Review

Guidelines for treatment of umbilical and epigastric hernias from the European Hernia Society and Americas Hernia Society

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Background: **Umbilical and epigastric hernia repairs are frequently performed surgical procedures with an expected low complication rate. Nevertheless, the optimal method of repair with best short- and long-term outcomes remains debatable. The aim was to develop guidelines for the treatment of umbilical and epigastric hernias.**

Methods: **The guideline group consisted of surgeons from Europe and North America including members from the European Hernia Society and the Americas Hernia Society. The Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach, the Scottish Intercollegiate Guidelines Network (SIGN) critical appraisal checklists, and the Appraisal of Guidelines for Research and Evaluation (AGREE) instrument were used. A systematic literature search was done on 1 May 2018, and updated on 1 February 2019.**

Results: **Literature reporting specifically on umbilical and epigastric hernias was limited in quantity and quality, resulting in a majority of the recommendations being graded as weak, based on low-quality evidence. The main recommendation was to use mesh for repair of umbilical and epigastric hernias to reduce the recurrence rate. Most umbilical and epigastric hernias may be repaired by an open approach with a preperitoneal flat mesh. A laparoscopic approach may be considered if the hernia defect is large, or if the patient has an increased risk of wound morbidity.**

Conclusion: **This is the first European and American guideline on the treatment of umbilical and epigastric hernias. It is recommended that symptomatic umbilical and epigastric hernias are repaired by an open approach with a preperitoneal flat mesh.**

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Introduction

Umbilical and epigastric hernia repairs are frequently performed surgical procedures with an expected low complication rate of 3·5 per cent[1]. The optimal repair method with the best short- and long-term outcomes remains debatable. The choices are many. For instance, is it necessary to use a mesh and, in the case of mesh repair, is a preformed patch better than a flat mesh, and in which anatomical layer should it be placed? Furthermore, when is a laparoscopic approach preferable to an open approach?

In recent decades, the European Hernia Society (EHS) has facilitated the creation of a number of guidelines on the treatment and prevention of hernias, aiming at improving and standardizing hernia care[2,3]. The International Endohernia Society (IEHS)[4–6] published guidelines on laparoscopic treatment of both primary ventral and incisional hernias in 2014, but did not address open ventral

hernia repair. The Society of American Gastrointestinal Endoscopic Surgeons (SAGES)[7] published a guideline on laparoscopic ventral hernia repair in 2016. An expert-guided consensus for the management of all types of ventral hernias exists[8], and the World Society of Emergency Surgery (WSES)[9] addressed emergency repairs of both primary ventral and incisional hernias. To date, no guideline has been published on the treatment of umbilical and epigastric hernias, specifically addressing both open and laparoscopic techniques.

The aim was to develop guidelines for the treatment of umbilical and epigastric hernias using watchful waiting or any surgical technique. The guideline group included surgeons from Europe and North America, thus including members from both the EHS and the Americas Hernia Society (AHS).

Methods

Guideline group

The project was approved by the EHS and AHS boards in February 2017. Two coordinators were appointed to manage the project. The guideline was intended for surgeons, general practitioners and patients. A list of the members of the group and their responsibilities is available in the acknowledgements. Conflicts of interest (COI) for each member were recorded transparently. The meetings were funded by the EHS and AHS. There was no involvement from industry.

Timeline and meetings

The protocol, including key questions and timeline, was approved by eight participants at the AHS/EHS congress in Miami, March 2018. A second meeting was held in Amsterdam, September 2018, with 11 participants. Each team presented their systematic review of the literature for each subject, and draft recommendations were proposed. Key questions needing further work were identified and discussed at the third meeting in Malmö, February 2019, with nine participants. All suggested recommendations were discussed, some reformulated and thereafter approved. The remaining three participants approved the recommendations by e-mail. All members participated in at least two of the three meetings.

Methodology

The Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach was used in formulating the recommendations. The Scottish Intercollegiate Guidelines Network (SIGN) critical appraisal checklists were used for evaluation of the quality of full-text papers. Key questions were proposed by the coordinators, revised and thereafter approved by the group.

The group was divided into teams (2–3 members per team) working on specific key questions. Each team decided on important outcomes of key questions using the PICO (patient, intervention, comparator, outcome) approach. A systematic literature review was performed for each key question. If up-to-date high-quality meta-analyses or systematic reviews on the subject were available, the conclusions were derived from these. Next level in quality were RCTs and thereafter observational studies. Case series were included only if they added substantial evidence/information, or if no higher level of evidence was available. Case reports and expert opinions were not included. The Appraisal of Guidelines for Research and Evaluation (AGREE) instrument was followed.

The guideline was published in two parts. The current guideline addressing the most common considerations on the treatment of umbilical and epigastric hernias, and a second guideline addressing umbilical and epigastric hernias in rare circumstances as wel as Spigelian and lumbar hernias[10]. The guideline was presented at the EHS meeting in September 2019, where consensus voting on selected recommendations took place.

Literature search

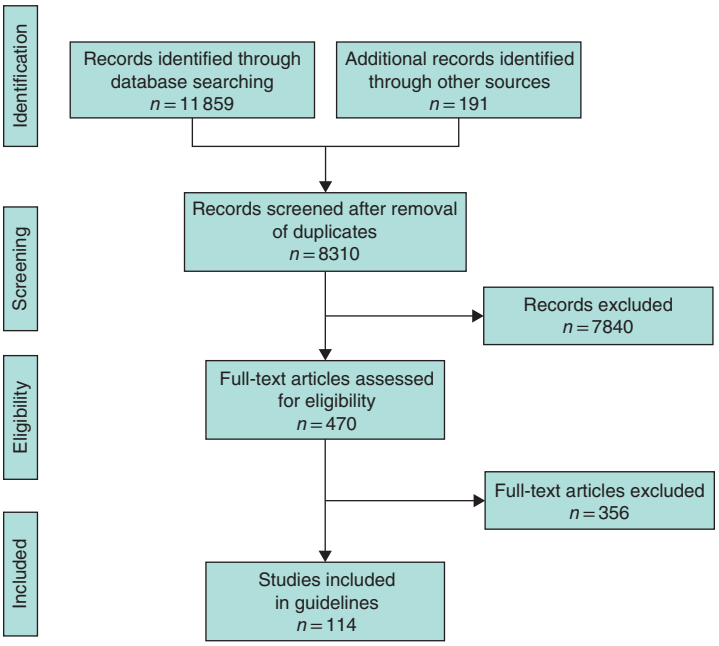
A systematic literature search was performed by two reviewers independently and reported on 1 May 2018, and updated on 1 February 2019. The Cochrane Library, PubMed, Embase, CINAHL and Google Scholar were searched using Medical Subject Headings (MeSH) terms. Search terms for each subject are available in *Appendix S1* (supporting information) together with PRISMA flow charts (*Figs S1–S5*, supporting information). Records were screened by title and abstract by two assessors. Full texts were evaluated by two assessors independently. Only papers rated as acceptable or high quality according to the SIGN checklist were included, to limit the risk of bias. Any disagreement between assessors was settled by discussion either in the entire group or by a third assessor.

As data on primary ventral hernias were sparse, papers concerning both primary ventral and incisional hernias were included. Authors were contacted for extraction of data on primary ventral hernias specifically. If this was not possible, the paper was still included, but it was specified in the text that data were derived from both primary ventral and incisional hernias.

