A systematic review of outcome reporting in incisional hernia surgery

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Abstract

Background: The incidence of incisional hernia is up to 20 per cent after abdominal surgery. The management of patients with incisional hernia can be complex with an array of techniques and meshes available. Ensuring consistency in reporting outcomes across studies on incisional hernia is important and will enable appropriate interpretation, comparison and data synthesis across a range of clinical and operative treatment strategies.

Methods: Literature searches were performed in MEDLINE and EMBASE (from 1 January 2010 to 31 December 2019) and the Cochrane Central Register of Controlled Trials. All studies documenting clinical and patient-reported outcomes for incisional hernia were included.

Results: In total, 1340 studies were screened, of which 92 were included, reporting outcomes on 12,292 patients undergoing incisional hernia repair. Eight broad-based outcome domains were identified, including patient and clinical demographics, hernia-related symptoms, hernia morphology, recurrent incisional hernia, operative variables, postoperative variables, follow-up and patient-reported outcomes. Clinical outcomes such as hernia recurrence rates were reported in 80 studies (87 per cent). A total of nine different definitions for detecting hernia recurrence were identified. Patient-reported outcomes were reported in 31 studies (34 per cent), with 18 different assessment measures used.

Conclusions: This review demonstrates the significant heterogeneity in outcome reporting in incisional hernia studies, with significant variation in outcome assessment and definitions. This is coupled with significant under-reporting of patient-reported outcomes.

Introduction

Incisional hernia is a common complication with a documented incidence of 2–20 per cent after open abdominal surgery. The presence of an incisional hernia is associated with significant morbidity and has a considerable impact on patients’ overall quality of life. The management of incisional hernia is complex due to a combination of factors including patient co-morbidity, hernia morphology and the vast array of available surgical options. Consequently, generating a robust evidence base in this cohort of patients is difficult.

The current evidence base in incisional hernia surgery consists of a large number of retrospective cohort studies with a paucity of well designed RCTs. In addition to this, outcome reporting in hernia surgery research is variable. Two systematic reviews examining outcome reporting in inguinal hernia and ventral hernia both reported significant heterogeneity between RCTs in defining and reporting clinical outcomes and patient-reported outcomes (PROs).

The European Hernia Society (EHS) has previously issued a series of recommendations regarding outcome reporting in
abdominal hernia repair⁵. Following a systematic review and a consultation exercise with international experts, 20 key reporting recommendations were made; 11 of these related to study design, two to hernia morphology, three to operative strategy and four to clinical follow-up. This guideline represents a step towards improving outcome reporting in abdominal wall hernia. However, it has a number of limitations, including the lack of definition to underpin the reporting outcomes, the lack of diversity amongst the expert members of the consultation exercise with no representation of patient perspectives or views and the exclusion of PROs. Current clinical guidelines recommend that surgical repair for incisional hernia should be undertaken to improve patient symptoms and quality of life. Despite this, the majority of studies fail adequately to capture or report patient-centred outcomes such as quality of life and pain. Parker and colleagues reported failure adequately to capture or report patient-centred outcomes such as quality of life and pain. Despite this, the majority of studies fail adequately to capture or report patient-centred outcomes such as quality of life and pain. To ensure outcome reporting reflects the goals and aims of incisional hernia repair, it is essential that PROs are appropriately defined, captured and reported.

The reporting of standardized definitions and outcomes important to all stakeholders, including clinicians and patients, has been recognized to be of key importance in improving overall outcome reporting and in delivering high-quality clinical research by the Core Outcome Measures in Effectiveness Trials (COMET) initiative. The COMET initiative has developed standard methodology to help formulate core outcome sets (COS) in a variety of clinical scenarios⁷. The aim of a COS is to develop a universally agreed minimum number of key outcomes which are important to all stakeholders and should be reported for all studies in a particular clinical area. A COS in incisional hernia surgery has the potential to overcome a number of the documented limitations of outcome reporting in hernia surgery. The first step towards achieving a COS in incisional hernia repair is to identify the current reported outcomes. The aim of this systematic review was to identify variation in clinical outcomes and PROs currently reported within the literature for incisional hernia.

