RESEARCH ARTICLE

REVISED The choice between surgical scrubbing and sterile covering before or after induction of anaesthesia: A prospective study [version 2; referees: 2 approved]

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Abstract

Background: Day surgery is increasing, and safe and effective logistics are sought. One part of the in-theatre logistics commonly discussed is whether surgical scrub and sterile covering should be done before or after induction of anaesthesia. The aim of the present study was to compare the impact of surgical scrub and sterile covering before vs. after the induction of anaesthesia in male patients scheduled for open hernia repair.

Methods: This is a prospective randomised study. Sixty ASA 1-3 patients scheduled for open hernia repair were randomised to surgical scrub and sterile covering before or after induction of anaesthesia; group “awake” and “anaesthetised”. Need for vasoactive medication during anaesthesia was primary study objective. Duration of anaesthesia and surgery, theatre time, recovery room stay and time to discharge, patients and theatre nurses experiences and willingness to have the same logistics on further potential surgeries, by a questionnaire provided before discharge was also assessed.

Results: The duration of anaesthesia was shorter and doses of propofol and remifentanil were reduced by 10 and 13%, respectively, in the awake group. We found still no difference in the need for vasoactive medication during anaesthesia Time in recovery area was significantly reduced in the awake group 39 (SD 15) vs. 48 SD 16) ($p<0.05$), but time to discharge was not different. There was further no difference in the patients’ assessment of quality of care, and only one patient in the awake group would prefer to be anaesthetised on a future procedure. All nurses found pre-anaesthesia scrubbing acceptable as routine.

Conclusion: Surgical scrub and sterile covering before the induction of anaesthesia can be done safely and without jeopardising patients’ quality of care and possibly improve perioperative logistics. Further studies are warranted assessing impact of awake scrubbing and sterile covering on quality and efficacy of perioperative care.

Open Peer Review

Referee Status: ✓ ✓

	Invited Referees 1	2
REVISED version 2 published 09 Aug 2017	✓ report	
version 1 published 28 Jun 2017	? report	✓ report

1 **Jakob Walldén**, Umeå University, Sweden

2 **Adam Magos**, Royal Free Hospital, UK

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Comments (0)

Corresponding author: Jan Jakobsson (jan.jakobsson@ki.se)

Author roles: Sellbrandt I: Conceptualization, Formal Analysis, Project Administration, Supervision, Writing – Original Draft Preparation, Writing – Review & Editing; **Brattwall M**: Data Curation, Funding Acquisition, Investigation; **Jildenstål P**: Conceptualization; **Warrén Stomberg M**: Conceptualization, Data Curation, Investigation, Methodology; **Jakobsson J**: Conceptualization, Writing – Original Draft Preparation

Competing interests: No competing interests were disclosed.

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The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

First published: 28 Jun 2017, **6**:1019 (doi: 10.12688/f1000research.11965.1)

REVISED **Amendments from Version 1**

The manuscript is revised based on the structured and constructive comments by the referees. The primary study objective on which the power analysis is based, is more adequately expressed in the Methods, Results and Discussion sections. The limitations and need for further studies are also incorporated.

We have tried as far as possible to adhere to all comments from referees.

See referee reports

Introduction

Day surgery, where the patient leaves the hospital on the same day as surgery, is increasing. Shortening a hospital stay is associated to several benefits: Early ambulation reduces the risk for thromboembolic complications, as well as postoperative infections; and it will reduce health care costs. Thus, its implementation is of value for both patients and society. However, day surgery calls for good perioperative care, enabling rapid recovery to send patients safely home after a few hours following the end of surgery/anaesthesia. Shortening anaesthesia time, avoiding unnecessary anaesthetic exposure, has several potential benefits, including avoiding unnecessary cardiovascular depression, since there is a miss-match between anaesthetic depression and stimuli, thus requiring vasoactive support, improving early recovery, and reducing the amount of anaesthetic used.

The aim of the present study was to compare surgical scrub and sterile covering before *vs.* after induction of anaesthesia. Our hypothesis was that avoiding prolonged anaesthesia by inducing anaesthesia prior to surgical scrubbing and sterile covering would reduce the need for vasoactive medication. Additionally, the study aimed to determine if this different theatre logistic further affect drug doses of anaesthetic agents, post-anaesthesia care unit (PACU) time and quality of care.

Methods

Ethical approval

The study protocol has been reviewed and approved by the Gothenburg Ethical Committee (Dnr. 751-16 scientific secretary Sven Wallerstedt, October 24th 2016).

