Perioperative management of obstructive sleep apnea in bariatric surgery : a consensus guideline

Perioperative Management of Obstructive Sleep Apnea in Bariatric Surgery:

A Consensus Guideline

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Abstract

Introduction: The frequency of bariatric surgery (BS) is increasing worldwide, with over 500,000 cases performed every year. Obstructive sleep apnea (OSA) is present in 35%-94% of BS patients. Nevertheless, consensus regarding the perioperative management of OSA in BS patients is not established.

Objectives: To provide consensus based guidelines utilizing current literature and, when in the absence of supporting clinical data, expert opinion by organizing a consensus meeting of experts from relevant specialties.

Methods: A panel of 15 international experts with extensive clinical experience in the field of sleep, anesthesiology, pulmonology, otorhinolaryngology and head and neck surgery, BS and clinical neurophysiology identified 75 questions covering preoperative screening, treatment, postoperative monitoring, anesthetic care and follow-up. Relevant literature was selected by an independent information specialist. Additionally, the meeting included two moderators, one external advisor and six researchers who reviewed the literature systematically and used the Oxford- and GRADE system to evaluate each included article. During this meeting, the "Amsterdam Delphi Method" was utilized including controlled acquisition of feedback, aggregation of responses and iteration. 'Consensus' level was set at ≥ 70% agreement among the experts.

Results: Recommendations or statements were provided for 58 questions. In the judgment of the experts, seventeen questions provided no additional useful information and it was agreed to exclude them. With the exception of three recommendations (64%, 66% and 66% respectively), consensus was reached for 55 statements and recommendations.

Conclusion: This first international expert meeting provided 58 statements and recommendations for a clinical consensus guideline regarding the perioperative management of OSA patients undergoing BS.

Keywords

Bariatric Surgery; Obstructive Sleep Apnea; Continuous Positive Airway Pressure; Postoperative Monitoring; Anesthesia; Consensus Guideline

Introduction

Bariatric surgery (BS) is increasingly being performed as a long-term treatment for morbid obesity, which is defined as a Body Mass Index (BMI) greater than 40 kg/m^2 or as a BMI greater than 35 kg/m^2 in combination with obesity related comorbidities. At present, around 500,000 BS procedures are performed worldwide and the number is growing (1). Morbid obesity is associated with multiple comorbidities, of which one of the most common is obstructive sleep apnea (OSA). This comorbidity is characterized by repetitive collapse of the upper airway leading to intermittent hypoxia, sympathetic activation and, with obesity, increased carbon dioxide levels. Due to these pathophysiological changes, there is an increased risk of cardiovascular, neurovascular and pulmonary complications.

Two meta-analyses and a recent systematic review of 63 publications reporting 413,576 OSA patients and 8,557,044 control (non-OSA) patients confirmed a higher incidence of postoperative oxygen desaturations, cardiac events and respiratory failure in the presence of OSA (2-5). Although numbers vary in the literature, OSA is present in 35%-93.6% of BS patients (6-19).

Despite the high number of BS procedures and high prevalence of OSA, consensus regarding the perioperative management of OSA in BS patients is lacking. Our aim was to provide consensus based guidelines for this topic. This was done by using current literature and, in the absence of supporting clinical data, expert opinion was solicited. For these matters, a consensus meeting was held with experts from the relevant specialties.

Methods

Group and main topics

Five authors were involved in the organization of this project (CdR, MGS, NdV, AS and BvW). A multidisciplinary panel of 15 international experts was invited to attend a consensus meeting held in Amsterdam of March 2016. The selection of panelists was based on the extensive clinical experience of experts in the field of sleep, anesthesiology, pulmonology, otorhinolaryngology & head and neck surgery, BS and clinical neurophysiology. Additionally, the Executive Board of the International Federation for the Surgery of Obesity and Metabolic disorders (IFSO) was asked to provide suggestions for experts within their network.

This consensus meeting was held under the principles established for the 2015 consensus meeting on appendicitis of the European Association for Endoscopic Surgery (EAES) (20). Accordingly, the head of experts of the EAES meeting (HJB) operated as an external advisor prior to and during the current meeting. Furthermore, the meeting included two independent moderators (CdR and MGS), six researchers (BR, MT, NvdW, UC, AvR, RvdH) and one independent information specialist (RS).

The organizing group identified five main topics in which there remains lack of consensus. These five topics include: 1) preoperative screening; 2) treatment; 3) postoperative monitoring; 4) anesthetic care and 5) follow-up of OSA patients undergoing BS. Consequently, all experts were approached and asked to provide clinically relevant questions within these topics before the meeting was held. All experts provided approval for the final selection of study questions (Appendix #1).

Processing literature

An independent information specialist performed a systematic literature search on each main topic (Supplementary Material #1). Studies were identified by searching PubMed, Embase and the Cochrane Central Register for Controlled Trials. The last search was run on 07-12-2015. Studies were identified by using keywords "Bariatric Surgery" AND "Obstructive Sleep Apnea" AND "[subquestion]". In order to identify additional articles concerning morbidly obese patients, an additional search was performed by using keywords "Morbid Obesity" AND "Obstructive Sleep Apnea" AND "[subquestion]". Mesh terms and free text words were combined for both searches.

The articles were assembled in five separate Reference Manager (®) databases after which duplicates were removed. These five databases each covered one main topic. They were transmitted to the researchers for further selection.

The six researchers were divided into three teams of two members each. Each team received one or two databases. Both members of each team individually reviewed the same literature. Only articles written in English were included. Articles were selected based on their titles and abstracts. The remaining articles were read in full text and categorized according to subquestions developed for each topic. This was followed by deliberation between team members regarding their suitability for inclusion in the analysis. In case of a lack of consensus between the researchers, two independent referees were available (CdR and MGS) to help make this determination.

All categories of studies i.e. randomized controlled trials, retrospective studies and expert opinion, were eligible for inclusion. Level of evidence was provided for all articles according to the Oxford system (21). During the process, team meetings were organized in order to assure that everyone followed the same strategy and to discuss any difficulties. A definitive list of full-text articles was transferred to the website Mendeley (®) where all articles were available online for the researchers and experts.

For each subquestion, the researchers prepared a preliminary answer based on the available literature. The answers included conclusions, recommendations, level of evidence of all included articles and strength of recommendations, according to the GRADE system (22). Subsequently, all subquestions were distributed among all 15 experts based on their expertise. Experts were asked to review the literature and answers provided by the research teams and offer suggestions for correction using the experience and knowledge they have in the field. When no literature was available to answer a subquestion, the assigned expert was asked to provide an expert opinion.

Throughout the manuscript, recommendations or statements are referred to their main topic and subquestion. For example, topic 1 (preoperative screening) and subquestion 1 (prevalence of OSA in BS) is documented as (Q 1.1). Results of every subquestion are displayed in Table 1-5.

Consensus Meeting

The consensus meeting was held on the 17 and 18 of March 2016 in Amsterdam, the Netherlands. All invited experts attended the meeting in person. The consensus meeting was held according to an adjusted Delphi methodology referred as to the "Amsterdam Delphi Method" in order to address the large number of questions (20). The following key components of the Delphi method were used: iteration (two rounds); controlled acquisition of feedback and aggregation of responses. Anonymity, which is also a key component in the Delphi method, was not feasible in this face-to-face setting. 'Consensus' level was set at 70% agreement among experts. The structure of the meeting is displayed in Figure 1. The two moderators independently chaired the meeting and kept time and track of the methodology.

When more appropriate, the experts could suggest a statement rather than a recommendation. Finally, in the judgment of the experts, questions were excluded from further process if they provided no additional useful information.

Results

Literature search

Initially the searches were categorized as either focused on BS or on morbid obesity. The "Bariatric Surgery" search resulted in 5546 articles. After duplicates were removed, a total of 2471 unique articles remained. An additional "Morbid Obesity" search provided 14,584 articles, of which 4882 articles remained after removing duplicates within this search and from the "Bariatric Surgery" search. Consequently, a total of 7353 articles were screened on title and abstract by our research teams. The selection procedure for each topic is displayed in Figure 2.

Consensus meeting

During the consensus meeting, all 75 study questions were addressed. Recommendations including their strength were provided for 49 questions. Nine questions resulted in the formulation of a clear statement, not requiring strength, instead of a recommendation. Seventeen questions provided no additional useful information and were voted out by the experts and thus excluded from being processed further. With the exception of three recommendations (64%, 66%, 66% respectively), consensus was reached for 55 statements and recommendations. Recommendations or statements, quality of evidence and strength of recommendation of all questions are displayed in Tables 1-5. Results of both voting rounds are shown in Supplementary Material #2.

Topic 1. Preoperative screening (Table 1)

The value of mandatory OSA screening in the preoperative period was one of the most important discussions held at the meeting.

OSA is one of the most common comorbidities among morbidly obese patients. Fourteen prospective studies were found that primarily investigated the prevalence of OSA using sleep studies. The prevalence varied between 35% and 94% (Table 1, Q 1.1) (6-19). Of these 14 studies, 11 reported prevalence higher than 60%.

In general, adequate detection and treatment of OSA is important for three main reasons: reducing clinical symptoms such as sleepiness and cognitive dysfunction, reducing the long term cardio- and

neurovascular risks and reducing the occurrence of traffic, domestic or workplace accidents. In morbidly obese patients requiring general anesthesia, a fourth important reason is reducing the preventable perioperative risks, as clinically relevant complications seem more frequent in OSA patients (Table 1, Q 1.2) (23-40).