Methods

This systematic review was conducted according to a pre-specified protocol based on guidance from the Centre for Reviews and Dissemination⁸ and the Cochrane Handbook⁹ and is reported in line with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement¹⁰. The protocol was registered with the international, prospective register of systematic reviews, PROSPERO (CRD42018090084).

Eligibility criteria

All studies reporting clinical outcomes and/or PROs in adults (over 18 years old) undergoing incisional hernia repair between 2010 and 2019 were included. Studies were excluded if clinical outcomes and PROs were reported for other types of hernias (umbilical, epigastric, port-site). In addition, case reports, systematic reviews and letters were excluded.

Search strategy

The OPID SP versions of MEDLINE (1950 to present), EMBASE (1980 to present) and the Cochrane Central Register of Controlled Trials were searched using the following search terms ‘incisional hernia’, ‘abdominal wall reconstruction’, ‘patient-reported outcomes’ and ‘quality of life’ separated by the Boolean operator ‘AND’. The search strategy was limited to human studies published in English between 1 January 2010 and 31 December 2019. This time frame was chosen to reflect current clinical guidelines from the EHS and contemporary surgical practice, including minimally invasive surgical techniques and enhanced recovery after surgery. Reference lists of included articles were hand-searched to identify any additional studies. All citations were collated within EndNote X7® (Philadelphia, USA) and duplicates were removed.

Selection of studies

All relevant titles and abstracts were screened by two reviewers (D.H. and C.T.). Full papers of potentially eligible abstracts were retrieved in full. Any conflicts were resolved through discussion with a senior author (B.G.).

Data extraction

Data extraction was conducted by two reviewers and was verified by a third reviewer. Data were extracted under the broad categories of participant demographics, clinical details, treatment and surgery-related details, clinical outcomes and PROs reported.

All reported outcomes were identified and recorded verbatim. Outcomes were considered defined if text was provided to explain the outcome or a citation was provided to define the outcome. If no explanation or appropriate citation were provided, outcomes were classified as not defined.

Study quality

Methodological quality assessment of studies included in this review was undertaken using the Risk of Bias In Non-Randomised Studies of Intervention (ROBINS-I) assessment tool¹¹ for non-randomized studies and the Cochrane risk of bias tool for RCTs.

Data analysis

Individual reporting outcomes were extracted and the frequency that each outcome was reported was calculated. The definitions of reporting outcomes were identified and extracted. The consistency of reporting outcomes and the frequency of inconsistencies in definitions of reported outcomes were compared between studies. Descriptive data were expressed using basic statistics including proportions and averages. All data were entered into Microsoft® Excel (Microsoft, Redmond, Washington, USA) for analysis.

Results

The search strategy identified a total of 1760 manuscripts, of which 456 duplicate references were identified and 1304 studies were screened. Some 171 manuscripts were examined in full, of which 92 studies were eligible for inclusion¹²-¹⁰³ (Fig. 1). Fifteen RCTs (16 per cent), 25 prospective cohort studies (27 per cent), of which 2 (2 per cent) were sub-analyses from RCTs, and 52 retrospective cohort studies (57 per cent) were identified (Table 1). Eleven multicentre (14 per cent) and 69 single-centre (86 per cent) studies were included. The primary outcome was defined in 39 studies (42 per cent). Clinical primary endpoints were reported in 30 studies (32.6 per cent), which included complications, hernia recurrence, mesh-related complications (infection or protrusion), structural mesh changes, length of stay, biomechanics and truncal flexion. Patient-reported primary endpoints were assessed in nine studies (10 per cent) which included the SF36 questionnaire⁵⁵, the
physical health subscale of the SF36 at 21 days after surgery, postoperative pain, postoperative pain scores at 3 weeks, Americas Hernia Society Quality Collaborative (AHSQC) pain questionnaire and HerQLes. Two studies (2.1 per cent) employed a composite primary endpoint of pain and recurrence.