Study group

The study was conducted at Capio Lundby Hospital in Gothenburg, November 2016 – February 2017. Male patients scheduled for elective open hernia repair with a modified Lichtenstein technique under general anaesthesia were requested to participate. Exclusion criteria was severe cardiovascular, respiratory, hepatic or renal disease, and American Society of Anaesthesiology (ASA) score of >3. Sixty ASA 1–3 patients scheduled for elective open hernia repair, modified Lichtenstein procedure, participated in the study following verbal and written informed consent. These patients were randomised by envelope technique into two groups:

1. Awake group: Surgical scrub and sterile covering before induction of anaesthesia, having the patient awake but sedated.
2. Anesthetised group: Surgical scrub and sterile covering when the patient is asleep, anaesthesia induction and securing airway and start of maintenance has been initiated.

Patients received all medication and care in accordance to routine procedures of the department, apart from the scrubbing and sterile covering. Premedication was with paracetamol and diclofenac.

Anaesthesia was induced and maintained with propofol and remifentanil (total intravenous anaesthesia; TIVA). Anaesthesia was adjusted per clinical signs. No EEG-based depth of anaesthesia monitor was used. Patients had local anaesthesia in the wound area during the surgery. Postoperative nausea and vomiting (PONV) prophylaxis was administered based on risk, assessed by Apfel score.

Data collection

Patients' assessment of their experience being awake or anaesthetised during surgical scrub and sterile covering was collected using a postoperative survey. The survey used a visual analogue scale (VAS; 0, unacceptable to 10, fully acceptable) to describe the experience, and the question 'would you like to have the same care if you needed further surgery?' (yes/no/I don't know).

Perioperative observations were collected from the patient case record.

Operating room nurses (n=7) were asked whether they found the surgical scrub and covering acceptable from a patient care perspective (VAS scale 0 not at all – 10 fully acceptable) only for awake patients.

Data analysis

All data is presented as mean ± standard deviation (SD), unless otherwise stated. Differences between groups' continuous data, e.g. demographics and perioperative observation were assessed by Student's *t*-test, and categorical data with Chi-square test. A $p<0.05$ was considered statistically significant. Data was analysed with StatView (v1.04) for MAC.

The number of patients studied is based on a power analysis from findings in a pilot study; awake surgical scrub and sterile covering should reduce the need for vasoactive medication. A difference of 10 to 5 mg composite with SD of 6 with a power of 80% would require two groups of patients with 23 each to show a difference $p<0.05$.

Results

All 60 patients asked for participation accepted and signed informed consent. Assessment of quality of care during surgical scrub and sterile covering was assessed by all 60 patients; three patients were excluded from analysis of anaesthesia and recovery, as the surgery became more extensive than planned or for social reasons, and the patients were kept as inpatients. There were only minor demographic differences between the groups: the mean age of the awake group was 5 years older, but the ASA class was not different (Table 1).

Duration of anaesthesia and time with laryngeal mask airway was shorter in the awake group (Table 2). The amount of propofol and remifentanil required was also lower in the awake group: 10% reduction in propofol and 13% reduction of remifentanil, but this difference in drug amount was not significant. We found however no difference in vasoactive need between groups. There were no differences in early recovery or vital signs, and first pain was reported at similar times in both groups. Time in PACU was shorter for the awake patients ($p<0.05$), but time to discharge, pain and post-operative nausea and vomiting showed no difference between groups (Table 2).

In total, 27 of the awake patients would undergo surgery using the same logistics, two were indifferent and one was "negative", while 21 of the anaesthetised patient would like to have the same logistics, and nine were indifferent. The theatre nurses rated patients being awake during surgical scrub and sterile covering as acceptable; 4out of the 7 nurses rated 10(scale 0 -10), while the remaining rated; 1 nurse made a rating of 6 and 2 nurses, both rated the process of washing and dressing as 8 (on the 0 -10 scale). All 7 nurses involved in the patient care considered it feasible to perform surgical scrub and sterile covering before induction of anaesthesia as routine procedure.

Dataset 1. Demographics, perioperative observations, and response to questionnaire of the patients undergoing surgical scrub and covering pre and post-anaesthesia

http://dx.doi.org/10.5256/f1000research.11965.d166034

Table 1. Patient demographics of patients in the awake and anaesthetised group. Data is displayed as the mean (standard deviation), unless otherwise stated.