In the long term, cardiovascular, neurovascular and pulmonary outcomes are improved after BS and this may be related to treatment of OSA through weight loss surgery (Table 1, Q 1.3). Considering perioperative complications in severely obese patients, adequate OSA treatment with Continuous Positive Airway Pressure (CPAP) is advisable to reduce the incidence of perioperative pulmonary complications and cardiovascular risks (Table 1, Q 1.4) (31;36;41). In case of CPAP intolerance and/or low CPAP adherence, patients need to be considered for the most appropriate non-CPAP treatment option, such as oral appliances (42). Other successful therapies include positional therapy, maxillofacial surgery and upper airway surgery/stimulation (43;44).

Currently, the gold standard for diagnosis of OSA is an overnight laboratory polysomnography (PSG) (Table 1, Q 1.5) (45-47). Such a study determines the frequency and duration of apneas and hypopneas during a full night of accurately documented sleep and subsequently generates amongst other variables the apnea-hypopnea-index (AHI). Briefly, the AHI quantifies the number of pharyngeal collapses (partial or complete) per hour during sleep and is used to judge OSA severity. OSA is defined as an AHI $\geq$ 5 events/hour in adults. The internationally used severity levels are 5-14.9 events/hour (mild OSA), 15-29.9 events/hour (moderate OSA) and $\geq$ 30 events/hour (severe OSA). More research is needed to evaluate and introduce additional cutoffs, i.e. $\geq$ 60 events/hour to represent extremely severe OSA (Table 1, Q 1.19) (48).

Besides the AHI, there are other severity metrics available that could be considered. The oxygen desaturation index (ODI), which is also an accurate tool to screen for OSA (Table 1, Q 1.23) (49-56), has been shown to be a useful non-invasive severity measure, whereas other measures such as length of apneas percentage of apneas and cumulated time for oxygen saturation < 90% need further evaluation (Table 1, Q. 1.17) (19;49;54;55;57-63). One study found that patients with mean preoperative overnight SpO2 <92.7% or ODI >28.5 events/hour or cumulative time percentage with SpO2 <90% more than >7.2% are at higher risk for postoperative adverse events (64).

A less time consuming and more patient friendly sleep study than PSG is a portable study of a limited range of variables, known as Type 3 portable sleep monitoring according to the definitions of the American Academy of Sleep Medicine (65). This can be used to screen for OSA in the BS population with high pre-test probability. Its use is most reliable when moderate to severe OSA is suspected (Table 1, Q 1.6) (66;67).

Despite these findings regarding the value of overnight measurements to determine the perioperative risk, mandatory sleep studies prior to BS have not been accepted as the standard of care due to limited sleep laboratory capacity, costs, time management and the unknown importance of OSA detection. As a portable monitor is considered a useful adjunct to questionnaires in OSA screening (Table 1, Q 1.12) (68), this has led to the development of several other strategies including screening questionnaires. A commonly used and validated questionnaire is the STOP-Bang, the score of which can be used as a screening tool to stratify high risk OSA in (morbidly) obese patients (Table 1, Q 1.7) (69). This was also the conclusion in two more recent studies (70;71). Additionally, with a sensitivity of 86% and specificity of 77%, the Berlin questionnaire can also be used to identify risk of OSA (Table 1, Q 1.9) (72-74). The Epworth Sleepiness Scale, however, should not be used as a screening tool for OSA, as this is a symptom severity score and has a poor correlation in the bariatric population for OSA detection (Table 1, Q 1.8) (14;15;53;75).

In addition to screening questionnaires, other tests such as $PaCO_2$, have been investigated. Literature shows that $PaCO_2$ is not an accurate indicator of the presence of OSA. However, elevated $PaCO_2$ is important for perioperative risk stratification and can be used as part of a diagnostic tool for obesity hypoventilation syndrome (OHS) in a patient with OSA (Table 1, Q 1.14) (18;76;77). OHS is a condition in which obese patients fail to maintain adequate levels of ventilation (minute ventilation), leading to oxygen desaturation and high CO_2 levels. OHS is a triad of three components existing of BMI above 30 kg/m^2, daytime hypoxemia and CO_2 elevation. While the prevalence of OHS is reported to be as high as 20% among obese OSA patients, it is often underrecognized. The coexistence of OHS and OSA is associated with a higher morbidity and mortality rate after BS. Therefore, OHS should be screened for in BS patients with OSA (Table 1, Q 1.18) (78-85). This higher complication rate was also shown in a more recent article (83). To accomplish the aim of screening for coexistence of OHS,

it is recommended to perform venous $HCO3^-$ measurements as part of the routine screening (Table 1, Q 1.16) (84;86;87). A $HCO3^-$ cutoff > 27 mmol/l has a sensitivity and specificity of approximately 86% and 90% respectively, for diagnosing OHS. In addition, it is recommended to include CO_2 measurements in future prospective trials assessing the relation of OHS with perioperative complications and evaluating its role in the risk stratification in BS (Table 1, Q 1.15).

Taking these matters into consideration, mandatory OSA screening appears indicated due to the high prevalence of OSA in morbidly obese subjects and the increased risk of perioperative complications. While the gold standard to diagnose OSA is a PSG, other tools such as the STOP-Bang questionnaire could be used to identify high risk patients, with portable type 3 sleep studies adding additional information.

Another interesting topic is the coexistence of other comorbidities. The presence of neuromuscular disorders involving the respiratory muscles or advanced obstructive lung diseases should be considered in the preoperative screening. While there is little direct evidence as yet regarding their influence, any combination might increase the perioperative risk of hypoventilation and upper airway obstruction (Table 1, Q 1.21) (80;88;89).

Finally, there is no evidence that patients should be specifically investigated for venous thromboembolisms, unless they have a history of prior deep VTE and/or coagulation disorders (Table 1, Q 1.22) (90).

2. Treatment (Table 2)

The use of CPAP in the perioperative period has been shown to be effective in reducing perioperative pulmonary complications and is therefore the most prescribed treatment for OSA (Table 2, Q 2.8) (31;36;41;91-97). Consequently, it is recommended to use CPAP perioperatively in patients with a preoperative AHI ≥ 15/hour, defining moderate to severe OSA (Table 2, Q 2.1) (91). Besides using CPAP to reduce the pulmonary complication risk, CPAP usage is advised as a therapeutic tool in patients with previous atrial fibrillation (Table 2, Q 2.7) (92;94;98).

As a certain time period is necessary to get used to CPAP, patients should get acclimated to its use prior to surgery if possible. This may take up to several weeks (Table 2, Q 2.4) (40;92;99-102). On

admission for surgery, patients should bring their own CPAP machine and mask to the hospital. Adequate observation of its efficacy is required, as pressure requirements may change in the postoperative setting (Table 2, Q 2.5) (31;33;100;103). During admission, its efficacy can be assessed by continuously monitoring vital signs and SaO2. After discharge, a more appropriate method is to assess airway efficacy and compliance from downloaded data from the CPAP device.

Choice of nasal versus full-face CPAP systems should be based on patient comfort and efficacy (Table 2, Q 2.6). Next to CPAP, other treatment strategies are available. Positional therapy is recommended in patients with positional OSA who cannot tolerate CPAP (Table 2, Q 2.3) (24). Another evidence based non-CPAP device is a mandibular advancement device (MAD) (42). If patients use MAD prior to surgery, it is recommended that they continue efficacious MAD usage postoperatively (Table 2, Q 2.9) (104-106).

3. Postoperative monitoring (Table 3)

Observation and monitoring are essential during and after surgery to decrease perioperative risks. Requirements depend on the type of surgery and patients' comorbidities. Patients who undergo minor surgery and those without comorbidities are often transferred to the general surgical ward in the postoperative setting. These wards generally only have the capability for intermittent vital parameter measurements. BS patients with OSA are at increased risk of complications and should be continuously monitored in the early postoperative period until they are no longer at risk of respiratory depression (Table 3, Q 3.1) (36;38;40;92;99;107-110). The minimum required monitoring is a pulse oximeter, but there may be a role for additional monitoring such as heart rate, blood pressure, respiratory rate and end-tidal carbon dioxide, especially in patients receiving postoperative narcotics (Table 3, Q 3.15) (39;40). The risk of postoperative complications is even greater in patients who are male, age above 50 years have a BMI $\geq$ 60 kg/m^2 (Table 3, Q 3.2) (32;41;101;107;109;111;112).

To identify high risk patients and to determine subsequent appropriate management, there is a role for a prolonged stay in the Post Anesthesia Care Unit (PACU) (Table 3, Q 3.9). A designated surgical ward with the capability of continuous oxygen saturation measurements, or Medium Care Unit (MCU) should be present in order to accomplish adequate postoperative care. Routine admission of OSA

patients to the Intensive Care Unit (ICU) is not necessary (Table 3, Q 3.3) (36;38;40;41;108;109;113). These monitoring recommendations are independent from CPAP usage as CPAP compliance is not guaranteed. The usage of CPAP should go along with monitoring in OSA patients. If CPAP is used, monitoring is still recommended (Table 3, Q 3.7) (36;108).

Length of stay in the monitored environment is dependent on several factors, including opioids requirements, and generally varies between the day of surgery and two days postoperatively. An absolute contraindication to outpatient surgery in morbidly obese OSA patients is the absence of a suitable home caregiver (Table 3, Q 3.12). Presently, there is no absolute AHI cutoff that would be a contraindication to outpatient surgery in OSA patients compliant with CPAP, without severe comorbidities and not requiring opioids or sedatives (Table 3, Q 3.13).

Finally, postoperative care should not be different for patients based on the choice of operation (Table 3, Q 3.14). It is hypothesized, but not documented, that the type of surgery has no influence on OSA related perioperative outcomes, whereas the length of the operation, the approach (open or laparoscopic) and level of expertise of the center may influence outcomes (Table 1, Q 1.20).