Results

Eighteen key questions (KQs) were formulated and a total of 114 studies were finally included (*Fig. 1*).

Fig. 1 PRISMA flow chart showing selection of articles for review



Definition and diagnosis

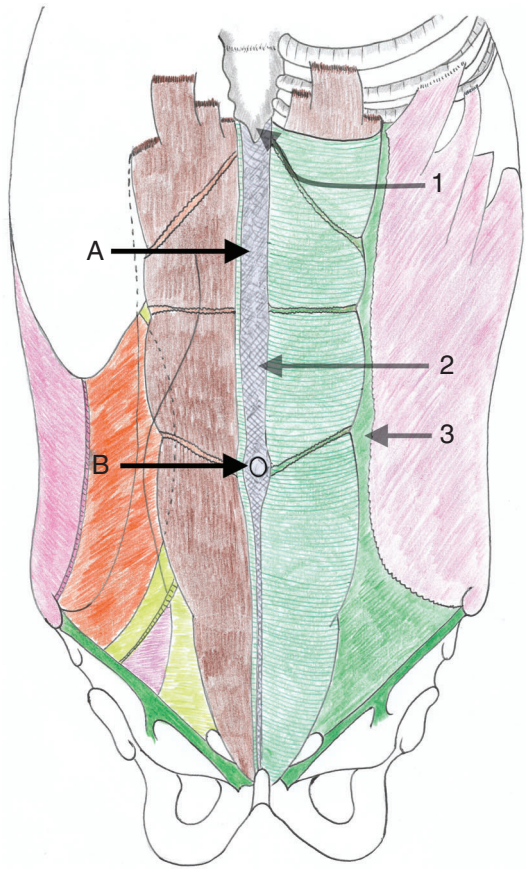
KQ 1: What is the definition of an umbilical hernia and an epigastric hernia?
Statement: There is no available classification that classifies sizes of umbilical and epigastric hernias satisfactorily. An umbilical hernia is defined as a primary hernia with the defect located in the midline in the centre of the umbilical ring. An epigastric hernia is defined as a hernia with the centre of the defect in the midline above the umbilicus up to the xiphoid process. The guideline group classified umbilical and epigastric hernias into small (0–1 cm), medium (more than 1 cm up to 4 cm) and large (over 4 cm) based on defect diameter.
Recommendation: It is suggested that a new consensus on definition and size classification of umbilical and epigastric hernias is created.
Quality of evidence: ⊠□□□
Strength of recommendation: Weak

Umbilical hernias are common; asymptomatic hernias may be present in up to 25 per cent of the population when examined by ultrasound imaging[11]. In a nationwide register-based study[12] from Denmark, the prevalence of an umbilical or epigastric hernia repair in a 5-year interval showed a bimodal distribution. The overall number of umbilical hernia repairs is higher in men than women. The age-specific prevalence was observed to peak in early childhood (0–5 years) for both sexes, in older age (61–70 years) for men, and in middle age for women (31–40 years). The number of repairs for epigastric hernias was similar for both sexes, with the age-specific prevalence peaking at 51–70 years for men and 41–50 years for women.

Studies specifically addressing risk factors for the development of umbilical/epigastric hernias are lacking. Connective tissue disorders, colonic diverticular disease, obesity, presence of ascites, pregnancy, rectus diastasis, native African and American ethnicity, and syndromes like Down's and Beckwith–Wiedemann have been suggested as potential risk factors[13–15].

The current classification system for both primary ventral and incisional hernias was published in 2009 by the EHS[16], based on a consensus discussion of hernia specialists. This classification is based on both defect location and size. As primary hernias in the midline usually have a defect that is more or less round or oval-shaped, the size was described with one measurement being the diameter of the defect. Sizes were divided into small (0–2 cm), medium (more than 2 up to 4 cm) and large (over 4 cm). The exact definition of umbilical and epigastric hernias was not clear in that publication. In 2012, another paper was published on the development of the European registry for abdominal

Fig. 2 Anatomical location of epigastric and umbilical hernias



A, epigastric hernia; B, umbilical hernia; 1, xiphoid process; 2, linea alba – midline; 3, linea semilunaris (artist: Y. Renard).

wall hernias (EuraHS) from the EHS[17]. Here, an umbilical hernia was defined as a primary hernia with its centre at the umbilicus, and an epigastric hernia as a primary hernia with its centre close to the midline above the umbilicus.

The guideline group discussed the definition of umbilical and epigastric hernias thoroughly. The size division into small, medium and large does not match the treatment choices based on recent research, so it was decided to create a new size classification. The guideline group defined umbilical hernia as a primary hernia with the defect located in the midline within the umbilical ring. An epigastric hernia is defined as a primary hernia with the centre of the defect located in the midline above the umbilicus up to the xiphoid process (*Fig. 2*). The guideline group decided to divide umbilical and epigastric hernias into small (0–1 cm), medium (more than 1 cm up to 4 cm) and large (over 4 cm) based on defect diameter.

KQ 2: Are diagnostic modalities indicated in the management of umbilical and epigastric hernias?
Statement: Studies specifically designed to evaluate diagnostic modalities for primary ventral hernias are lacking. Umbilical and epigastric hernias are typically diagnosed by clinical examination only. Imaging by ultrasound examination or CT can be considered if clinical examination is inconclusive.
Recommendation: It is recommended that umbilical or epigastric hernias are diagnosed by clinical examination alone. Imaging by ultrasound examination or CT can be considered in case of doubt.
Quality of evidence: ⊠□□□
Strength of recommendation: Strong (upgraded)

In most patients, an umbilical or epigastric hernia can be diagnosed by clinical examination alone. Only one case series[18] was identified that looked specifically at imaging modalities, which found that ultrasound imaging is useful if there is doubt on clinical examination. In general, diagnostic tests that may be used include ultrasound imaging, CT, MRI, plain radiography and herniography. Additional imaging has been reported to increase the accuracy of the diagnosis to over 97 per cent[19]. Furthermore, one study[20] reported that there is only a moderate correlation between clinical examination, CT and intraoperative laparoscopic assessment when measuring defect sizes in ventral hernias. Preoperative imaging may be necessary in patients with abdominal pain without a palpable hernia, or in obese patients for measurement of the defect size when planning the surgical approach.

Based on the limited evidence, it is not possible to make a recommendation on any diagnostic approach. The guideline group suggested diagnosing umbilical or epigastric hernias by clinical examination alone. Imaging by ultrasound examination or CT can be considered if the diagnosis is in doubt.

KQ 3: Is a watchful waiting strategy safe in patients with asymptomatic umbilical or epigastric hernias?
Statement: There are limited data on watchful waiting for patients with umbilical and epigastric hernias, but a watchful waiting strategy seems safe.
Recommendation: For asymptomatic umbilical and epigastric hernias, a watchful waiting strategy can be suggested.
Quality of evidence: ⊠□□□
Strength of recommendation: Weak

Only one study[21] has evaluated the safety of watchful waiting in patients with ventral hernias. A total of 1358

ventral hernias, including incisional, umbilical and epigastric defects, were evaluated. Watchful waiting was defined as non-operative management. It appears safe, even though up to 19 per cent of the patients may undergo surgery at a later point. Data specifically on umbilical and epigastric hernias were not available. In a small prospective observational study[22] of 25 patients in whom non-operative treatment of a primary ventral hernia was planned, and who were followed for a median of 12 months, 20 and 4 per cent underwent elective and emergency repair respectively.