**Outcome reporting**

A total of 2215 outcomes were reported, these outcomes were mapped to eight broad-based domains (Fig. 2), including patient and clinical demographics, hernia-related symptoms, hernia morphology, recurrent incisional hernia, operative variables, postoperative variables, follow-up and PROs.

**Study bias**

The risk of bias associated with the RCTs is outlined in Fig. 3 and with observational studies is outlined in Fig. 4. The risk of bias was high in six RCTs, with the majority of bias being attributed to the lack of blinding of outcome assessors and selective outcome reporting. For observational studies, 17 studies were identified as being seriously or critically biased, with the domains associated with the highest risk of bias being participant selection, measurement of outcomes and selection of reported outcomes.

**Patient and clinical demographics**

Outcomes were reported in 12 292 patients undergoing incisional hernia repair. Patient demographics were well reported, however, clinical demographics relating to BMI, ASA classification and co-morbidity were less well reported (Table 2). Patient co-morbidity was reported in 48 studies (52 per cent), of which chronic obstructive pulmonary disease was the commonest co-morbidity reported. Comorbidities were often reported in an ad hoc manner, with only one study employing a systematic approach by using the APACHE system. Important clinical demographic details regarding steroid use and smoking status were poorly reported, with 17 (18 per cent) and 33 (36 per cent) studies reporting these outcomes respectively. Smoking status was defined in 12 studies (13 per cent), with significant variation in the definition employed (Table 3).

**Hernia-related symptoms**

Symptomatic indications for surgical intervention were reported in 12 studies (13 per cent): six prospective cohort studies, one RCT and five retrospective cohort studies (Table 4). A number of composite symptoms were often reported, with studies failing to discriminate between different hernia-related symptoms, treatment strategy and outcomes. Two studies used validated quality-of-life measures to assess hernia-related symptoms. The majority of studies reported hernia-related symptoms in the elective setting, with only one study reporting symptomatic indications in the emergency setting.
Table 1 Study characteristics

| Variable              | Number of studies (n = 92) |
|-----------------------|----------------------------|
| Study type            |                            |
| RCT                   | 15 (16)                    |
| Prospective cohort study | 25 (27)                   |
| Retrospective cohort study | 52 (57)                 |
| Multicentre           | 11 (14)                    |
| Single centre         | 69 (86)                    |
| Year of publication   |                            |
| 2010                  | 8 (9)                      |
| 2011                  | 5 (5)                      |
| 2012                  | 5 (5)                      |
| 2013                  | 12 (13)                    |
| 2014                  | 11 (12)                    |
| 2015                  | 16 (17)                    |
| 2016                  | 12 (13)                    |
| 2017                  | 11 (12)                    |
| 2018                  | 5 (5)                      |
| 2019                  | 7 (8)                      |
| Country               |                            |
| Austria               | 1 (1)                      |
| Brazil                | 3 (3)                      |
| China                 | 3 (3)                      |
| Croatia               | 1 (1)                      |
| Denmark               | 1 (1)                      |
| Egypt                 | 1 (1)                      |
| France                | 3 (3)                      |
| Finland               | 1 (1)                      |
| Germany               | 5 (5)                      |
| India                 | 2 (2)                      |
| Italy                 | 10 (11)                    |
| Japan                 | 1 (1)                      |
| Lithuania             | 1 (1)                      |
| Nigeria               | 1 (1)                      |
| Norway                | 2 (2)                      |
| Pakistan              | 4 (4)                      |
| Poland                | 3 (3)                      |
| Romania               | 6 (7)                      |
| Serbia                | 1 (1)                      |
| Spain                 | 4 (4)                      |
| Sweden                | 5 (5)                      |
| The Netherlands       | 6 (7)                      |
| Turkey                | 8 (9)                      |
| UK                    | 6 (7)                      |
| USA                   | 12 (13)                    |

Values in parentheses are percentages.

