 (0.414)		0.659

* Items recoded into a four-point score so that higher numbers represent stronger agreement to the recommendations.

^a Appears in the 2013 updated recommendations.

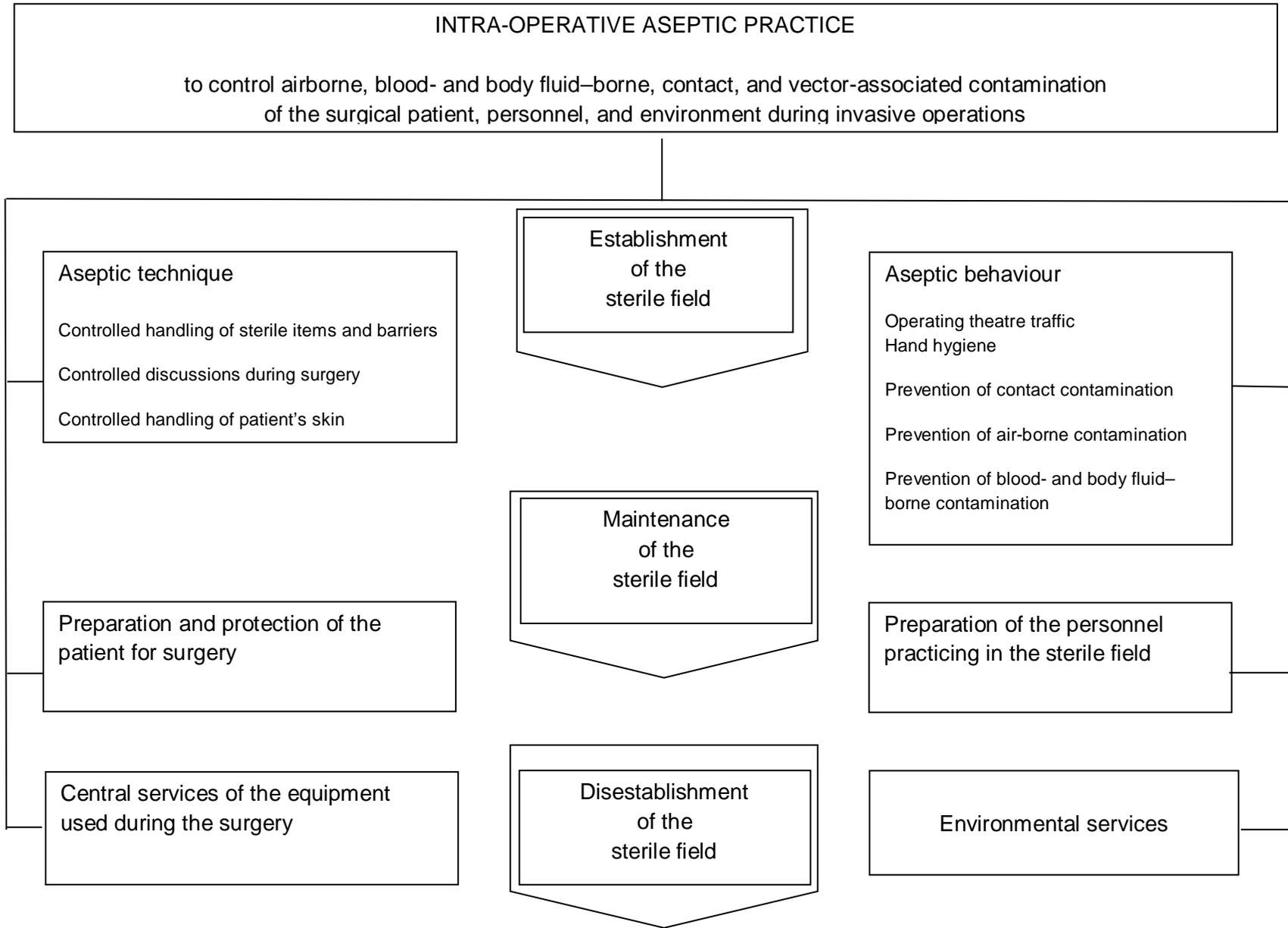


Figure 1. Model for Intra-operative Aseptic Practices Constructed for Quality Development in the Operating Theatre