Data are lacking on the prevalence of umbilical and epigastric hernias in general and on the number of patients undergoing hernia repair. The guideline group suggested a watchful waiting strategy for asymptomatic umbilical and epigastric hernias.

Optimization for surgery

KQ 4: Is optimization of the patient necessary before elective umbilical or epigastric hernia repair?
Statement: Wound complications are the most common complication in ventral hernia repair. Smoking and obesity increase the risk of postoperative wound complications in general, but data are limited considering umbilical and epigastric hernia repair specifically. From other types of surgery, it is known that 4 weeks of smoking cessation before surgery, and weight loss for obese patients, reduce the risk of surgical-site infection.
Recommendation: It is suggested to advise smoking cessation for 4–6 weeks, and weight loss to BMI below 35 kg/m^2, before elective umbilical or epigastric hernia repair.
Quality of evidence: ⊠□□□
Strength of recommendation: Weak

The literature on complications after primary ventral hernia repair is limited. Only two large cohort studies[1,23], both with data from the Danish Hernia Database, were identified. A total of 6783 umbilical and epigastric hernia repairs were included. The overall readmission rate was 5·9 per cent. Reasons were: wound infection (36·8 per cent), pain (30·6 per cent) and haematoma (16·5 per cent)[1]. Patients undergoing recurrent hernia repair had a significantly higher risk of readmission for either a surgical or medical complication, compared with patients undergoing primary hernia repair (7·4 and 4·9 per cent respectively; $P = 0{\cdot}026$). The 30-day reoperation and mortality rates were 0·3 and 0·2 per cent respectively[1]. No data were available on smoking, BMI or patient co-morbidity[1].

In a large cohort study[24] from the American College of Surgeons National Surgical Quality Improvement Project of more than 220 000 patients, including inguinal, umbilical and incisional hernia repairs, smoking was associated with increased readmissions and reoperations[24].

Small retrospective studies have looked at risk factors for recurrence after primary ventral hernia repair. Four small case series[25–28] reported no association between obesity and recurrence, whereas obesity was reported to be an independent risk factor for recurrence in two other studies[29,30]. Wound infection after primary repair may be associated with an increased recurrence rate[29,31], but other studies[27,28,32] could not confirm this finding.

In an expert consensus report[8] on elective surgical management of both primary ventral and incisional hernias, it was suggested that patients should quit smoking and lose weight if their BMI exceeded 30 kg/m^2.

The most frequent complications after umbilical and epigastric hernia repair are wound complications[1]. Smoking and obesity are known to be associated with increased wound morbidity in general[33], but there are no clear data on whether smoking or obesity is related to a poorer postoperative outcome after umbilical or epigastric hernia repair. No recommendation can therefore be made based on the available literature, but the guideline group suggested that smoking cessation and weight loss to BMI less than 35 kg/m^2 is advised before elective hernia repair.

KQ 5: Is antibiotic prophylaxis indicated for umbilical and epigastric hernia repair?
Statement: There is insufficient evidence to recommend routine use of antibiotic prophylaxis in umbilical and epigastric hernia repair to decrease the rate of surgical-site infection. However, surgical-site infection is a significant complication of umbilical and epigastric hernia repair, especially when mesh is inserted; in this situation antibiotic prophylaxis may be useful.
Recommendation: Prophylactic antibiotics, given as a single perioperative dose, is suggested when a mesh is used for umbilical or epigastric hernia repair.
Quality of evidence: ⊠□□□
Strength of recommendation: Weak

In 2016, the WHO[34] published guidelines on the prevention of surgical-site infection after surgery. These guidelines included a list of 29 concrete recommendations distilled by leading experts reviewing the latest evidence. However, these recommendations were not specifically aimed at hernia surgery, and did not address perioperative antibiotic prophylaxis. Nevertheless, it was recommended that antibiotic prophylaxis should not be prolonged after completion of surgery.

Literature on the use of perioperative antibiotics for elective primary ventral hernia repair is limited. One meta-analysis[35] on antibiotic prophylaxis for abdominal

wall hernia repair in general was identified, which concluded that further studies are needed on ventral hernia repair. This meta-analysis included one small RCT[36] of 19 patients scheduled for umbilical hernia repair and randomized to preoperative antibiotics or not. One of nine patients in the antibiotics group had postoperative wound infection compared with four of ten in the control group ($P = 0{\cdot}3$). A sample size of 19 patients is extremely small, so the study is of limited value. The IEHS[6] and SAGES[7] guidelines for laparoscopic ventral hernia repair both recommend a single dose of second-generation cephalosporin for ventral hernia repair.

It is known that postoperative wound infection is a significant complication in umbilical and epigastric hernia repair[1]. Previous guidelines for laparoscopic repair of all types of ventral hernia recommend antibiotic prophylaxis. Wound infection rates may be higher for open repairs than for laparoscopic repairs. All included literature was published before the WHO guideline[34] on the prevention of surgical-site infection, which is why it is likely that not all recommendations from the WHO guidelines were followed. Data are limited for umbilical and epigastric hernia repair specifically, but the guidelines group suggests that prophylactic antibiotics are given as a single perioperative dose for both laparoscopic and open repair when a mesh is used. The type of antibiotic is chosen according to local protocol.

Surgical considerations

KQ 6: Is there a place for sutured repair in elective umbilical or epigastric hernia repair?
Statement: The use of mesh for open umbilical or epigastric hernia repair reduces the rate of recurrence without increasing the rate of surgical-site infection or postoperative pain. The quality of evidence is limited for hernias with defect sizes smaller than 1 cm.
Recommendation: It is recommended that mesh is used for repair of umbilical and epigastric hernias to reduce the recurrence rate. Sutured repair can be considered in shared decision-making and for small hernia defects of less than 1 cm.
Quality of evidence: ⊠⊠⊠⊠
Strength of recommendation: Strong

Repair of umbilical and epigastric hernias can be achieved with both suture and mesh repair. The recurrence rate after sutured umbilical hernia repair varies between 1 and 54·5 per cent, depending on the follow-up method[25,37–39]. A large cohort study[40] of 1313 patients having a suture or mesh repair of an umbilical or epigastric hernia with a defect smaller than 2 cm reported an overall recurrence rate of 14 per cent after median of 3 years. Until recently, studies evaluating the use of mesh for smaller umbilical and epigastric hernias were limited. In the past decade, five meta-analyses[41–45] evaluating the use of mesh for umbilical and epigastric hernias have been published. All concluded that mesh is superior to sutures in terms of decreasing recurrence. The most recent high-quality meta-analysis[44] included data from RCTs[37,38,46–48], retrospective cohort studies[26,49–51] prospective observational studies[25,31] and studies from hernia registries[40,52,53]. All found that the recurrence rate decreased with the use of mesh compared with sutures, without increasing surgical-site infections, seroma, haematoma or chronic pain. However, in a large database study[1] of umbilical and epigastric hernias, the use of mesh was associated with increased readmission rates[1]. In a recent RCT[48] comparing mesh *versus* suture repair of umbilical hernia, a secondary outcome was patient-reported preoperative and postoperative quality of life. Patients did not report any difference in either the Short Form 36 or five-level EuroQoL Five Dimensions (EuroQoL Group, Rotterdam, the Netherlands) questionnaire between the two techniques. No other studies were identified that compared patient-reported outcomes after sutured or mesh repair.