Hernia morphology

Significant variation exists in the reporting and assessment of hernia morphology (Table 5). The site of the hernia was reported in 25 studies: six prospective cohort studies, three RCTs and 16 retrospective cohort studies. Recommended EHS guidelines for the classification of incisional hernia were only used in seven studies. A total of 15 prospective cohort studies, 10 RCTs and 35 retrospective cohort studies reported hernia defect size, using a variety of definitions. The most common definition used was defect surface area, with 11 studies reporting this metric. Surface area was calculated using the length and width dimensions of the hernia, with these measurements assessed during the operation in two studies, clinically in the supine position in two studies and using preoperative CT imaging in two studies. Twenty-five studies reported the mode of assessment of hernia defect size with preoperative clinical assessment reported by four studies, CT in 10 studies, with one study reserving CT for use in hernia defect size greater than 10 cm, CT or ultrasound scan (USS) in two studies, USS in two studies and intraoperative assessment in 11 studies. Loss of domain was reported by six studies. A total of 12 studies reported on grade of incisional hernia, with three prospective studies and five retrospective studies employing the Ventral Hernia Working group classification.

Recurrent incisional hernia

Recurrent incisional hernia outcomes were reported by 37 studies: 11 prospective cohort studies, three RCTs and 23 retrospective cohort studies. The number of previous incisional hernia repairs were documented by 12 studies alone, with detail on mesh use provided in 16 studies and mesh placement in 12 studies. Use of previous component separation was reported in five studies. Use of adjunctive measures, such as botox or preoperative pneumoperitoneum, was reported in four studies.

Operative variables

Operative variables were reported in the majority of studies, with mode and timing of surgery reported in 83 (90 per cent) and 42 (46 per cent) studies respectively (Table 6). The majority of studies (21 per cent) reported outcomes on open incisional hernia repair (57 studies, 62 per cent), 19 studies reported outcomes on laparoscopic incisional hernia repair, 15 (16 per cent) reported on both open and laparoscopic repair and one (1 per cent) reported on a hybrid procedure. Elective hernia repair was reported in 25 studies (27 per cent), emergency repair in three (3 per cent) and a combination of elective and emergency in six (7 per cent). Operative technique, including mesh use, mesh placement and fixation, were reported by the majority of studies. Outcomes pertaining to use of specialist techniques, including component separation (24 studies, 26 per cent), use of adjuncts (8 studies, 9 per cent) and intra-abdominal pressure monitoring (2 studies, 2 per cent), were poorly reported.

Postoperative outcomes

Postoperative morbidity was reported by 82 studies (89 per cent) (Table 7), with this outcome defined as 30-day morbidity in 17 studies (18 per cent). Generic postoperative complications, including respiratory, cardiovascular, thromboembolic and gastrointestinal, were reported by a third of studies. Specific postoperative complications were more widely reported, with wound infection (68 studies, 74 per cent) and seroma formation (60 studies, 65 per cent) being the most commonly reported. Skin necrosis and mesh infection were significantly under-reported, with only 12 (13 per cent) and eight (9 per cent) studies respectively, reporting these outcomes.

Significant variation was demonstrated in defining postoperative complications. Wound infection was defined in 10 studies, with a total of eight different definitions employed (Table 8). Four different definitions for seroma formation were identified (Table 9). Of the five studies reporting mesh infection, only two studies provided a comprehensive definition. Complications were graded in 17 studies, with 12 studies providing detail on classification/grading systems. Postoperative mortality was reported in 23 studies (29 per cent), with two studies documenting the time frame in which this outcome was measured. Re-operation and re-intervention rate were reported in 31 (33 per cent) and 25 (28 per cent) studies respectively.
Follow-up

Time to follow-up was reported in 81 studies (88 per cent), with a variety of time points reported for follow-up ranging from 14 days to 137 months. Hernia recurrence was the only long-term outcome reported in the majority of studies, with recurrence rate reported in 80 studies (87 per cent) \( (\) \). A total of nine different definitions for detecting hernia recurrence were identified, of which four were based on clinical examination, one on patient or physician reporting, two on combined clinical and radiological examination and two on radiological examination alone (Table 10).