4. Anesthetic care (Table 4)

An important aspect of the perioperative management is anesthetic care. As OSA increases risk of perioperative complications, anesthesiologists should assess risk and take precautions to ensure patient safety (3;4).

Optimal anesthetic care starts in the preoperative area where the patient is assessed by the anesthesiology team. Within the operating room, special attention is placed on the optimal positioning of the patient. The ramped position is the preferred position for induction and intubation as morbidly obese patients with diagnosed OSA should be considered at increased risk for difficult intubation. This position improves oxygenation and the laryngoscopic view during intubation. Other positions such as the flat supine position should be avoided in morbidly obese patients who may desaturate readily if there are difficulties with mask ventilation or intubation, because of the effects of obesity on lung volumes and thereby oxygen stores and gas exchange (Table 4, Q 4.1) (93;114-117).

Videolaryngoscopy is available for patients in whom there is a concern for a difficult intubation, although routine usage may not be necessary in morbidly obese OSA patients (Table 4, Q 4.3). CPAP is strongly recommended at induction in the diagnosed moderately severe and severe OSA patient to maintain lung capacity and reduce time to oxygen desaturation (Table 4, Q 4.10) (25;114;115;118;119). Additionally, high flow oxygenation could be considered in patients with predicted potential for airway difficulties during induction (Table 4, Q 4.4).

Further considerations are related to drug use before and during induction. Sedatives as premedication should be avoided in patients with OSA. Opioid analgesia, if used at all, should be titrated slowly and patients should be monitored carefully (Table 4, Q 4.2) (115).

At the end of the surgical procedure, patients should only be extubated when close to fully awake, i.e. opening their eyes and coughing well, with neuromuscular blockade fully reversed and muscle function restored (Table 4, Q 4.8 + 4.13) (99;104;116;120).

In the postoperative setting, the use of opioids should be minimized and if needed, used with caution (Table 4, Q 4.5) (94;99;104;115;116;121-129). A multimodal analgesic model minimizing the necessity for the administration of opioids includes the use of paracetamol, non-steroidal anti-inflammatory drugs, local anesthetics for incisional infiltration, epidural analgesia and peripheral nerve blocks. Although other strategies such as ketamine, magnesium, intravenous lidocaine and alpha 2-agonists like clonidine and dexmedetomidine seem promising, high quality supportive evidence regarding their use in this setting is lacking (Table 4, Q 4.6) (94;104;115;116;121;122;124;127); (Table 4, Q 4.7) (115;116;122;123;127;130). When practical and as an adjunct for postoperative pain management, regional anesthesia should be considered as part of multimodal analgesia in open weight loss surgery (Table 4, Q 4.19) (115;116;121;122).

In the immediate postoperative period, CPAP treatment may be beneficial particularly in the patient with severe OSA. When needed, CPAP could be supported by oxygen therapy (Table 4, Q 4.16). Instead of CPAP, non-invasive ventilation (BPAP) should be considered if there is persistent CO_2 retention postoperatively (Table 4, Q 4.17).

Lastly, Enhanced Recovery After BS (ERABS) principles should be a standard of care in the morbidly obese patients (Table 4, Q 4.11).

5. Follow-up (Table 5)

While OSA increases the perioperative risk in BS, BS decreases the OSA severity in the long-term. The majority of OSA patients (80%) show improvement of their disease with weight loss (131). The elimination of OSA is defined as a postoperative AHI < 5/hour and is more common in preoperatively diagnosed mild OSA than severe OSA disease (54% versus 18%) (132). Moreover, in at least three-quarter of patients with a preoperative AHI ≥ 15/hour, the AHI is reduced below 15/hour during follow-up. This implies that around 75% of the preoperatively CPAP dependent patients become CPAP independent after BS (133). Prior to the decision to discontinue CPAP, a patient should be re-evaluated (Table 5, Q 5.1) (132;134-136). Currently, there are no reliable screening tools to assess for residual disease in the postoperative setting (Table 5, Q 5.4) (137;138). Therefore, postoperative in-laboratory PSG or home evaluation is recommended. The timing should be dependent on weight loss and patient symptoms (Table 5, Q 5.2) (132;138;139). A reduction of required CPAP pressure might be helpful in timing postoperative PSG. Patients should continue their OSA therapy until objectively documented to be free of OSA (Table 5, Q 5.7) (135;138-141). In case of persistent OSA, the patient should be managed according to conventional therapy (Table 5, Q 5.8) (132;135;138).

Compliance is known to be a challenge in these patients. It has been reported that up to 50-60% of moderately-severe to severe OSA patients do not attend postoperative PSG or portable monitoring (24;133). In addition to the low compliance in follow-up, previous reports have shown that up to 70% of patients are non-compliant with their CPAP therapy in the long-term (142).

To increase adherence, counselling on the importance of compliance, follow-up testing and information regarding alternative OSA therapies to CPAP should begin prior to BS (Table 5, Q 5.5). Adequate education of care givers and preoperative counseling for patients should address this matter and align patient expectations with realistic outcomes (Table 5, Q 5.6) (135).

Discussion

This was the first international consensus meeting regarding the perioperative management of OSA in BS. The 58 formulated recommendations and statements resulting from this meeting serve as a guideline for all physicians involved in the treatment of morbidly obese patients with OSA scheduled for (bariatric) surgery requiring general anesthesia.

While independent guidelines were available for both BS and OSA management, no guideline has been available that addresses both issues despite the high prevalence of OSA in the BS population (2;103). As OSA and morbid obesity are independently associated with an increased perioperative risk, preparing guidelines addressing these patients' perioperative care requires a multidisciplinary approach. Thus, an international panel of experts from relevant specialties including sleep, anesthesiology, pulmonology, otorhinolaryngology & head and neck surgery, BS and clinical neurophysiology were asked to participate in the development of this manuscript. Due to the multidisciplinary experience of this panel whose expertise covered the continuum of care of these patients, all relevant aspects of perioperative care were extensively addressed.

As OSA is one of the most prevalent comorbidities among morbidly obese subjects and the number of procedures in morbidly obese patients is increasing worldwide, the meeting was timely and its results are likely to be valuable in the surgical management of these patients. By providing recommendations that are directly applicable in the clinical setting, the recommendations in this manuscript could lead to more standardized care of these patients.

This meeting was conducted using the "Amsterdam Delphi Method" (20). In this modified Delphi Method, consensus was reached when there was more than 70% agreement among experts. Current literature does not provide a solid cut-off for Delphi models. Even though this cut-off is still the subject of discussion, it was validated and accepted in methods developed for the 2015 EAES consensus meeting on appendicitis. The results of the consensus meeting, subsequent websurvey and EAES meeting were comparable (20).

This methodology has several limitations. Due to the need of the numerous questions being addressed, a strict time schedule was required and prolonged discussions were not possible. It is possible that some questions might not have been fully addressed.

In the expert face-to-face setting, anonymity is not feasible. While this setting leads to extensive discussion and sharing of experts' opinion, an experts' vote could possibly be influenced by the voting of the other experts. This may have caused bias to the results.

Moreover, only articles written in English were considered eligible for inclusion. Since BS is increasingly being performed in the Middle-East and Latin America, relevant papers written in other languages might have been missed due to this language restriction.

Since the last literature search was performed in December 2015, articles published after this date were not systematically included. Also, literature with a high level of evidence was often not available to answer certain questions, resulting in recommendations based on expert opinion. Nevertheless, due to a multidisciplinary approach including experts with extensive experience in the field of OSA in morbidly obese patients, recommendations from the experts are the best level of evidence available. Furthermore, the areas of clinical care where there is a paucity of evidence, should challenge physicians and researchers to perform more research on these topics.

Future exploration in this field should address the major gaps that were identified during the present meeting. As routine preoperative PSG measurements are not universally feasible, one of the major challenges is to develop a reliable alternative diagnostic method that can be more readily adopted. Although the AHI is a commonly used metric of severity, the value of other metrics such as the length of apneas, degree of oxygen desaturation and percentage of apneas versus hypopneas need further evaluation as these parameters might have a role in the prediction of OSA severity, including the propensity to arouse in response to events, and thus perioperative risk.

Additionally, physicians should be mindful of the possible coexistence of OHS in patients with OSA presenting for BS. The inclusion of CO_2 measurements should be addressed in future prospective trials. Another major challenge for the anesthesiologists is to minimize opioids in the perioperative care. While some new alternatives such as ketamine, lidocaine, magnesium and alpha 2-agonists seem promising, the benefits of these agents should be evaluated in larger cohorts or prospective studies.

In conclusion, this consensus meeting resulted in 58 recommendations and statements concerning the perioperative care of OSA patients undergoing BS, providing guidance to physicians that will help optimize the perioperative care and safety.