Evidence is limited for hernia defects smaller than 1 cm. A subgroup analysis of a meta-analysis[44] suggested that mesh is also beneficial for small defects, in decreasing recurrence rates. More evidence is needed concerning the role and optimal placement of mesh in patients with an umbilical hernia smaller than 1 cm[44].

The use of mesh reduces recurrence without significantly increasing the rate of surgical-site infection or postoperative pain; therefore, it is recommended that mesh is used for umbilical and epigastric hernia repairs. For defects smaller than 1 cm the evidence is limited, and a sutured repair may be considered in shared decision-making with the patient.

KQ 7: Which is the preferred technique for sutured repair of umbilical or epigastric hernias?
Statement: There is insufficient evidence to recommend the use of a specific type of suture or suturing technique for sutured repair of umbilical or epigastric hernias. Studies indicated that slowly resorbable or non-absorbable sutures were used most commonly.
Recommendation: It is suggested that slowly resorbable or non-absorbable sutures are used for sutured repair of umbilical and epigastric hernias. The suture technique can be chosen by the surgeon. It is recommended not to use quickly absorbable sutures.
Quality of evidence: ⊠□□□
Strength of recommendation: Weak

Suture type (non-absorbable, slowly absorbable or quickly absorbable) and technique (continuous or interrupted) may play a role in reducing the risk of recurrence. Special techniques named after surgeons such as Mayo[54] have also been described.

Two large studies[40,52] from the Danish Hernia Database compared non-absorbable (most patients), slowly absorbable and quickly absorbable sutures after a median of 21–43 months' follow-up, and found no difference in the cumulative recurrence rate between suture types. There were no studies evaluating the role of antibiotic-coated sutures in primary ventral hernia repair.

In the non-mesh group of cohort studies and RCTs (mesh *versus* suture) for umbilical and epigastric hernias, interrupted non-absorbable sutures were used in most studies[37,38,46,48–50,55]. Type of suture was not specified in two studies[25,31].

In two RCTs[38,55] and two case series[25,50], the technique was further specified as the Keel technique[55] (defect sutured in 2 layers) or Mayo technique (double-breasted sutures)[25,38,50]. Dalenbäck and colleagues[50] reported no difference in recurrence between use of double-row sutures (8·2 per cent), single-row sutures (4·7 per cent) or Mayo repair (5·3 per cent). In the study by Kaufmann and co-workers[48], continuous or simple interrupted sutures were used (surgeon's choice), and there was no difference in recurrence rates between the techniques.

There is insufficient evidence to recommend the use of a specific type of suture or suturing technique for repair of umbilical or epigastric hernias. The guideline group suggested using a non-absorbable or slowly absorbable suture, and the technique chosen by the surgeon.

KQ 8: Which is the optimal surgical approach for an acutely strangulated/incarcerated umbilical or epigastric hernia?

Statement: Emergency hernia repairs are heterogeneous. Many patient-related factors play a role in potential morbidity and mortality. There is low-level evidence to suggest that the use of non-resorbable mesh is safe for strangulated/incarcerated umbilical or epigastric hernia repair. Mesh can be used in patients with a clean or clean-contaminated surgical field.

Recommendation: It is suggested that the emergency repair of umbilical or epigastric hernias should be tailored to patient and hernia characteristics. The use of mesh can be considered.

Quality of evidence: ⊠□□□

Strength of recommendation: Weak

An emergency procedure is associated with worse outcomes than elective surgery. These differences are largely related to patient co-morbidity rather than the emergency nature of the procedure[56]. Data from the Danish Hernia Database[1] suggest that emergency repair of an umbilical or epigastric hernia is associated with up to 15-fold higher mortality, reoperation and readmission rates. In the USA, the incidence of urgent hernia repairs has increased slightly during the past decade, with the greatest increase in patients aged over 65 years. For umbilical hernias, the incidence per 100 000 person-years reached its highest rate in 2009 (11·7 per cent)[57].

It has been suggested that the use of a mesh repair for incarcerated umbilical hernia is safe[55,58]. The presence of non-viable intestine should not be regarded as a contraindication to mesh repair[55]. Wound infection rates are higher after emergency hernia repair, but clinical consequences are relatively rare[59]. No studies were identified on the use of biological mesh in emergency repair of umbilical or epigastric hernias.

In the WSES guideline[9] for emergency repair of hernias, it is recommended that synthetic mesh is used in clean or clean-contaminated procedures. In a contaminated field, a primary sutured repair is suggested for defects smaller than 3 cm; alternatively, biological mesh may be considered[9]. In this guideline, ventral hernias included both primary and incisional hernias.

Sepsis and co-morbidity play a role in the morbidity and mortality of emergency repair. There is low-quality evidence indicating that the use of a non-resorbable mesh in a clean or clean-contaminated emergency hernia repair is safe. Based on this, the guideline group suggested tailoring the repair based on patient and hernia characteristics. A non-resorbable mesh can be used in both clean and clean-contaminated procedures. The guideline group suggested placing the mesh outside the peritoneal cavity.

Open hernia repair of umbilical and epigastric hernias with mesh

KQ 9: Which is the preferred type of mesh, and the preferred layer for mesh placement when doing an open umbilical or epigastric hernia repair?

Statement: The use of intraperitoneal preformed patches for umbilical or epigastric hernia repairs may shorten operating time, but may be associated with increased complication rates compared with placing a flat mesh in the preperitoneal space. Patches or preshaped prosthetics with antiadhesive barriers are more expensive than a synthetic flat mesh. There is acceptable evidence that placement of mesh in the retromuscular or

preperitoneal position is associated with a lower rate of surgical-site infection and recurrence. Placement of the mesh in the preperitoneal space seems safe and feasible.
Recommendation: It is suggested that a flat permanent mesh is placed in the preperitoneal space for open umbilical or epigastric hernia repair.
Quality of evidence: ⊠□□□
Strength of recommendation: Weak

There is acceptable evidence that umbilical and epigastric hernias can be repaired safely using a synthetic polypropylene mesh[30,37,48,60,61]. Similar to incisional hernias, there are five theoretical anatomical layers for mesh placement: onlay, in the prefascial plane above the linea alba; fixing the mesh to the borders of the repair (inlay plug); retromuscular, between the rectus muscle and the posterior rectus sheath; preperitoneal, between the posterior rectus sheath and the peritoneum; and intraperitoneal, also called intraperitoneal onlay mesh (IPOM)[62,63].

The number of preformed meshes, plugs and prosthetics for repair of umbilical and epigastric defects is increasing. Although the use of these prosthetics may shorten operating time[64–66] and reduce postoperative pain[38], there is no evidence to support their use instead of a conventional flat synthetic mesh. Most of these prosthetics are manufactured to allow their use in the intraperitoneal position with an antiadhesive barrier. There are a number of case series on their safety[51,64,66–69]. Concerns have arisen from a few reports of severe late complications, such as bowel obstruction, explantation owing to infection and enterocutaneous fistula formation[69–71]. For this reason, preperitoneal placement of a preformed patch should be considered, when possible[72].