Patient-reported outcomes

PROs were evaluated in 31 studies (34 per cent): 11 prospective cohort studies, nine RCTs and 11 retrospective cohort studies. A variety of patient-reported outcome measures (PROMs) were used, including ten ad hoc measures, two disease-specific measures and eight generic measures (Table 11). Fourteen studies were designed as cross-sectional studies assessing PROs as a one-off assessment ranging from 3–49 months after surgery. Sixteen studies were designed as longitudinal studies. Thirteen studies provided baseline data and only three studies provided long-term data beyond 3 years.

Pain was evaluated in 39 studies (42 per cent): 17 prospective cohort studies, nine RCTs and 16 retrospective cohort studies. Pain was assessed at variable time points using a variety of measurement tools. The majority of studies assessing pain employed a pain scale, however a total of seven different types of pain scale were used to assess pain scores. Only one study used a disease-specific assessment measure to assess pain-related outcomes \( ^{14} \). Twenty-three studies were designed as longitudinal studies, with 15 studies providing baseline data and two studies providing long-term data at 5 years.

Discussion

Incisional hernia surgery is a complex surgical entity, which requires comprehensive assessment and planning prior to selecting the correct operative strategy to improve patient symptoms and quality of life whilst limiting morbidity and reducing the risk of recurrence. Study reporting pertaining to incisional hernia should reflect all component parts of this process of clinical decision making and management. At present reporting standards for incisional hernia do not appropriately reflect this complexity. There is a huge emphasis on reporting clinical outcomes, with the most commonly reported outcomes being mesh use and placement, hernia recurrence and postoperative complications, with significant under-reporting of patient selection criteria, hernia morphology and PROs. Coupled with this there is significant heterogeneity in the manner in which they are defined, with multiple differing definitions for a number of key outcomes.

Hernia recurrence was a primary endpoint in 14 studies and was reported overall in 80 studies (87 per cent). Despite this outcome being widely reported, the majority of studies failed to define how recurrence was defined; of the 32 studies (35 per cent) that defined hernia recurrence, a total of nine definitions were
identified. Only one of these nine definitions relied on patient- and/or professional-led reporting of recurrence. The remaining studies used a mixture of differing clinical assessment and radiological evaluation to determine recurrence. Postoperative complications were also widely reported, with 82 studies (87 per cent) reporting this outcome, however, the time frame in which
this outcome was assessed was reported by only two studies, and the severity of complications by 17 (18 per cent). There is significant under-reporting of important postoperative complications, such as wound infection, seroma formation and mesh infection. Furthermore, when these outcomes are reported, there is significant heterogeneity in the definitions employed to determine their incidence. Wound infection was reported in 68 studies (74 per cent), of which nine studies defined this outcome measure using a total of eight different definitions. Wound infection has previously been documented to be poorly reported in surgical trials, both as a primary and secondary endpoint, due to a lack of standardized definition. This consequently reduces the measurement properties of this outcome due to the variation in definition across studies, thus leading to variable detection rates of the outcome.

There is significant under-reporting of important preoperative factors regarding optimal patient selection and indication for surgical intervention. More than half of the identified studies included in this review failed to report co-morbid status, BMI, ASA grade, smoking status and steroid use. These important parameters are recognized risk factors for adverse events in surgical intervention. Due to a lack of previously being documented to be poorly reported in surgical trials, both as a primary and secondary endpoint, due to a lack of standardized definition. This consequently reduces the measurement properties of this outcome due to the variation in definition across studies, thus leading to variable detection rates of the outcome.