	Anaesthetised (n=30)	Awake/sedated (n=30)	P-value
Age (years)	58 (16)	63 (15)	0.2
BMI	26 (3)	26 (3)	0.4
ASA, 1/2/3	5/18/7	9/17/4	.3
Smoking, yes/no	5/25	3/27	0.7

Table 2. Perioperative observations of the patients in the awake and anaesthetised group. Data is displayed as the mean (standard deviation), unless otherwise stated. Two patients in the awake group and one in the anaesthetised group were excluded from analysis, since they were kept as inpatients. Surgery time is defined as the time the patient is being operated on; theatre time is defined as the entrance to theatre to leaving for PACU. LMA, laryngeal mask airway; PACU, post-anaesthesia care unit; VAS, visual analog scale.

	Anaesthetised (n=29)	Awake/sedated (n=28)	P-value
Anaesthesia (min.)	64 (10)	60 (14)	0.17
Propofol (mg)	506 (114)	455 (119)	0.10
Remifentanil (µg)	837 (205)	731 (256)	0.08
Ephedrine (mg), median (range)	0 (0-15)	0 (0-25)	0.16
Phenylephrine (mg), median (range)	0 (0-0.8)	0 (0-0.4)	0.46
Time with LMA (min.)	58 (10)	52 (14)	0.068
Surgery (min.)	39 (9)	38 (13)	0.78
Theatre (min.)	70 (10)	69 (13)	0.77
PACU (min)	48 (16)	39 (15)	p0.042
Max pain during PACU (VAS)	1.8 (2.7)	1.2 (2.1)	0.33
Time to discharge (min.)	224 (58)	235 (65)	0.45
Patient assessed quality of care (VAS), median (range)	10 (6-10)	10 (3-10)	0.09

Discussion

We could not prove our hypothesis that sterile washing and dressing before induction of anaesthesia reduced anaesthetic drug usage. But, no difference in need for vasoactive medication was found. We found however that surgical scrub and sterile covering prior to induction of anaesthesia feasible and with a maintained quality of care. We have the experience that theatre nurses in Sweden prefer the patient being asleep while surgical scrubbing and sterile covering is performed is performed. The argument is that it may be distressful for patients if they are awake during preparation, surgical scrubbing and sterile covering. However, in this study, generally patients did not mind being awake, on the contrary some patients gave positive feedback about being awake during preparation. Some nurses also feel that the liquid used for scrubbing may cause a freezing sensation in patients; we did not hear any comments supporting this notion. There are also discussions regarding that awake patients may be at an increased risk for surgical site infections (SSI). In a majority of SSI cases, the pathogen source is the native flora of the patient's skin and there is no firm evidence that the anaesthetic technique used, i.e. patient being awake or asleep during scrub and sterile covering, should impact the infection risk[1,2]. Two recent studies in a huge number of patients undergoing orthopaedic procedures did not show any difference between general anaesthesia, spinal anaesthesia and peripheral blocks[3,4].

Washing and dressing after induction prolongs the time of anaesthesia and to titrate optimal depth keeping patient asleep with only merely minor stimulation following induction may cause additional need for vasoactive medications and may prolong recovery. Shortening the duration of anaesthesia and drug doses may be of value, especially for elderly patients. There are studies suggesting that tailoring anaesthesia reduces the risks for cognitive side effects[5]. We did not follow patients beyond discharge. All our patients had total intravenous anaesthesia; whether use of inhaled anaesthesia for maintenance could further improve emergence, the early recovery, and quality of recovery cannot be assessed from the present study. We found in a previous study that inhaled anaesthesia facilitates early recovery[6]. We could however not see any reduced need for vasoactive medication, thus our primary hypothesis was negative. We cannot give any firm explanation as to why this occurred, since in the awake group the need for both propofol and remifentanil was reduced.

Theatre turnaround time is of increasing importance. Efforts to improve efficacy has been addressed in several studies. Koenig *et al.* studied anaesthesia induction when the surgeon was in theatre or not, and its impact on waiting time and unnecessary anaesthesia duration[7]. They found a significant shortening of anaesthesia time when surgeons were readily available in the theatre. Saha *et al.* found that transfer of patient to and from theatre has a significant impact on theatre turnaround time[8]. We found clear logistical benefits associated with the use of local anaesthesia and sedation as compared to general anaesthesia in a previous study[9]. The benefit of local anaesthesia sedation technique has also been supported by others for vaginal prolapse surgery[10,11]. Open hernia repair is commonly done under local anaesthesia only[12]. Thus, avoiding anaesthesia during surgery preparation also seems to be a feasible alternative when patients are undergoing general anaesthesia. The anaesthetised patients were somewhat younger and whether that could have impacted the results, need for vasoactive medication cannot be stated, the ASA profile was however similar between the groups.