To date, only one RCT (mesh *versus* patch repair for epigastric and umbilical hernia, MORPHEUS)[64] has compared an intraperitoneal patch with a preperitoneal low-weight polypropylene flat mesh. Surgery was easier and slightly quicker with an intraperitoneal patch and the early reoperation rate owing to serious complications was significantly higher in the intraperitoneal patch group. The complication rate was higher in the patch group than in the flat mesh group at 2-year follow-up (32·5 *versus* 22·1 per cent; $P = 0{\cdot}044$). There was no difference in recurrence rate[65]. The cost of a patch is higher than that of a flat mesh. Nevertheless, this study evaluated only one specific type of patch; there are many different patches on the market.

One small prospective cohort study[73] evaluated the use of a biological mesh for primary umbilical hernia repair in 36 patients, and concluded that it seemed to be safe and reliable, with a high degree of patient comfort. As this is the only available study, with preliminary results and no control group, the use of biological mesh cannot be supported on this basis. There are no studies comparing the use of polyester, polyvinylidene fluoride or absorbable meshes, and there are no data comparing the efficacy and safety of meshes of different porosity or density used in open repairs.

Data from the AHS database (AHS quality collaborative)[74] showed no difference in 30-day morbidity between matched sublay (pooling retromuscular, preperitoneal and intraperitoneal) and onlay repairs of primary ventral and incisional hernias. Two meta-analyses[75,76], also including both primary ventral and incisional hernias, found that retromuscular mesh placement had the lowest probability of surgical-site infection and recurrence. However, these results cannot be extrapolated to primary ventral hernias alone.

A cohort study[52] from the Danish Hernia Database, including 4786 patients who had an umbilical or epigastric hernia repair, found no difference in reoperation rate between different mesh positions, except that use of an inlay plug had a higher recurrence rate. A recent RCT[48] comparing suture repair with mesh repair of 1–4-cm umbilical hernias found that preperitoneal flat mesh had a lower recurrence rate (4 per cent *versus* 12 per cent for suture repair), without an increase in complications.

Even though data are sparse, there may be more serious complications associated with the use of intraperitoneal patches and a higher rate of reoperations. Based on this, together with a higher cost of patches, the guideline group suggested placing a conventional flat permanent mesh in the preperitoneal space.

KQ 10: Which is the preferred mesh overlap for open umbilical or epigastric hernia repair?
Statement: There is not enough evidence to recommend a specific mesh overlap that may reduce recurrence after umbilical and epigastric hernia repair. A preperitoneal mesh with an overlap of 3 cm has been associated with low recurrence rates in umbilical hernia repairs with defects of 1–4 cm.
Recommendation: In preperitoneal mesh repair for open umbilical and epigastric hernia repair, an overlap of 3 cm is suggested for defects of 1–4 cm.
Quality of evidence: ⊠□□□
Strength of recommendation: Weak

In a systematic literature review[77] including both open and laparoscopic primary ventral and incisional hernia repairs, it was concluded that there was no significant association between hernia recurrence and mesh overlap for

open repairs. In a prospective case series[66] that used an intraperitoneal patch, there were no differences in mesh overlap between recurrent and non-recurrent hernias. In a recent retrospective study[78] of 1558 patients with a mean follow-up of 4 years, an overlap of less than 1 cm was associated with a higher recurrence rate in univariable analysis. In two recent RCTs[48,64], use of a mesh overlap of 3 cm was associated with low recurrence rates. For defects less than 1 cm, a smaller mesh overlap may be sufficient, but there are currently no data available. Based on this, it seems reasonable to suggest a 3-cm mesh overlap for open primary ventral hernia repairs with defects of 1–4 cm.

KQ 11: Which is the preferred method of mesh fixation for open umbilical or epigastric hernia repair?
Statement: There is not enough evidence to recommend any method of fixation over another, where to fix the mesh, or whether mesh fixation is even necessary in open umbilical or epigastric hernia repair. Most studies described suture fixation with non-absorbable sutures.
Recommendation: If the mesh is fixed for an umbilical or epigastric hernia repair, it is suggested that a non-absorbable suture is used.
Quality of evidence: ⊠□□□
Strength of recommendation: Weak

There are no studies comparing different fixation techniques or types of suture to fix the mesh in open repair of primary ventral hernias. In two high-quality RCTs[48,64] of open mesh repair of umbilical hernias, a non-absorbable suture was used for mesh fixation. The guideline group discussed whether mesh fixation was always necessary, and many agreed that it may not be necessary when preperitoneal mesh placement is used. However, there is no literature addressing this issue. If the mesh is fixed, the guideline group suggested using a non-absorbable suture for mesh fixation.

KQ 12: Should the defect be closed for open umbilical and epigastric hernia repairs when a mesh is used?
Statement: There is not enough evidence to recommend whether the defect should be left open or closed in open primary ventral hernia repair. Studies using a flat mesh have reported closing the defect.
Recommendation: When performing umbilical or epigastric hernia repair and a flat mesh is used, it is suggested that the defect is closed.
Quality of evidence: ⊠□□□
Strength of recommendation: Weak

There are no studies on primary ventral hernias focusing specifically on defect closure. When mesh plug inlay techniques or preformed patches are used, the defect may not be closed as the mesh is fixed to the border of the defect[38,70]. When preperitoneal flat mesh or an onlay mesh is used, the fascial defect is usually closed[48,74]. In the MORPHEUS trial[65], patients with umbilical hernia were randomized to preperitoneal flat mesh or intraperitoneal patch; the fascia was closed in 86 per cent of patients.

It is unknown whether closing the defect influences the outcome of the repair. However, there is a growing tendency towards restoration of the midline. When mesh is placed in the preperitoneal plane, closure of the defect prevents the mesh entering the subcutaneous space. Based on the available sparse data, it is suggested that the defect is closed with a slowly absorbable or non-absorbable suture.

KQ 13: Which is the preferred anaesthetic method for open umbilical and epigastric hernia repair?
Statement: Available evidence shows that local anaesthesia can be used safely for open umbilical and epigastric hernia repairs. There is no evidence to support the superiority of local anaesthesia over general anaesthesia.
Recommendation: The guideline group suggests adhering to local protocols, and that the patient, surgeon and anaesthetist agree on the type of anaesthesia for open umbilical or epigastric hernia repair based on shared decision-making.
Quality of evidence: ⊠□□□
Strength of recommendation: Weak

In a systematic review of available evidence, the use of local anaesthesia led to a shorter postoperative stay compared with general anaesthesia[79]. The use of local anaesthesia did not lead to serious perioperative complications, allergic responses or anaesthesia-related deaths[80]. There is no consensus regarding the type of anaesthetic drug or technique used for local anaesthesia. Local anaesthesia for umbilical hernia repair seems safe and feasible. There is no literature on potential advantages of using local rather than general anaesthesia. Based on this, no recommendation is given on method of anaesthesia. The guideline group suggested adhering to local protocols, and that the patient and surgeon agree on the type of anaesthesia based on shared decision-making.