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Table 1 – Recommendations and statements concerning OSA preoperative screening in bariatric surgery

Question	Recommendation	% consensus	Quality of evidence	Strength of recommendation
1.1	The prevalence of OSA in bariatric surgery patients varies between 35% and 94%	-	⊠⊠⊠⊠	Statement
1.2	Clinically relevant perioperative complications seem more frequent in OSA patients	93	⊠☐☐☐	Statement
1.3	CV, neuromuscular, and pulmonary outcomes are improved after bariatric surgery and this may be related to treatment of OSA	100	⊠☐☐☐	Statement
1.4	CPAP is advisable to reduce the incidence of perioperative complications and CV risks	64*	⊠☐☐☐	Weak
1.5	The gold standard for diagnosis of OSA is an overnight laboratory polysomnography	86	⊠⊠⊠⊠	Strong
1.6	Type 3 polygraphy can be used to screen for OSA in the bariatric population with high pre-test probability; its use is most reliable when moderately severe OSA is suspected	100	⊠⊠☐☐	Strong
1.7	The STOP-Bang score can be used as a screening tool to stratify high risk OSA	93	⊠⊠⊠☐	Strong
1.8	The ESS should not be used as a screening tool for OSA	100	⊠⊠☐☐	Strong
1.9	The Berlin questionnaire can be used to stratify risk of OSA	93	⊠☐☐☐	Weak
1.12	A portable monitor is a useful adjunct to questionnaires in OSA screening	100	⊠⊠⊠☐	Weak
1.14	$PaCO_2$ does not indicate the risk of OSA. However, elevated $PaCO_2$ is important for perioperative risk stratification and is a diagnostic tool for OHS in a patient with OSA	100	⊠☐☐☐	Strong
1.15	CO_2 measurements assessing the relation of OSA with perioperative complications should be implemented in future prospective trials to evaluate its role in risk stratification	100	⊠☐☐☐	Statement
1.16	Venous $HCO3^-$ should be part of the routine screening tool for coexistence of OHS	100	⊠⊠⊠⊠	Strong
1.17	The ODI is a useful non-invasive severity measure; other measures need further evaluation	80	⊠⊠⊠☐	Statement
1.18	OHS should be screened for in bariatric surgery patients with OSA (coexistence 20%)	100	⊠⊠⊠⊠	Strong
1.19	More research is needed to evaluate and introduce additional AHI cutoffs i.e. ≥ 60hour	80	⊠☐☐☐	Statement
1.20	Length of operation, open or laparoscopic approach and level of expertise of a center may be of influence on OSA related outcome	93	⊠☐☐☐	Weak
1.21	The presence of neuromuscular disorders or obstructive lung diseases should be considered as this might increase the perioperative risk of hypoventilation and upper airway obstruction	100	⊠⊠☐☐	Strong
1.22	There is no evidence that patients should specifically be investigated for VTE risk, unless they have a history of prior deep VTE and/or coagulation disorders	100	⊠☐☐☐	Weak
1.23	The ODI seems reliable and clinically useful in detection OSA	93	⊠⊠⊠☐	Strong

* Consensus level < 70%; Question 1.10, 1.11 and 1.13 were excluded

AHI = Apnea Hypopnea Index; CPAP = Continuous Positive Airway Pressure; CV = Cardiovascular ESS = Epworth Sleepiness Scale; ODI = Oxygen Desaturation Index; OHS = Obesity Hypoventilation Syndrome; OSA = Obstructive Sleep Apnea; VTE = Venous Thromboembolisms

Table 2 - Recommendations and statements concerning OSA treatment in bariatric surgery

Question	Recommendation	% consensus	Quality of evidence	Strength of recommendation
2.1	Perioperative usage of CPAP is recommended in patients with a preoperative AHI ≥ 15/hour, defining moderate to severe OSA	100	☒☐☐☐	Weak
2.3	Positional therapy is recommended in patients with positional OSA who cannot tolerate CPAP	100	☒☒☒☐	Strong
2.4	It is recommended to let patients get acclimatized to CPAP prior to surgery; this may take up to several weeks	100	☒☒☐☐	Weak
2.5	Patients should bring their own CPAP machine and mask to the hospital; adequate observation of its efficacy is required as requirements may change in the postoperative setting	100	☒☐☐☐	Strong
2.6	Choice of nasal versus full-face CPAP systems should be based on patient comfort and efficacy	100	☒☐☐☐	Strong
2.7	Preoperative CPAP usage is recommended as a risk reduction tool in patients with previous atrial fibrillation	87	☒☐☐☐	Weak
2.8	CPAP is effective in reducing perioperative pulmonary complications and is therefore the most prescribed treatment for OSA	93	☒☒☒☐	Strong
2.9	If patients use MAD prior to surgery, it is recommended that they continue efficacious MAD usage postoperatively	100	☒☐☐☐	Strong

Question 2.2 was excluded
AHI = Apnea Hypopnea Index; CPAP = Continuous Positive Airway Pressure; MAD = Mandibular Advancement Devise; OSA = Obstructive Sleep Apnea

Table 3 - Recommendations and statements concerning postoperative monitoring of OSA patients in bariatric surgery

Question	Recommendation	% consensus	Quality of evidence	Strength of recommendation
3.1	Continuous monitoring is recommended in patients with OSA in the early postoperative period until they are no longer at risk of respiratory depression	100	⊠⊠⊠☐	Strong
3.2	Patients who are either male, aged above 50 or have a BMI > 60 kg/m^2 and/or had open surgery are at higher risk of postoperative complications	100	⊠⊠⊠☐	Statement
3.3	Routine admission of OSA patients to the ICU is not necessary	93	⊠⊠⊠☐	Strong
3.7	Monitoring recommendations are independent from CPAP usage as CPAP compliance is not guaranteed; CPAP usage should go along with monitoring	93	⊠⊠⊠☐	Strong
3.9	There is a role for prolonged stay in the PACU to identify high risk patients and to determine subsequent appropriate management	93	⊠☐☐☐	Statement
3.12	Absence of a suitable home caregiver is an absolute contraindication to outpatient surgery in morbidly obese OSA patients	100	⊠☐☐☐	Strong
3.13	There is no absolute AHI cutoff that would be an contraindication to outpatient surgery in OSA patients compliant with CPAP, without severe comorbidities and not requiring opioids or sedatives	79	⊠☐☐☐	Weak
3.14	Postoperative care should not be different for different bariatric procedures	100	⊠☐☐☐	Strong
3.15	The minimum required monitoring is a pulse oximeter, but there may be a role for additional monitoring, especially in patients receiving postoperative narcotics	100	⊠⊠☐☐	Strong

Question 3.4, 3.5, 3.6, 3.8, 3.10 and 3.11 were excluded
AHI = Apnea Hypopnea Index; BMI = Body Mass Index; CPAP = Continuous Positive Airway Pressure; ICU = Intensive Care Unit; OSA = Obstructive Sleep Apnea; PACU = Post Anesthesia Care Unit

Table 4 - Recommendations and statements concerning anesthetic care of OSA patients in bariatric surgery

Question	Recommendation	% consensus	Quality of evidence	Strength of recommendation
4.1	The ramped position is preferred for induction and intubation; avoid flat supine position	100	☒☐☐☐	Strong
4.2	Avoid sedatives as premedication; opioid analgesia, if used at all, should be titrated slow and patient should be monitored carefully	100	☒☐☐☐	Strong
4.3	Videolaryngoscopy is available when there are concerns for difficult intubation; routine usage may not be necessary	100	☒☐☐☐	Weak
4.4	High flow oxygenation could be considered in patients with predicted potential for airway difficulties during induction	100	☒☐☐☐	Weak
4.5	Postoperative use of opioids should be minimized and if needed used with caution	100	☒☐☐☐	Strong
4.6	Alternatives for opioids are paracetamol, NSAIDs, local anaesthetics for incisional infiltration, epidural analgesia and peripheral nerve blocks	94	☒☐☐☐	Strong
4.7	Ketamine, magnesium, lidocaine and alpha 2-agonists seem promising, yet high quality supportive evidence regarding their use in this setting is lacking	86	☒☐☐☐	Weak
4.8	At the end of the surgical procedure, patients should be as fully awake as soon as possible, without sedative effects, opioids and neuromuscular weakness	94	☒☐☐☐	Strong
4.10	CPAP is strongly recommended at induction in the diagnosed moderately severe OSA patient to maintain lung capacity and reduce time to oxygen desaturation	94	☒☒☐☐	Strong
4.11	ERABS principles should be a standard of practice in the morbidly obese patient	100	☒☐☐☐	Strong
4.13	The patient should only be extubated when close to fully awake, i.e. opening their eyes and coughing well, with neuromuscular blockade fully reversed and muscle function restored	94	☒☐☐☐	Strong
4.16	In the immediate postoperative period, CPAP treatment may be beneficial, particularly in the patient with severe OSA; when needed, CPAP could be supported by increasing oxygen therapy	100	☒☐☐☐	Strong
4.17	Instead of CPAP, non-invasive ventilation should be considered if there is persistent CO_2 retention postoperatively	100	☒☐☐☐	Strong
4.19	When practical and as an adjunct for postoperative pain management, regional anesthesia should be considered as part of multimodal analgesia in open weight loss surgery	93	☒☐☐☐	Weak

Question 4.9, 4.12, 4.14, 4.15, 4.18 and 4.20 were excluded
BiPAP = Bilevel Positive Airway Pressure; CPAP = Continuous Positive Airway Pressure; ERABS = Enhanced Recovery After Bariatric Surgery; NIV = Non Invasive Ventilation; NSAIDs = Non-Steroidal Anti-Inflammatory Drugs

Table 5 - Recommendations and statements concerning follow-up of OSA in bariatric surgery

Question	Recommendation	% consensus	Quality of evidence	Strength of recommendation
5.1	Prior to the decision to discontinue CPAP, a patient should be re-evaluated	93	☒☒☐☐	Strong
5.2	PSG the recommended test to assess for residual disease in the postoperative setting; timing should be dependent on weight loss and patient symptoms	66*	☒☐☐☐	Weak
5.4	Currently, there are no other reliable screening tools to assess for residual disease in the postoperative setting	93	☒☐☐☐	Statement
5.5	Counseling on the importance of compliance, follow-up testing and information regarding alternative OSA therapies to CPAP should begin prior to bariatric surgery	66*	☒☐☐☐	Strong
5.6	Adequate education of care givers and preoperative counseling for patients should address this matter and align patient expectations with realistic outcomes	-	☒☐☐☐	Strong
5.7	Patients should continue their OSA therapy until objectively documented to be free of OSA	87	☒☐☐☐	Weak
5.8	In case of persistent OSA, the patient should be managed according to conventional therapy	93	☒☐☐☐	Strong