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Table 8 Reported definitions for wound infection

| Author              | Definitions                                                                 |
|---------------------|-----------------------------------------------------------------------------|
| Peres et al.        | Infectious cellulitis, treated with local measures and changing antibiotics  |
| Bittner et al.      | Centers for Disease Control and Prevention classification                   |
| Kaafarani et al.    | Deep wound infection defined as purulent suppuration                        |
| Westphalen et al.   | Redness or purulent wound secretion                                          |
| Strambu et al.      | Superficial SSI defined as clinical signs of cutaneous wound infection in need of antibiotic or bedside treatment; deep SSI as wound infection surgically drained in the operating ward |
| Pajtak et al.       | Superficial infections occurred mainly during the early postoperative period (the first 10–14 days); they generally evolved in the subcutaneous dead space associated with a serohematic collection and had a favourable evolution after the application of conservative measures. Deep juxtagastric infections, with a significant local and general response, required wide opening of the prosthetic bed, repeated antiseptic lavage in the focus, targeted antibiotic therapy and exhibited a favourable slow progress over 3 to 8 weeks. |
| Rogmark et al.      | Wound complications were reported as surgical site occurrences, defined as any wound complication (haematoma, superficial and deep wound infection, abscess, seroma, fistula and wound dehiscence). Infectious wound complications were reported separately as SSIs, defined as abscess, infected seroma, superficial or deep wound infection |
| Ion et al.          | Superficial infections occurred mainly during the early postoperative period (the first 10–14 days); they generally evolved in the subcutaneous dead space associated with a serohematic collection and had a favourable evolution after the application of conservative measures. Deep juxtagastric infections, with a significant local and general response, required wide opening of the prosthetic bed, repeated antiseptic lavage in the focus, targeted antibiotic therapy and exhibited a favourable slow progress over 3 to 8 weeks. |
| Mommers et al.      | Wound complications were reported as surgical site occurrences, defined as any wound complication (haematoma, superficial and deep wound infection, abscess, seroma, fistula and wound dehiscence). Infectious wound complications were reported separately as SSIs, defined as abscess, infected seroma, superficial or deep wound infection |
| Moreno-Egea et al. | Wound infection was defined as redness, discharge of pus from the wound or a positive bacterial culture |

SSI, surgical site infection.

Table 9 Reported definitions for seroma formation

| Author             | Definition                                                                 |
|--------------------|-----------------------------------------------------------------------------|
| Rogmark et al.     | A fluid accumulation in need of aspiration/surgical intervention           |
| Munegato et al.    | Morales–Conde classification                                                |
| Pajtak et al.      | Ultrasound scan proven                                                       |
| Moreno-Egea et al. | Seroma was defined as a fluid collection detected by palpation on clinical examination when patients attended for routine follow-up clinic appointments |

incisional hernia repair and help decision making and risk stratification when considering the optimal operative strategy in incisional hernia repair. The lack of detail regarding patient physiology and co-morbid status fails to provide clear guidance on patient selection, thus limiting the clinical application of the obtained results, and further contributing to the heterogeneity observed in clinical practice.

PROs are of particular relevance and importance in the benign disease setting whereby the main goals of treatment are to improve quality of life and symptom control. This is not reflected in the current literature for incisional hernia surgery, with only a third of studies reporting PROs, pain-related outcomes and hernia-related symptoms. Furthermore, a PRO was the primary endpoint in only nine studies. In contrast, a third of studies reported a clinical outcome as the primary endpoint, thus highlighting the greater emphasis on clinician-centric outcomes in this cohort of patients. Coupled with the under-reporting of PROs, there are significant methodological drawbacks associated with the design of the studies reporting these outcomes. These include the lack of use of validated, disease-specific measures for hernia surgery combined with the lack of baseline and longitudinal data and consistent assessment time points. The Carolinas Comfort Scale (CCS) and the HerQLes measures were the only disease-specific measures identified to assess quality of life and were used in only five studies. The CCS is a well designed, validated outcome measure for use in patients undergoing hernia repair. The Americas Hernia Society Quality Collaborative pain questionnaire was the only disease-specific measure used to assess pain in patients undergoing ventral hernia repair. Disease-specific measures have the ability to detect subtle differences between patient and treatment groups, which generic measures may potentially miss. The use of hernia-specific PROMs should be advocated when reporting PROs in this cohort of patients. Designing methodologically robust studies with appropriate PRO assessment is key to better outcome reporting. Alongside this, high-quality reporting of PROs is paramount to the clinical interpretation and utility of these complex outcome measures.