Laparoscopic repairs of umbilical and epigastric hernias

KQ 14: What are the indications for laparoscopic umbilical and epigastric hernia repair?
Statement: Laparoscopic repair decreases the risk of wound complications. It may be beneficial for large (over

4 cm) umbilical or epigastric hernias. For medium-sized hernias, laparoscopic repair may be considered in patients at high risk of wound infection.
Recommendation: It is suggested that laparoscopic repair is considered for large umbilical or epigastric hernias, or if the patient has an increased risk of wound infection.
Quality of evidence: ⊠□□□
Strength of recommendation: Weak

One systematic review and meta-analyses[81] compared laparoscopic and open repair of umbilical hernias. It included three RCTs and seven retrospective cohort studies with a total of 16 549 patients. Open repair was associated with a higher risk of wound infection, wound dehiscence, recurrence, increased duration of hospital stay, but shorter operating times than laparoscopic repair. Six other meta-analysis and systematic reviews[82–87] compared the effectiveness of laparoscopic and open repair, but included both primary ventral and incisional hernias. These studies showed no differences in recurrence rates, seroma risk, duration of operation or postoperative pain between techniques, but with conflicting data and low levels of evidence. Laparoscopic repair had a significantly lower rate of wound infections and shorter hospital stay than open repair, but laparoscopic repair was associated with a slightly higher rate of perioperative bowel injury[86,87]. The results of these meta-analyses should be interpreted with caution because techniques, mesh types, mesh position and fixation methods differed greatly. No distinction was made between umbilical, epigastric or incisional hernia.

Laparoscopic ventral hernia repair is associated with a decreased risk of surgical-site infection. Larger defect sizes and obesity may be associated with an increased risk of wound complication following open hernia repair[29,30]. Based on this, it is suggested that laparoscopic repair is considered for large (over 4 cm) umbilical or epigastric hernias, or if the patient has an increased risk of wound infection.

KQ 15: What is the preferred laparoendoscopic repair method for umbilical or epigastric hernias?
Statement: Novel laparoscopic and endoscopic techniques, including robot-assisted techniques with extraperitoneal mesh placement, seem promising, with theoretical advantages over the traditional IPOM technique. There are insufficient data to suggest one technique over another for repair of umbilical or epigastric hernias. As an intraperitoneal mesh may cause adhesions, placement of the mesh in the preperitoneal or retromuscular position is suggested, when possible. Closure of the hernia defect seems to decrease seroma formation, bulging and recurrence. A mesh overlap of at least 5 cm seems to decrease recurrence rates. For IPOM repairs, fixation of the mesh using non-absorbable sutures or tacks decreases the recurrence rate.
Recommendation: For laparoscopic umbilical or epigastric hernia repairs, it is suggested that the defect is closed when possible, and the mesh is placed in the preperitoneal or retromuscular position with an overlap of at least 5 cm. It is suggested that an intraperitoneal mesh is fixed with non-absorbable sutures or tacks.
Quality of evidence: ⊠□□□
Strength of recommendation: Weak

The initial description of the laparoscopic technique for ventral hernia repair used IPOM[88]. This is now the most used technique. There has been concern about the risk of adhesions related to the intraperitoneal mesh. In a series of 733 patients undergoing laparoscopic IPOM, 2 per cent had reoperation for bowel obstruction, and 2 per cent for mesh infection after a mean follow-up of 19 months[89].

The robotic technique has reinvigorated interest in the potential for extraperitoneal mesh placement (retromuscular or preperitoneal)[90]. Furthermore, endoscopic/mini-open sublay (eMILOS) repair, the totally extraperitoneal (eTEP) approach and totally endoscopic sublay repair are new endoscopic techniques that avoid intraperitoneal mesh placement[91–93]. Case series[92,94,95] report low complication and recurrence rates. eMILOS, eTEP and robotic surgery seem promising, with theoretical advantages over the traditional IPOM technique[96–99]. There are currently insufficient data to suggest the superiority of one technique over another.

The classical IPOM repair included fixation of the mesh that bridged the defect. The durability of the repair depended on the strength of fixation[100]. Protrusion or bulging of the non-closed defect can occur, which can mimic recurrence, and has a reported incidence of up to 31·5 per cent[42,101–103]. Furthermore, the bridge technique may have high rates of seroma, infection and patient dissatisfaction[42,102,103]. Laparoscopic defect closure, sometimes referred to as 'IPOM plus', attempts to recreate a normal, functional dynamic anatomy by re-approximating the abdominal wall under tension, which may restore function and prevent bulging[42,102,103].

One high-quality meta-analysis[103] and a systematic review[42] of acceptable quality comparing closure with non-closure of the gap reported decreased recurrence and seroma rates in the closure group. The variability in study quality, and inclusion of both primary ventral

and incisional hernias, mean that conclusions must be interpreted with caution. Four other studies[101,104–106] have since been published, which included both primary ventral and incisional hernia repairs. Two[104,106] confirmed the results of the review and meta-analyses, whereas the other two[101,105] did not show any difference in seroma formation or surgical-site complications.

Closure of the defect may allow a wider lateral mesh overlap, which may further reduce the recurrence rate. There is no convincing evidence for type of suture material or technique for closing the defect in laparoscopic umbilical hernia repair. In a systematic literature review[77] of 95 articles, the risk of recurrence was decreased with increasing mesh overlap for laparoscopic repairs, mainly without defect closure. The lowest recurrence rate was found with a mesh overlap of more than 5 cm. The IEHS guidelines[4–6] recommend a mesh overlap of more than 3 to 4 cm in all directions, and over 5 cm if the mesh is fixed without transfascial sutures.

Another study[107] evaluated 213 consecutive patients undergoing laparoscopic repair of incisional and primary ventral hernias, and reported that the mesh area to defect ratio was the most important predictor of recurrence. A mesh to defect ratio of 16 is the threshold above which the risk of recurrence is almost zero[107]. In a physical model mimicking a passive abdominal wall, it was reported that defect size was the most important parameter regarding stress of the mesh and overlap related to mesh stress[108].

The mesh may be fixed by one of two main types of device: sutures and tacks, alone or combined. Both can be of absorbable or permanent material. Two systematic reviews[109,110] and four high-quality meta-analyses[111–114] compared tacks *versus* sutures *versus* both for repairs including primary ventral and incisional hernias. The four meta-analyses all evaluated different studies and outcomes, making comparisons difficult.

The two systematic reviews evaluated suture and tack fixation. One[109] reported a lower recurrence rate for the sutured technique; the other[110] could not confirm this finding, but found more infections with sutures than tacks. In a network meta-analysis[113], there seemed to be an overall advantage of combining tacks with sutures to decrease the recurrence rate, compared with tacks alone.

In a comparison of non-absorbable tacks and non-absorbable transfascial sutures, there were no significant differences in the rates of chronic pain (lasting more than 3 months), duration of stay, recurrence rate, and seroma and haematoma occurrence. The operating time was significantly lower when tacks were used, but the cost of the devices was higher[114]. The finding of a shorter operating time with tacks as opposed to sutures was confirmed in another meta-analysis[112] that also found decreased postoperative pain in the suture group, with no difference in recurrence rate and duration of hospital stay. Comparing absorbable and non-absorbable tacks, there were no differences in recurrence rate or chronic pain, but operating time was longer in the absorbable tack group[111].

One small RCT[115] (40 patients) analysed the difference between titanium tacks and fibrin sealant, in a study including 90 per cent primary ventral hernias (defect size 1·5–5 cm). Pain scores were significantly lower over the first 10 days after surgery with use of glue, but there was no difference between groups at 30 days. The recurrence rate was 26 per cent after use of fibrin sealant *versus* 6 per cent with tacks at 1-year follow-up[116].