* Consensus level < 70%
Question 5.3 was excluded
CPAP = Continuous Positive Airway Pressure; OSA = Obstructive Sleep Apnea

Figure 1 - Consensus meeting according to the "Amsterdam Delphi Method"

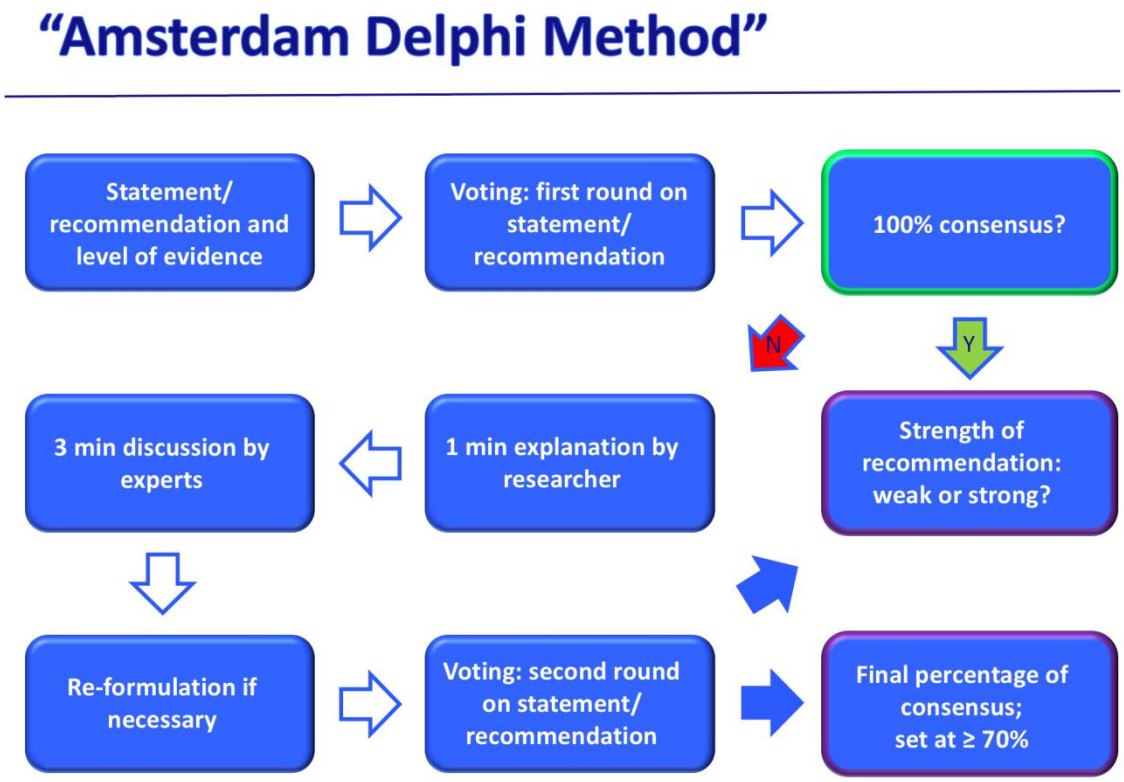
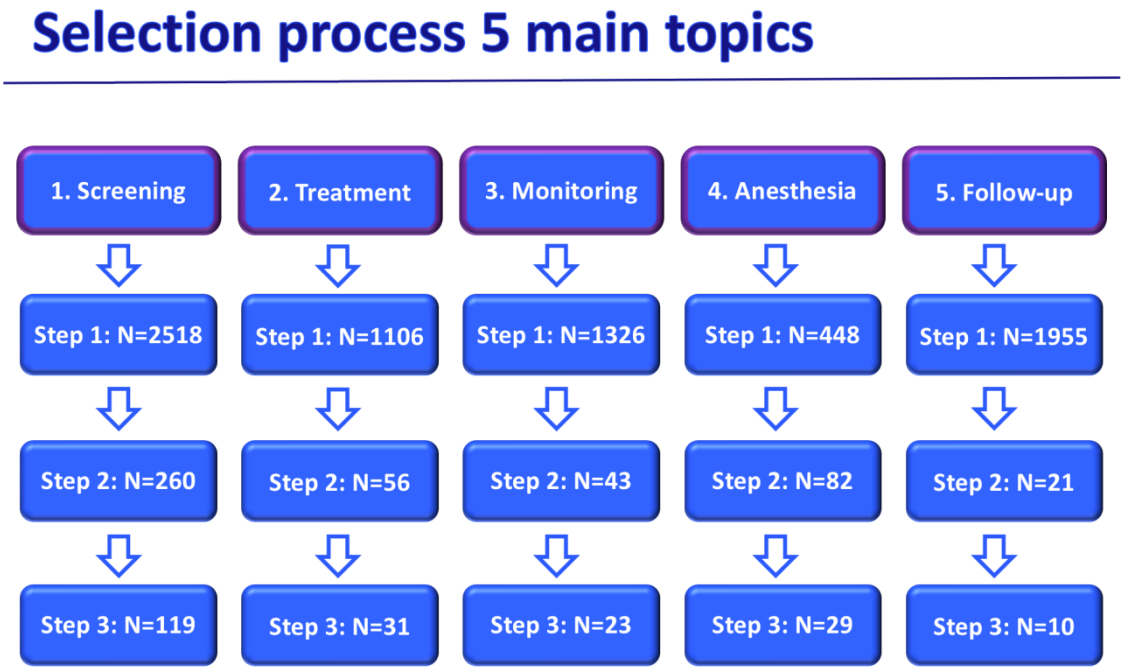


Figure 2 - Flowchart article selection



Step 1: Articles from PubMed, Embase, Cochrane after removal of duplicates
Step 2: Inclusion based on title + abstract
Step 3: Inclusion based on full-text

Appendix I - List of subquestions and references

1.	Preoperative screening	No. articles
1.1	What is the prevalence of OSA in BS patients?	14
1.2	Which complications, including percentages, are reported as a consequence of OSA?	18
1.3	Is the long-term cardiovascular, neurovascular and pulmonary risk reduced if BS patients receive adequate treatment of their OSA?	0
1.4	Are the perioperative cardiovascular and pulmonary risks reduced if BS patients receive adequate treatment of their OSA?	3
1.5	Should PSG be the golden standard to diagnose OSA?	2
1.6	Is (portable) PG an accurate tool to screen OSA? If so, how accurate (sensitivity & specificity)?	2
1.7	Is the STOP-BANG an accurate tool to screen OSA? If so, how accurate (sensitivity & specificity)?	1
1.8	Is the ESS an accurate tool to screen OSA? If so, how accurate (sensitivity & specificity)?	3
1.9	Is the Berlin an accurate tool to screen OSA? If so, how accurate (sensitivity & specificity)?	2
1.10	Is the Wisconsin an accurate tool to screen OSA? If so, how accurate (sensitivity & specificity)?	0
1.11	Are clinical symptoms an accurate tool to screen OSA? If so, how accurate (sensitivity & specificity)?	4
1.12	What is the value of the combination of questionnaires and portable monitoring as screening tool?	0
1.13	Are there phenotypic characteristics that suggest increased perioperative risk i.e. age, gender, BMI, PSG findings etc.?	0
1.14	Is there a role for Pa CO_2 in stratifying at risk OSA patients? Does it add to sensitivity and specificity of the screening test? If so, by how much?	3
1.15	At what OSA score or clinical symptoms should we be adding a CO_2 component to our risk stratification?	0
1.16	Is there a role for HCO3 levels as elevated day HCO3 can indicate buffering of overnight CO_2 retention?	3
1.17	Are there other OSA severity metrics that should be considered besides AHI? For example: length of obstructive events, severity of associated hypoxemia/desaturations, and presence of associated hypoventilation.	11
1.18	Should the degree of (non-obstructive) hypoventilation during sleep be assessed as OSA and sleep hypoventilation frequently coexist in morbid obesity (Obesity Hypoventilation Syndrome)?	8
1.19	Should there be less or more severity levels than AHI 5, 15, 30 events/hour? For example AHI 60 and 90 events/hour.	1
1.20	Is there an influence of length of BS on OSA related outcomes?	0
1.21	Is there an influence of presence of comorbidities such as neuromuscular- and respiratory disease?	3
1.22	Should there be more investigation of OSA patients for either cardiac or DVT/PE risk?	1
1.23	Which alternative (vital) parameters are an accurate tool to screen for OSA?	7

2.	CPAP treatment	No. articles
2.1	Is there an AHI cut-off that indicates necessity for CPAP therapy?	1
2.2	Is it necessary to evaluate the supine AHI?	2
2.3	Is there an indication for positional therapy in patients with positional OSA?	1
2.4	Is a certain period necessary to get used to CPAP prior to surgery? If so, how long?	6
2.5	Should patients bring their own CPAP mask to the hospital following surgery?	4
2.6	Is there a difference between nasal CPAP versus oral (full-face) CPAP?	0
2.7	Is there any cardiac benefit in using CPAP preoperatively? If so, how long should CPAP be used to achieve this benefit?	3
2.8	Is CPAP efficient in reducing perioperative complications?	10
2.9	Is there a role for treatment with mandibular device?	3