There are limitations to our study. We studied only one procedure, elderly male patients scheduled for inguinal hernia repair. We had need for vasoactive medication as the primary study objective; this may not be the optimal choice and the number of patients studied is also relatively few. The number of patients was based on our power analysis from pilot experience. Whether these results are transferable to other procedures needs further studies. Proper information around the importance of scrubbing and covering should be given to patients, and providing light sedation should be done in accordance to a patient's wish. Whether fine tuning anaesthetic delivery could further impact the results cannot be stated. We could not find studies assessing the surgical scrub and sterile covering impact on quality of care or theatre time events, thus we are not able to truly put our findings into perspective of previous similar results. We still believe that our findings can be of interest and importance as lean operating theatre planning is of growing importance. Further studies are indeed warranted assessing impact of awake scrubbing and sterile covering on quality and efficacy of perioperative care. There are studies looking at different anaesthetic techniques and the use of a holding area for theatre preparation, which show benefits to introducing peripheral blocks before entry to the theatre[13].

In conclusion, preparation, surgical scrub and sterile covering, before induction of anaesthesia is feasible, and does not jeopardise quality of care. In addition, it reduces anaesthetic agents need and may thus shorten recovery room stay.

Data availability

Dataset 1: Demographics, perioperative observations, and response to questionnaire of the patients undergoing surgical scrub and covering pre and post-anaesthesia. doi, 10.5256/f1000research.11965.d166034[14]

Competing interests

No competing interests were disclosed.

Grant information

This study has been supported by Capio Lundby Hospital. No external funding or financial support has been received.

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Acknowledgements

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Data Source

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Current Referee Status: ✔ ✔

Version 2

Referee Report 10 August 2017

doi:10.5256/f1000research.13385.r24882

✔ **Jakob Walldén**
Anaesthesia and Intensive Care, Umeå University, Sundsvall, Sweden

The authors have adressed the issues raised in the first version adequetely. The manuscript is now clear and of good quality.

Competing Interests: No competing interests were disclosed.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Referee Report 04 August 2017

doi:10.5256/f1000research.12935.r24416

✔ **Adam Magos**
Royal Free Hospital, London, UK

This is a simple, small prospective RCT addressing the issue of scrubbing and prepping patients undergoing hernia repair ("anaesthetised" group) before or after ("awake" group) induction of general anaesthesia. The manuscript is clearly written and provide adequate details about methodology, including a power calculation. The results show that the only statistically significant advantage an "awake" approach was less time in recovery by 9 (48 v 39) minutes. None of the other variables were significantly different although there was a trend to less anaesthetic usage in the awake group associated with a 4 (64 v 60) minutes reduction in anaesthetic time.

Whether or not there is a meaningful advantage of pre-anaesthetic scrubbing and prepping is not confirmed by this study, perhaps because it was underpowered, and this is reflected in the authors' conclusions.

Nonetheless, this is an interesting study and one which may stimulate larger studies in different surgical areas. For this reason, publication would be worthwhile.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Referee Report 17 July 2017

doi:10.5256/f1000research.12935.r23882

? **Jakob Walldén**
Anaesthesia and Intensive Care, Umeå University, Sundsvall, Sweden

General comments:

Interesting pragmatic study evaluating if surgical scrub should be done before or after induction of anesthesia. The perspective is both from the patients and nurses point of view. The authors have found no major differences between the approaches and the major conclusion of the study is adequate.

My major concerns regarding the manuscript is that the authors must be more consistent with the endpoints in the study, there is no clear line in the manuscript of the primary and secondary endpoints. The power analysis is done on the reduction of an undefined vasoactive drug and this is consistent with the hypothesis stated in the end of the introduction, but this outcome is not even mentioned in the abstract.

Please define the endpoint in the study clearly, and be consistent with these endpoint when presenting and discussing the results throughout the manuscript.

Please correct tense throughout the manuscript and use past tense when describing the study. Please also proof-read so that grammar is correct throughout the manuscript, there are still quite a few grammatical errors.

Specific comments:

Abstract/Results: Present the figures of the main results, not only the p-values.
Abstract/Conclusion: Is the statement "safe" supported"? No outcomes regarding safety.

Introduction:
Relevant section. Punctuation instead of question-mark in in last sentence of introduction.

Methods:

- Please use correct name of the review board (Regional Ethical Review Board in Gothenburg). State date for decision.
- Please state main outcome variables, primary and secondary.
- Duplicated sections?