Only one study[117] has reported on primary ventral hernias alone; non-absorbable tacks were compared with absorbable tacks in a cohort study of 80 patients with an umbilical hernia (defect size no larger than 2 cm). Early and chronic pain were the only outcomes evaluated. Less pain was reported in the absorbable tacks group until 12 weeks, but not at follow-up of 18 months.

The literature is heterogeneous and does not specifically evaluate laparoscopic repairs of umbilical and epigastric hernias. Recommendations should be applied with care. Novel laparoscopic techniques with extraperitoneal mesh seem promising, with theoretical advantages over traditional IPOM techniques. There are currently insufficient data to suggest the superiority of one technique over another. As an intraperitoneal mesh may cause adhesions, extraperitoneal mesh placement is suggested, when possible. Closure of the defect seems to decrease seroma formation, bulging and recurrence, and should be attempted. For laparoscopic repair, a mesh overlap of at least 5 cm appears to decrease recurrence rates. For IPOM repairs, fixation of the mesh with a non-absorbable device, either sutures or tacks, decreases the recurrence rate.

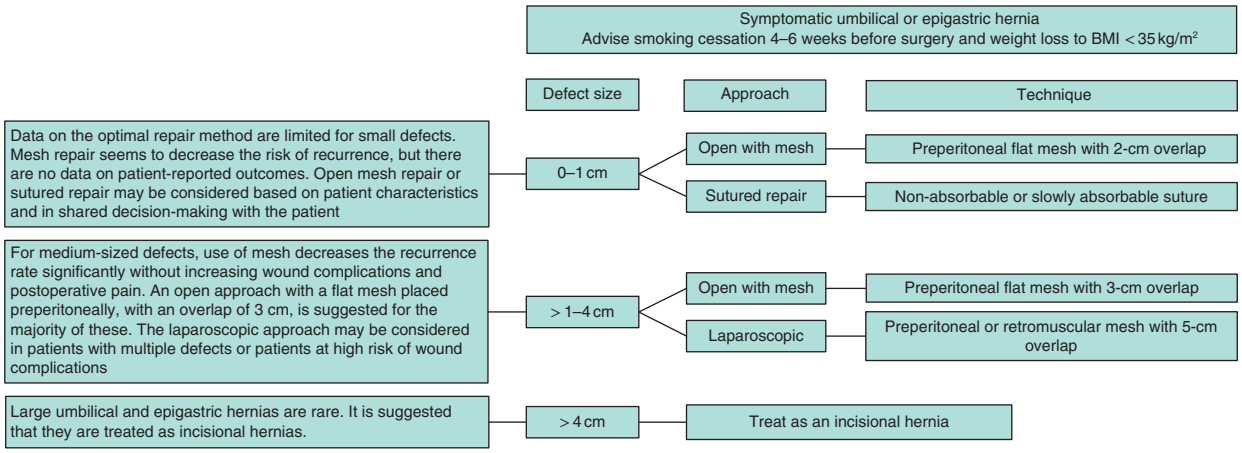
Umbilical and epigastric hernia repair, tailoring the approach

KQ 16: Which is the preferred repair method for umbilical and epigastric hernias based on hernia and patient characteristics?

Statement: Most umbilical and epigastric hernias can be repaired with an open mesh repair. For larger defects, or in patients with an increased risk of wound complications, laparoscopic repair or one of the novel endoscopic techniques may be considered.

Recommendation: Although most umbilical and epigastric hernias can be repaired with an open preperitoneal flat mesh, it is recommended that the repair is

Fig. 3 Suggested algorithm for repair of symptomatic umbilical and epigastric hernias



tailored based on patient and hernia characteristics and local resources. Patient and surgeon preferences should also be taken into account.
Quality of evidence: ⊠□□□
Strength of recommendation: Strong (upgraded)

An algorithm for the repair of symptomatic umbilical and epigastric hernias was constructed based on evaluation of the literature and expert opinions in the guideline group (*Fig. 3*).

The most common complication after umbilical and epigastric hernia repair is wound morbidity. Obesity, smoking, diabetes and immunosuppression are factors known to be associated with wound complications in general, but evidence is limited for umbilical and epigastric hernia repairs specifically.

The majority of umbilical and epigastric hernias are small or medium-sized, and an open repair with mesh reduces the recurrence rate without increasing complications, although data are limited for defects of 0–1 cm[44]. For all types of ventral hernia, sublay mesh placement has been associated with the lowest risk of surgical-site infection and/or recurrence[75,76]. Sublay placement includes the preperitoneal, retromuscular and intraperitoneal spaces. Owing to the risk of intra-abdominal adhesions, it seems advantageous to avoid intraperitoneal mesh placement. For small umbilical and epigastric hernia repairs, it causes less trauma to create a preperitoneal than a retromuscular space. Either a flat mesh or a preformed patch may be used in the preperitoneal space. Preformed patches are more expensive and associated with a higher rate of postoperative complications[65].

Based on this, the use of a flat mesh placed in the preperitoneal space is suggested. To avoid mesh migration to the subcutaneous space, it is suggested that the defect above the mesh is closed. The optimal mesh size for small and medium-sized umbilical and epigastric hernias has not been studied but, for open repairs, a mesh overlap of 2 cm is suggested for the smallest defects, and 3 cm for medium-sized defects. For small (less than 1 cm) umbilical and epigastric hernias, data concerning use of mesh are limited. Although mesh seems to decrease recurrence, a sutured repair may be considered in shared decision-making with the patient. For medium-sized (more than 1 cm up to 4 cm) umbilical or epigastric hernias, an open approach with a preperitoneal flat mesh is suggested. A laparoscopic approach may be considered for repair of multiple defects or in obese patients. Large umbilical and epigastric hernias (over 4 cm) are rare, and should be treated as an incisional hernia using mesh.

Learning curve and cost

KQ 17: What is the learning curve for umbilical and epigastric hernia repair?
Statement: The evidence concerning any learning curve for umbilical and epigastric hernia repairs is very limited. The specific number necessary to perform the procedure independently has not been assessed in the literature. Standard programmes for hernia repair including lectures and simulation training seem promising. The mentor plays an important role and should be trained to provide structured teaching of important

surgical steps. For laparoscopic ventral hernia repairs, the complication and recurrence rates seem to decrease after around 30 procedures.
Recommendation: The learning curve for open and laparoscopic umbilical and epigastric hernia repair is suggested to be around 20 and 30 supervised procedures respectively. It is suggested that a standard training programme should be offered to surgical trainees, with evaluation of when they can perform the procedures safely and independently.
Quality of evidence: ⊠□□□
Strength of recommendation: Weak

Training the next generations of surgeons is fundamental to a sustainable healthcare system. Surgical training is lengthy and costly. Open primary ventral hernia repair is often one of the earliest procedures a surgical trainee gets to perform. Day-care units offer an ideal setting for structured education and training in standard techniques, with attention to surgical details. The mentor plays an important role and should be trained to provide structured teaching. The impact of surgical training on quality of operative outcomes should be limited to possibly longer operations, and should not influence the quality of surgery adversely.