3.	Postoperative monitoring	No. articles
3.1	Should OSA patients be monitored continuously after surgery? If so, which OSA patients?	9
3.2	Which accompanying factors are important? i.e. gender, age, BMI	7
3.3	Do they warrant a need to plan for postoperative ICU?	7
3.4	Should patients with increasing AHI receive CPAP, monitoring at a designated ward or both?	3
3.5	Is this dependent on cut-off(s)? If yes, which?	0
3.6	Is CPAP compliance important for these decisions?	0
3.7	Does careful monitoring obviate the need for CPAP?	2
3.8	Is there a potential role of a prolonged stay in recovery room?	0
3.9	If yes, how long?	0
3.10	Should the role of prolonged stays in recovery room/PACU be considered as a means of determining who should go to a monitored bed vs. general ward (or home)?	2
3.11	If a patient is already getting CPAP preoperatively, should the postoperative pressure be higher?	2
3.12	Is the absence of an appropriate home caregiver/partner a contraindication to same day surgery?	0
3.13	Is there an AHI cut-off point which should be an absolute contraindication to same day surgery?	0
3.14	Is the postoperative care different for GB and LRYGB/LSG patients (for example day time surgery)?	0
3.15	What variables (SaO2, PetCO2, respiratory rate, etc.) should be followed post-operatively and in which patients?	2

4.	Anesthetic care	No. articles
4.1	Is there a benefit of optimal positioning of OSA patients for induction and intubation/during surgery? If yes, what is the most optimal positioning? For example HELP position.	5
4.2	Should premedication be avoided? If yes, why?	1
4.3	Should video laryngoscopy routinely be used?	0
4.4	What is the role of 'Os up the nose'/high flow O2 nasal cannula during intubation?	0
4.5	Should anesthesia be opioid and benzodiazepine free? If yes, why?	14
4.6	What are non-opioid options for anesthesia in these patients and what is their safety and efficacy?	8
4.7	Is clonidine, dexmedetomidine accepted postoperatively and at what dose?	6
4.8	Should we have our patient fully awake as soon as possible?	0
4.9	Is OSA a risk factor for difficult mask ventilation, intubation and extubation?	11
4.10	If yes, should any special procedures be used for these procedures?	5
4.11	What risk factors are associated with delay in extubation or reintubation?	0
4.12	In case of postoperative ventilation, what PCO_2 would be normal and targeted prior to extubation?	0
4.13	Should extubation criteria be different in these patients?	4
4.14	Is increasing the FiO2 necessarily beneficial for patients needing postoperative CPAP?	0
4.15	If yes, what is the ideal FiO2 range?	0
4.16	Is there a beneficial effect of postoperative non-invasive positive pressure oxygen therapy instead of simple oxygen therapy?	0
4.17	CPAP vs. BPAP for postoperative OSA management, what's better?	0
4.18	Can this be based upon severity (OSA to OHS)?	0
4.19	Is there a role/desirability of neuraxial blockade?	4
4.20	Is it beneficial for patients with OSA to have full reversal to train-of-four= 100% instead of 90%, as is used now?	1

5.	Follow-up	No. articles
5.1	When is a postoperative PSG indicated?	4
5.2	Should timing be dependent on weight loss?	3
5.3	Studies show that during the first half year the AHI decreases significantly after surgery and that thereafter the AHI continues to decrease but at a slower rate. Should one wait until after a year for the first post-op PSG or are we treating a portion of patients unnecessarily for a lengthy period of time?	1
5.4	Are there reliable screening tools in the postoperative setting?	2
5.5	When examining the current situation, many patients are non-compliant to CPAP and do not realize the necessity of treatment even after surgery. What can we do to improve compliance?	0
5.6	How can we increase awareness of patients, ward nurses and bariatric surgeons of the severity of the condition and the necessity for CPAP until a postoperative PSG has been done to check for residual disease?	1
5.7	Many patients indicate resolve of complaints after surgery and refuse postoperative PSG. Are these patients indeed free of residual disease?	5
5.8	If a patient has residual disease what you should be the diagnostic and treatment algorithm? New PSG after 6 months? If BMI < 32 DISE?	3

Supplementary material I - Literature searches

Topic 1.

Bariatric surgery:

(Bariatrics [Mesh] OR bariatric*[tiab] OR gastric bypass*[tiab] OR Roux-en-Y[tiab] OR LRYGB*[tiab] OR RYGB*[tiab] OR gastrojejunostom*[tiab] OR bilio pancreati*[tiab] OR duodenal switch*[tiab] OR BPD-DS[tiab] OR gastric sleeve*[tiab] OR sleeve gastrectom*[tiab] OR gastric band*[tiab] OR LABG*[tiab] OR biliopancreati*[tiab]) AND ("Sleep Apnea, Obstructive"[Mesh] OR OSA[tiab] OR OSAS[tiab] OR apnoea*[tiab] OR apnea*[tiab] OR hypopnea*[tiab] OR hypopnoea*[tiab] OR apneic*[tiab] OR apnoeic*[tiab] OR SDB[tiab] OR sleep-disordered[tiab] OR "Snoring"[Mesh] OR snoring*[tiab] OR snore*[tiab]) AND ("Prevalence"[Mesh] OR "Epidemiology"[Mesh] OR "Incidence"[Mesh] OR prevalen*[tiab] OR epidem*[tiab] OR inciden*[tiab] OR "Intraoperative Complications"[Mesh] OR "Postoperative Complications"[Mesh] OR complicat*[tiab] OR adverse effect*[tiab] OR risk*[tiab] OR ((polysomnograph*[tiab] OR "Polysomnography"[Mesh] OR PSG[tiab] OR somnograph*[tiab]) AND ("Diagnosis"[Mesh] OR diagnos*[tiab] OR exam*[tiab] OR assess*[tiab] OR determin*[tiab])) OR polygraph* OR PG OR "Questionnaires"[Mesh] OR questionnair*[tiab] OR survey*[tiab] OR stop-bang[tiab] OR ESS[tiab] OR epworth sleepiness scale*[tiab] OR ((diagnos*[tiab] OR screen*[tiab] OR examin*[tiab] OR asses*[tiab] OR determin*[tiab]) AND (clinical symp*[tiab] OR sleepiness[tiab])) OR "Carbon Dioxide"[Mesh] OR carbon diox*[tiab] OR PaCO2[tiab] OR CO2[tiab] OR PCO2[tiab] OR "Bicarbonates"[Mesh] OR bicarbon*[tiab] OR hydrogen carbonat*[tiab] OR carbonic acid ion*[tiab] OR HCO3[tiab] OR (("Anoxia"[Mesh] OR anoxia*[tiab] OR hypoxia*[tiab] OR hypoxem*[tiab] OR oxygen deficien*[tiab] OR desaturat*[tiab] OR ODI[tiab] OR obstructive event*[tiab] OR hypoventilat*[tiab] OR respiratory distress index*[tiab] OR RDI[tiab]) AND (sever*[tiab])) OR ((Apnea hypopnea index*[tiab] OR AHI[tiab]) AND (index*[tiab] OR level*[tiab] OR cut off*[tiab] OR rate[tiab] OR rates[tiab])))

Morbid obesity:

("Obesity, Morbid"[Mesh] OR ((severe[tiab] OR morbid*[tiab]) AND (obes*[tiab]))) AND ("Sleep Apnea, Obstructive"[Mesh] OR OSA[tiab] OR OSAS[tiab] OR apnoea*[tiab] OR apnea*[tiab] OR hypopnea*[tiab] OR hypopnoea*[tiab] OR apneic*[tiab] OR apnoeic*[tiab] OR SDB[tiab] OR sleep-disordered[tiab] OR "Snoring"[Mesh] OR snoring*[tiab] OR snore*[tiab]) AND ("Prevalence"[Mesh] OR "Epidemiology"[Mesh] OR "Incidence"[Mesh] OR prevalen*[tiab] OR epidem*[tiab] OR inciden*[tiab] OR "Intraoperative Complications"[Mesh] OR "Postoperative Complications"[Mesh] OR complicat*[tiab] OR adverse effect*[tiab] OR risk*[tiab] OR ((polysomnograph*[tiab] OR "Polysomnography"[Mesh] OR PSG[tiab] OR somnograph*[tiab]) AND ("Diagnosis"[Mesh] OR diagnos*[tiab] OR exam*[tiab] OR assess*[tiab] OR determin*[tiab])) OR polygraph* OR PG OR "Questionnaires"[Mesh] OR questionnair*[tiab] OR survey*[tiab] OR stop-bang[tiab] OR ESS[tiab] OR epworth sleepiness scale*[tiab] OR ((diagnos*[tiab] OR screen*[tiab] OR examin*[tiab] OR asses*[tiab] OR determin*[tiab]) AND (clinical symp*[tiab] OR sleepiness[tiab])) OR "Carbon Dioxide"[Mesh] OR carbon diox*[tiab] OR PaCO2[tiab] OR CO2[tiab] OR PCO2[tiab] OR "Bicarbonates"[Mesh] OR bicarbon*[tiab] OR hydrogen carbonat*[tiab] OR carbonic acid ion*[tiab] OR HCO3[tiab] OR (("Anoxia"[Mesh] OR anoxia*[tiab] OR hypoxia*[tiab] OR hypoxem*[tiab] OR oxygen deficien*[tiab] OR desaturat*[tiab] OR ODI[tiab] OR obstructive event*[tiab] OR hypoventilat*[tiab] OR respiratory distress index*[tiab] OR RDI[tiab]) AND (sever*[tiab])) OR ((Apnea hypopnea index*[tiab] OR AHI[tiab]) AND (index*[tiab] OR level*[tiab] OR cut off*[tiab] OR rate[tiab] OR rates[tiab])))

Topic 2.