Patients received all medication and care in accordance to routine procedures of the department, apart from the scrubbing and sterile covering. Premedication was with paracetamol and diclofenac.

All patients received care in accordance to routines of the department, apart from the preoperative preparation, surgical scrub and sterile covering awake or after induction of anaesthesia.

- How was the procedure/routine for giving vasoactive drugs during anesthesia? First choice, second choice? Blood pressure cutpoints?
- Power analysis: Reduction in what drug?

Results and Table 1:
Present the results in a structured order according to primary and secondary outcomes.

The primary endpoint (vasoactive drugs) is a parameter that might needs to be presented more extensively. Three drugs are presented, and there is a small tendency that the awake group received more vasoactive drugs. Another dimension to explore the data is to present the number of patients that needed vasoactive drugs.

Nurse rating: unclear what you mean with: / … follows: 1, 6/10; 2, 8/10./ Are there one nurse rating missing?

Discussion:
Main conclusions adequate in first paragraph.

In second paragraph regarding theatre nurses, there are many statements without references. (..prefer patients being asleep… distressful for patients…. freezing sensations…discussion regarding that awake patients may be at an increased risk for surgical site infections…). Please support the statements if

possible.

Discuss more extensively the differences between the group and possible impact on the results (i.e. age differences, anesthetic doses).

Discuss if the study was properly powered. Better to use other variable calculate power?

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
Partly

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response (*Member of the F1000 Faculty* and *F1000Research Advisory Board Member*) 27 Jul 2017

Jan Jakobsson, Department of Physiology and Pharmacology, Karolinska Institutet, Sweden

Thank you for adequate and constructive comments;

My major concerns regarding the manuscript is that the authors must be more consistent with the endpoints in the study, there is no clear line in the manuscript of the primary and secondary endpoints. The power analysis is done on the reduction of an undefined vasoactive drug and this is consistent with the hypothesis stated in the end of the introduction, but this outcome is not even mentioned in the abstract.

Please define the endpoint in the study clearly, and be consistent with these endpoints when presenting and discussing the results throughout the manuscript.

The study was set-up to study differences between the two logistics, sterile washing and dressing before or after induction of anaesthesia. The power analysis was based on a pilot study looking at the amount of ephedrine needed, with MAP 60 and SAP 90 as cut-off values.

Secondary outcomes where patients and scrub nurses assessment, any signs of safety concerns, and last theatre turn time around and PACU stay duration. We have now clarified and amended the manuscript accordingly.

Please correct tense throughout the manuscript and use past tense when describing the study. Please also proof-read so that grammar is correct throughout the manuscript, there are still quite a few grammatical errors.

We have amended the language to past tense and further checked spelling and grammar

Specific comments:

Abstract/Results: Present the figures of the main results, not only the p-values.

Added accordingly

Abstract/Conclusion: Is the statement "safe" supported"? No outcomes regarding safety.

Amended/clarified

Introduction:
Relevant section. Punctuation instead of question-mark in in last sentence of introduction.

Methods:
- Please use correct name of the review board (Regional Ethical Review Board in Gothenburg). State date for decision. *Amended/added*
- Please state main outcome variables, primary and secondary. Clarified
- Duplicated sections?

Patients received all medication and care in accordance to routine procedures of the department, apart from the scrubbing and sterile covering. Premedication was with paracetamol and diclofenac.

All patients received care in accordance to routines of the department, apart from the preoperative preparation, surgical scrub and sterile covering awake or after induction of anaesthesia.

Corrected
- How was the procedure/routine for giving vasoactive drugs during anesthesia? First choice, second choice? Blood pressure cutpoints?
- Power analysis: Reduction in what drug? Efedrin

Results and Table 1:
Present the results in a structured order according to primary and secondary outcomes.

The primary endpoint (vasoactive drugs) is a parameter that might needs to be presented more extensively. Three drugs are presented, and there is a small tendency that the awake group

received more vasoactive drugs. Another dimension to explore the data is to present the number of patients that needed vasoactive drugs.

Nurse rating: unclear what you mean with: / … follows: 1, 6/10; 2, 8/10./ Are there one nurse rating missing?

Discussion:
Main conclusions adequate in first paragraph.

In second paragraph regarding theatre nurses, there are many statements without references. (..prefer patients being asleep… distressful for patients…. freezing sensations…discussion regarding that awake patients may be at an increased risk for surgical site infections…). Please support the statements if possible.

Discuss more extensively the differences between the group and possible impact on the results (i.e. age differences, anesthetic doses).

Further commented

Competing Interests: No competing interests