Little has been published on the learning curve of primary ventral hernia repair. A retrospective study[118] including 508 open and laparoscopic umbilical hernia repairs revealed that trainees took longer, but with no differences in duration of stay or readmission rate compared with consultants or specialists. Bowel injury is a serious complication in laparoscopic ventral hernia repair that is significantly reduced after 25–32 operations[119]. The same trend has been observed for recurrence, which was reduced from 11 to 0 per cent between the first 32 and later operations. Performance can be studied more objectively using surgical simulation models for laparoscopic training. Standard training for laparoscopic inguinal and ventral hernia repair, including 1 day each of lectures, simulation training and surgery, has been reported to result in similar surgical outcomes for trainees and consultants, except for longer operations among trainees[120].

Evidence concerning the learning curve for umbilical and epigastric hernia repairs is limited. The number of procedures necessary before a trainee can perform the procedure safely and independently has not been assessed. It seems advantageous to include simulation training in the teaching of laparoscopic ventral hernia repair. For laparoscopic repairs, the complication and recurrence rates seem to decrease after around 30 procedures. For open repairs, the guideline group suggested that the learning curve is reached after around 20 procedures.

KQ 18: How can costs for umbilical and epigastric hernia repair be influenced?
Statement: Costs for umbilical and epigastric hernia repair will increase when wound complications and recurrence occur. Costs may be reduced by preoperative optimization, by using a low-cost permanent flat mesh, and by reserving the laparoscopic technique for patients with defects larger than 4 cm or at high risk of wound complications.
Recommendation: To reduce the costs of umbilical and epigastric hernia repair, it is suggested that open repair should be done with a preperitoneal flat mesh as a day case, with the utmost effort to reduce potential complications such as infection and recurrence by considering preoperative optimization and tailoring the approach.
Quality of evidence: ⊠□□□
Strength of recommendation: Weak

Overall costs of ventral hernia repair include pretreatment, treatment and post-treatment care. From a financial perspective, expenses are variable. These can be trimmed by prehabilitation, and appropriate choice of surgical technique and mesh type. Most of the available literature includes incisional and complex hernias; it is a challenge to find evidence for the most cost-effective treatment strategy for umbilical and epigastric hernias.

Pretreatment

The aim of prehabilitation is to avoid complications, such as infection and recurrence, which will minimize potential cost. For open ventral hernia repair of large defects, patients with preventable co-morbidities such as diabetes, obesity and smoking are more likely to experience wound-related complications[121]. Whether reducing preventable co-morbidities can improve outcomes after repair of small umbilical and epigastric hernias is unknown.

Treatment

The costs of surgical treatment, including operating theatre costs, ultimately serve as the most significant financial burden. Appropriate patient selection and surgical decision-making, therefore, hold the largest potential for overall cost reduction. Various factors can influence the net cost of a procedure: laparoscopic *versus* open repair, outpatient *versus* inpatient setting, type of medical equipment, type of mesh and experience of the surgeon.

The costs of non-surgical and surgical treatment of umbilical hernia have been compared, and the direct financial costs of umbilical hernia repair were higher in the

first year after surgery[122]. In patients who were chosen for non-operative management, days of healthcare utilization and estimated time off work were higher. The difference in cost between the groups reduced considerably over time. With longer follow-up, costs in the non-surgery group may surpass those in the surgery group[122].

In analyses including all types of ventral hernia, laparoscopic repair was associated with fewer complications, shorter duration of hospital stay, fewer readmissions, fewer outpatient appointments and fewer days off work than open repair[105,123,124]. These conclusions could differ significantly if only small or medium-sized primary ventral hernias are considered. Laparoscopic repair decreases wound complications and is particularly indicated in patients at increased risk of infection[86].

The notorious discussion about mesh type serves as a hallmark debate in the ventral hernia repair literature. Certain meshes or preformed patches for intraperitoneal use are more expensive as they are coated with antiadhesive barriers. In comparisons of the use of a preformed patch *versus* a basic flat mesh for umbilical and epigastric hernia repair, the operating time was shorter when a preformed patch was used, but the complication rate was higher[64,65].

The primary goal of umbilical and epigastric hernia repair should be a successful primary repair, avoiding complications and recurrences. In general, both complications and recurrence add substantially to total costs and resource use[125].

Taken together, most of the literature describes the costs of treatment of all ventral hernias (including incisional hernias). Making firm conclusions about umbilical and epigastric repairs alone is a challenge. It is recommended to consider prehabilitation, offer day-case surgery and optimal treatment strategies that decrease the risk of complications.

Comments

This international guideline covers the treatment of umbilical and epigastric hernias alone. The literature specifically on umbilical and epigastric hernias is limited in both quantity and quality. For some key questions, it was necessary to extrapolate data from studies reporting both incisional and primary ventral hernias. Therefore, most recommendations are weak, which is a significant limitation of the guideline. The only strong recommendation based on a high quality of evidence was to use mesh for defects of at least 1 cm to reduce recurrence. Recurrence was the most frequent outcome studied; data on patient-reported outcomes were lacking. Nevertheless, based on a thorough review of the available literature and expert opinions from the guideline group, a treatment algorithm for umbilical and epigastric hernias is suggested.

For small umbilical and epigastric hernias (0–1 cm), either open mesh repair or a sutured repair can be used. For symptomatic, medium-sized hernias (more than 1 cm up to 4 cm), open repair with a preperitoneal flat mesh is recommended. This technique is feasible and cheap, and is indicated in high-income as well as in middle- and low-income regions. Laparoscopic repair is recommended for large defects (over 4 cm), in obese patients, or for multiple defects.

Perspectives

The majority of the recommendations in the current guideline are weak, as there was a lack of direct evidence on umbilical and epigastric hernia repairs. The guideline group discussed and proposed some future studies that could lead to a change of practice. First, it is important to define an agreed minimum set of outcomes (core outcome set) that clearly outlines what patients and surgeons find important about the various techniques. Furthermore, pooling of primary ventral and incisional hernias should be avoided, to generate specific conclusions for each hernia type.

Future studies could be RCTs, which often require resources in money and time, with answers expected only after many years, and a risk of low external validity. Alternatively, an increasing number of registries are generating high-quality data with high external validity. Other alternatives are the multiarm multistage framework or trials within cohorts, which are efficient ways of evaluating treatment strategies and measuring outcomes in a large cohort.

It is unknown whether preoperative optimization of patients with preventable co-morbidities could decrease postoperative complications and recurrence. A database study could possibly answer these questions. The value of single-dose antibiotic prophylaxis in reducing postoperative wound complications should be examined in an RCT setting.

Concerning surgical technique for umbilical and epigastric hernia repair, further studies are needed to clarify whether defects of smaller than 1 cm benefit from mesh repair. For defects larger than 1 cm up to 4 cm, it would be of value to know whether laparoscopic or open repair is optimal. Furthermore, for open repair of small and medium-sized umbilical and epigastric hernias, the optimal mesh layer, size of mesh overlap, and whether or not the defect should be closed are unknown factors that could influence outcomes, and which could be assessed in either

database studies or RCTs. The potential benefits of closure of the defect in combination with mesh in different positions in the abdominal wall is also unclear, and could potentially be explored in large registry-based studies. The role of the novel laparoendoscopic and robot-assisted techniques also needs to be clarified for umbilical and epigastric hernia repair. Large database studies might be a useful initial approach in evaluating these technologies.

An update of the guideline is planned for 2023. Significant results from new research that would change the current recommendations are not likely to be available before this.

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Supporting information

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