Bariatric surgery:

(Bariatrics [Mesh] OR bariatric*[tiab] OR gastric bypass*[tiab] OR Roux-en-Y[tiab] OR LRYGB*[tiab] OR RYGB*[tiab] OR gastrojejunostom*[tiab] OR bilio pancreati*[tiab] OR duodenal switch*[tiab] OR BPD-DS[tiab] OR gastric sleeve*[tiab] OR sleeve gastrectom*[tiab] OR gastric band*[tiab] OR LABG*[tiab] OR biliopancreati*[tiab]) AND ("Sleep Apnea, Obstructive"[Mesh] OR OSA[tiab] OR OSAS[tiab] OR apnoea*[tiab] OR apnea*[tiab] OR hypopnea*[tiab] OR hypopnoea*[tiab] OR apneic*[tiab] OR apnoeic*[tiab] OR SDB[tiab] OR sleep-disordered[tiab] OR "Snoring"[Mesh] OR snoring*[tiab] OR snore*[tiab]) AND ("Continuous Positive Airway Pressure"[Mesh] OR CPAP*[tiab] OR Continuous Positive Airway Pressur*[tiab] OR apnea hypopnea index[tiab] OR AHI[tiab] OR "Supine Position"[Mesh] OR supine[tiab] OR dorsal position*[tiab] OR mandibular*[tiab] OR MAD[tiab] OR oral applianc*[tiab])

Morbid obesity:

("Obesity, Morbid"[Mesh] OR ((severe[tiab] OR morbid*[tiab]) AND (obes*[tiab]))) AND ("Sleep Apnea, Obstructive"[Mesh] OR OSA[tiab] OR OSAS[tiab] OR apnoea*[tiab] OR apnea*[tiab] OR hypopnea*[tiab] OR hypopnoea*[tiab] OR apneic*[tiab] OR apnoeic*[tiab] OR SDB[tiab] OR sleep-disordered[tiab] OR "Snoring"[Mesh] OR snoring*[tiab] OR snore*[tiab]) AND ("Continuous Positive Airway Pressure"[Mesh] OR CPAP*[tiab] OR Continuous Positive Airway Pressur*[tiab] OR apnea hypopnea index[tiab] OR AHI[tiab] OR "Supine Position"[Mesh] OR supine[tiab] OR dorsal position*[tiab] OR mandibular*[tiab] OR MAD[tiab] OR oral applianc*[tiab])

Topic 3.

Bariatric surgery:

(Bariatrics [Mesh] OR bariatric*[tiab] OR gastric bypass*[tiab] OR Roux-en-Y[tiab] OR LRYGB*[tiab] OR RYGB*[tiab] OR gastrojejunostom*[tiab] OR bilio pancreati*[tiab] OR duodenal switch*[tiab] OR BPD-DS[tiab] OR gastric sleeve*[tiab] OR sleeve gastrectom*[tiab] OR gastric band*[tiab] OR LABG*[tiab] OR biliopancreati*[tiab]) AND ("Sleep Apnea, Obstructive"[Mesh] OR OSA[tiab] OR OSAS[tiab] OR apnoea*[tiab] OR apnea*[tiab] OR hypopnea*[tiab] OR hypopnoea*[tiab] OR apneic*[tiab] OR apnoeic*[tiab] OR SDB[tiab] OR sleep-disordered[tiab] OR "Snoring"[Mesh] OR snoring*[tiab] OR snore*[tiab]) AND ("Postoperative Period"[Mesh] OR "Postoperative Care"[Mesh] OR postoperat*[tiab] OR post operat*[tiab] OR after surg*[tiab] OR post surg*[tiab] OR postsurg*[tiab] OR "Monitoring, Physiologic"[Mesh] OR monitor*[tiab] OR "Intensive Care Units"[Mesh] OR Intensive Care*[tiab] OR ICU[tiab] OR medium care*[tiab] OR MCU[tiab] OR (("Continuous Positive Airway Pressure"[Mesh] OR CPAP*[tiab] OR Continuous Positive Airway Pressur*[tiab]) AND ("Patient Compliance"[Mesh] OR complian*[tiab] OR adherenc*[tiab])) OR post anesthesia care uit*[tiab] OR PACU[tiab] OR "Recovery Room"[Mesh] OR Recovery[tiab] OR "Ambulatory Surgical Procedures"[Mesh] OR ambulator*[tiab] OR outpatient*[tiab] OR Same day*[tiab] OR Day surg*[tiab] OR Day time*[tiab])

Morbid obesity:

("Obesity, Morbid"[Mesh] OR ((severe[tiab] OR morbid*[tiab]) AND (obes*[tiab]))) AND ("Sleep Apnea, Obstructive"[Mesh] OR OSA[tiab] OR OSAS[tiab] OR apnoea*[tiab] OR apnea*[tiab] OR hypopnea*[tiab] OR hypopnoea*[tiab] OR apneic*[tiab] OR apnoeic*[tiab] OR SDB[tiab] OR sleep-disordered[tiab] OR "Snoring"[Mesh] OR snoring*[tiab] OR snore*[tiab]) AND ("Postoperative Period"[Mesh] OR "Postoperative Care"[Mesh] OR postoperat*[tiab] OR post operat*[tiab] OR after surg*[tiab] OR post surg*[tiab] OR postsurg*[tiab] OR "Monitoring, Physiologic"[Mesh] OR monitor*[tiab] OR "Intensive Care Units"[Mesh] OR Intensive Care*[tiab] OR ICU[tiab] OR medium

care*[tiab] OR MCU[tiab] OR (("Continuous Positive Airway Pressure"[Mesh] OR CPAP*[tiab] OR Continuous Positive Airway Pressur*[tiab]) AND ("Patient Compliance"[Mesh] OR complian*[tiab] OR adherenc*[tiab])) OR post anesthesia care uit*[tiab] OR PACU[tiab] OR "Recovery Room"[Mesh] OR Recovery[tiab] OR "Ambulatory Surgical Procedures"[Mesh] OR ambulator*[tiab] OR outpatient*[tiab] OR Same day*[tiab] OR Day surg*[tiab] OR Day time*[tiab])

Topic 4.

Bariatric surgery:

(Bariatrics [Mesh] OR bariatric*[tiab] OR gastric bypass*[tiab] OR Roux-en-Y[tiab] OR LRYGB*[tiab] OR RYGB*[tiab] OR gastrojejunostom*[tiab] OR bilio pancreati*[tiab] OR duodenal switch*[tiab] OR BPD-DS[tiab] OR gastric sleeve*[tiab] OR sleeve gastrectom*[tiab] OR gastric band*[tiab] OR LABG*[tiab] OR biliopancreati*[tiab]) AND ("Sleep Apnea, Obstructive"[Mesh] OR OSA[tiab] OR OSAS[tiab] OR apnoea*[tiab] OR apnea*[tiab] OR hypopnea*[tiab] OR hypopnoea*[tiab] OR apneic*[tiab] OR apnoeic*[tiab] OR SDB[tiab] OR sleep-disordered[tiab] OR "Snoring"[Mesh] OR snoring*[tiab] OR snore*[tiab]) AND ("Anesthesia"[Mesh] OR anesthes*[tiab] OR "Intubation"[Mesh] OR intubat*[tiab] OR "Airway Extubation"[Mesh] OR extubation*[tiab] OR induction*[tiab] OR "Patient Positioning"[Mesh] OR position*[tiab] OR "Preanesthetic Medication"[Mesh] OR preanesthetic*[tiab] OR premedicati*[tiab] OR "Laryngoscopy"[Mesh] OR laryngoscop*[tiab] OR "Analgesics, Opioid"[Mesh] OR opioid*[tiab] OR morphin*[tiab] OR Meperidin*[tiab] OR Hydromorphon*[tiab] OR Alfentanyl*[tiab] OR Fentanyl*[tiab] OR Remifentanil*[tiab] OR Sufenta*[tiab] OR Etorphin*[tiab] OR "Ketamine"[Mesh] OR "Lidocaine"[Mesh] OR "Dexmedetomidine"[Mesh] OR "Clonidine"[Mesh] OR "Nicotine"[Mesh] OR ketamin*[tiab] OR lidocain*[tiab] OR dexmedetomidin*[tiab] OR Nortryptilin*[tiab] OR pregabalin*[tiab] OR Clonidin*[tiab] OR Nabilone*[tiab] OR Nicotin*[tiab] OR non-opioid*[tiab] OR fraction of inspired oxyg*[tiab] OR fio2[tiab] OR non-invasive positive pressure*[tiab] OR Noninvasive positive pressure*[tiab] OR Noninvasive ventilati*[tiab] OR non-invasive ventilati*[tiab] OR NIPP*[tiab] OR Bilevel positive airway*[tiab] OR BIPAP[tiab] OR BI-PAP[tiab] OR "Autonomic Nerve Block"[Mesh] OR "Analgesia, Epidural"[Mesh] OR "Anesthesia, Spinal"[Mesh] OR spinal anesthe*[tiab] OR epidural anesthe*[tiab] OR neuraxial block*[tiab] OR nerve block*[tiab] OR "Neuromuscular Monitoring"[Mesh] OR neuromuscular monitor*[tiab] OR Train of Four*[tiab] OR TOF*[tiab])

Morbid obesity:

("Obesity, Morbid"[Mesh] OR ((severe[tiab] OR morbid*[tiab]) AND (obes*[tiab]))) AND ("Sleep Apnea, Obstructive"[Mesh] OR OSA[tiab] OR OSAS[tiab] OR apnoea*[tiab] OR apnea*[tiab] OR hypopnea*[tiab] OR hypopnoea*[tiab] OR apneic*[tiab] OR apnoeic*[tiab] OR SDB[tiab] OR sleep-disordered[tiab] OR "Snoring"[Mesh] OR snoring*[tiab] OR snore*[tiab]) AND ("Anesthesia"[Mesh] OR anesthes*[tiab] OR "Intubation"[Mesh] OR intubat*[tiab] OR "Airway Extubation"[Mesh] OR extubation*[tiab] OR induction*[tiab] OR "Patient Positioning"[Mesh] OR position*[tiab] OR "Preanesthetic Medication"[Mesh] OR preanesthetic*[tiab] OR premedicati*[tiab] OR "Laryngoscopy"[Mesh] OR laryngoscop*[tiab] OR "Analgesics, Opioid"[Mesh] OR opioid*[tiab] OR morphin*[tiab] OR Meperidin*[tiab] OR Hydromorphon*[tiab] OR Alfentanyl*[tiab] OR Fentanyl*[tiab] OR Remifentanil*[tiab] OR Sufenta*[tiab] OR Etorphin*[tiab] OR "Ketamine"[Mesh] OR "Lidocaine"[Mesh] OR "Dexmedetomidine"[Mesh] OR "Clonidine"[Mesh] OR "Nicotine"[Mesh] OR ketamin*[tiab] OR lidocain*[tiab] OR dexmedetomidin*[tiab] OR Nortryptilin*[tiab] OR pregabalin*[tiab] OR Clonidin*[tiab] OR Nabilone*[tiab] OR Nicotin*[tiab] OR non-opioid*[tiab] OR fraction of inspired oxyg*[tiab] OR fio2[tiab] OR non-invasive positive pressure*[tiab] OR Noninvasive positive pressure*[tiab] OR Noninvasive ventilati*[tiab] OR non-invasive ventilati*[tiab]

OR NIPP*[tiab] OR Bilevel positive airway*[tiab] OR BIPAP[tiab] OR BI-PAP[tiab] OR "Autonomic Nerve Block"[Mesh] OR "Analgesia, Epidural"[Mesh] OR "Anesthesia, Spinal"[Mesh] OR spinal anesthe*[tiab] OR epidural anesthe*[tiab] OR neuraxial block*[tiab] OR nerve block*[tiab] OR "Neuromuscular Monitoring"[Mesh] OR neuromuscular monitor*[tiab] OR Train of Four*[tiab] OR TOF*[tiab])

Topic 5.

Bariatric surgery:

(Bariatrics [Mesh] OR bariatric*[tiab] OR gastric bypass*[tiab] OR Roux-en-Y[tiab] OR LRYGB*[tiab] OR RYGB*[tiab] OR gastrojejunostom*[tiab] OR bilio pancreati*[tiab] OR duodenal switch*[tiab] OR BPD-DS[tiab] OR gastric sleeve*[tiab] OR sleeve gastrectom*[tiab] OR gastric band*[tiab] OR LABG*[tiab] OR biliopancreati*[tiab]) AND ("Sleep Apnea, Obstructive"[Mesh] OR OSA[tiab] OR OSAS[tiab] OR apnoea*[tiab] OR apnea*[tiab] OR hypopnea*[tiab] OR hypopnoea*[tiab] OR apneic*[tiab] OR apnoeic*[tiab] OR SDB[tiab] OR sleep-disordered[tiab] OR "Snoring"[Mesh] OR snoring*[tiab] OR snore*[tiab]) AND ("Postoperative Care"[Mesh] OR postoperat*[tiab] OR post operat*[tiab] OR postsurg*[tiab] OR post surg*[tiab] OR after surg*[tiab] OR "Follow-Up Studies"[Mesh] OR followup*[tiab] OR follow up*[tiab] OR longterm*[tiab] OR long term*[tiab]) AND ("Polysomnography"[Mesh] OR polysomnograph*[tiab] OR PSG[tiab] OR somnograph*[tiab] OR "Questionnaires"[Mesh] OR questionnair*[tiab] OR survey*[tiab] OR ((screen*[tiab]) AND (tool*[tiab] OR instrument*[tiab])) OR stop-bang[tiab] OR ESS[tiab] OR epworth sleepiness scale*[tiab] OR (("Continuous Positive Airway Pressure"[Mesh] OR CPAP*[tiab] OR Continuous Positive Airway Pressur*[tiab]) AND ("Patient Compliance"[Mesh] OR complian*[tiab] OR adherenc*[tiab])) OR drug induced sleep endoscop*[tiab] OR DISE[tiab] OR improv*[tiab] OR residual*[tiab] OR reduc*[tiab] cure*[tiab] OR curat*[tiab] OR resolv*[tiab] OR recurr*[tiab] OR increas*[tiab] OR decreas*[tiab] OR enhanc*[tiab] OR progress*[tiab] OR weight loss*[tiab] OR "Weight Loss"[Mesh] OR weight reduct*[tiab] OR BMI loss*[tiab] OR BMI reduct*[tiab])

Morbid obesity:

("Obesity, Morbid"[Mesh] OR ((severe[tiab] OR morbid*[tiab]) AND (obes*[tiab]))) AND ("Sleep Apnea, Obstructive"[Mesh] OR OSA[tiab] OR OSAS[tiab] OR apnoea*[tiab] OR apnea*[tiab] OR hypopnea*[tiab] OR hypopnoea*[tiab] OR apneic*[tiab] OR apnoeic*[tiab] OR SDB[tiab] OR sleep-disordered[tiab] OR "Snoring"[Mesh] OR snoring*[tiab] OR snore*[tiab]) AND ("Postoperative Care"[Mesh] OR postoperat*[tiab] OR post operat*[tiab] OR postsurg*[tiab] OR post surg*[tiab] OR after surg*[tiab] OR "Follow-Up Studies"[Mesh] OR followup*[tiab] OR follow up*[tiab] OR longterm*[tiab] OR long term*[tiab]) AND ("Polysomnography"[Mesh] OR polysomnograph*[tiab] OR PSG[tiab] OR somnograph*[tiab] OR "Questionnaires"[Mesh] OR questionnair*[tiab] OR survey*[tiab] OR ((screen*[tiab]) AND (tool*[tiab] OR instrument*[tiab])) OR stop-bang[tiab] OR ESS[tiab] OR epworth sleepiness scale*[tiab] OR (("Continuous Positive Airway Pressure"[Mesh] OR CPAP*[tiab] OR Continuous Positive Airway Pressur*[tiab]) AND ("Patient Compliance"[Mesh] OR complian*[tiab] OR adherenc*[tiab])) OR drug induced sleep endoscop*[tiab] OR DISE[tiab] OR improv*[tiab] OR residual*[tiab] OR reduc*[tiab] cure*[tiab] OR curat*[tiab] OR resolv*[tiab] OR recurr*[tiab] OR increas*[tiab] OR decreas*[tiab] OR enhanc*[tiab] OR progress*[tiab] OR weight loss*[tiab] OR "Weight Loss"[Mesh] OR weight reduct*[tiab] OR BMI loss*[tiab] OR BMI reduct*[tiab])

Supplementary material II – Voting rounds and definitive percentage of consensus based on number of votes and number of voting experts

Question	Voting round 1	Voting round 2	% consensus
1.1	-	-	-
1.2	9	13	93
1.3	14	-	100
1.4	10	9	64*
1.5	12	12	86
1.6	10	14	100
1.7	7	13	93
1.8	12	14	100
1.9	4	13	93
1.10	1	Excluded	-
1.11	4	Excluded	-
1.12	5	14	100
1.13	-	Excluded	-
1.14	7	14	100
1.15	11	14	100
1.16	13	15	100
1.17	0	12	80
1.18	14	-	100
1.19	2	12	80
1.20	2	14	93
1.21	-	15	100
1.22	5	15	100
1.23	0	14	93

Question	Voting round 1	Voting round 2	% consensus
2.1	10	15	100
2.2	10	Excluded	-
2.3	2	15	100
2.4	2	15	100
2.5	11	15	100
2.6	1	15	100
2.7	10	13	87
2.8	13	14	93
2.9	2	15	100

Question	Voting round 1	Voting round 2	% consensus
3.1	8	14	100
3.2	7	14	100
3.3	10	13	93
3.4	8	Excluded	-
3.5	Excluded	-	-
3.6	Excluded	-	-
3.7	10	13	93
3.8	Excluded	-	-
3.9	0	13	93
3.10	Excluded	-	-
3.11	4	Excluded	-
3.12	9	14	100
3.13	4	11	79
3.14	14	-	100
3.15	7	14	100

Question	Voting round 1	Voting round 2	% consensus
4.1	13	15	100
4.2	5	15	100
4.3	15	15	100
4.4	5	15	100
4.5	6	15	100
4.6	10	14	94
4.7	5	13	86
4.8	13	14	94
4.9	Excluded	-	-
4.10	8	14	94
4.11	13	15	100
4.12	3	Excluded	-
4.13	0	14	94
4.14	0	Excluded	-
4.15	Excluded	-	-
4.16	9	15	100
4.17	5	15	100
4.18	Excluded	-	-
4.19	4	14	93
4.20	8	Excluded	-

Question	Voting round 1	Voting round 2	% consensus
5.1	5	14	93
5.2	14	10	66*
5.3	6	Excluded	-
5.4	3	14	93
5.5	9	10	66*
5.6	15	-	-
5.7	11	13	87
5.8	4	14	93