A number of clinical guidelines exist within the field of incisional hernia repair and help decision making and risk stratification when considering the optimal operative strategy in incisional hernia repair. The lack of detail regarding patient physiology and co-morbid status fails to provide clear guidance on patient selection, thus limiting the clinical application of the obtained results, and further contributing to the heterogeneity observed in clinical practice.

Table 10 Reporting for hernia recurrence

| Modality of detection for hernia recurrence | Frequency reported (n = 92) |
|-------------------------------------------|----------------------------|
| Clinical                                  | 7 (8)                      |
| Clinical defined as any palpable or detected fascial defect located within 7 cm of the hernia repair | 1 (1)                      |
| Clinical and CT                           | 12 (13)                    |
| Clinical – a recurrent hernia was diagnosed when a fascial defect could be palpated when lifting the head from the examination table to raise the abdominal pressure | 1 (1)                      |
| Clinical/USS/CT                           | 3 (3)                      |
| CT                                         | 4 (4)                      |
| Defined as a hernia discovered by clinical examination at 1 year | 1 (1)                      |
| Patient/professional reported             | 1 (1)                      |
| USS                                        | 3 (3)                      |

Values in parentheses are percentages. USS, ultrasound scan.
The development of a COS in incisional hernia has a number of advantages, including standardization of outcomes reporting through the inclusion of a minimum number of key outcomes in all incisional hernia-related research which are of equal importance to patients and clinicians. This will in turn lead to transparent, consistent and robust reporting between studies. A COS in incisional hernia can be used in a number of ways, including in clinical and epidemiological studies, in RCTs, integration into current national and international hernia registries and to aid robust evidence synthesis and comparison through systematic reviews and meta-analysis. Standardizing reporting outcomes methodology will help strengthen the evidence base in incisional hernia surgery and will aid the development and delivery of future high-quality research.

The main limitations of the present study include the inclusion of literature limited to the English language; this may have led to missing important outcomes relevant to an international audience. The second key limitation is that assessment of the current evidence was limited to published literature and did not include grey literature, including published guidelines. This may have a potential impact on the outcomes identified in this systematic review.

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### References

1. van Ramshorst GH, Eker HH, Hop WC, Jeekel J, Lange JF. Impact of incisional hernia on health-related quality of life and body image: a prospective cohort study. *Am J Surg* 2012; 204:144–150

2. Holihan JL, Nguyen DH, Flores-Gonzalez JR, Alawadi ZM, Nguyen MT, Ko TC et al. A systematic review of randomized controlled trials and reviews in the management of ventral hernias. *J Surg Res* 2016; 204: 311–318

3. Bhangu A, Singh P, Pinkney T, Blazeby JM. A detailed analysis of outcome reporting from randomised controlled trials and meta-analyses of inguinal hernia repair. *Hernia* 2015; 19: 65–75

4. Parker SG, Wood CPJ, Butterworth JW, Boulton RW, Plumb AAP, Mallett S et al. A systematic methodological review of reported perioperative variables, postoperative outcomes and hernia recurrence from randomised controlled trials of elective ventral hernia repair: clear definitions and standardised datasets are needed. *Hernia* 2018; 22: 215–226

5. Muysoms FE, Deerenberg EB, Peeters E, Agresta F, Berrevoet F, Campanelli G et al. Recommendations for reporting outcome results in abdominal wall repair: results of a Consensus meeting in Palermo, Italy, 28–30 June 2012. *Hernia* 2013; 17: 423–433

6. Parker SG, Halligan S, Erotopcrtitou M, Wood CPJ, Boulton RW, Plumb AAP et al. A systematic methodological review of non-randomised intervention studies of elective ventral hernia repair: clear definitions and a standardised minimum dataset are needed. *Hernia* 2019; 23: 859–872

7. Gargon E. The COMET (Core Outcome Measures in Effectiveness Trials) Initiative. *Maturitas* 2016; 91: 91–92

8. Centre for Reviews and Dissemination. *Systematic Reviews: CRD’S Guidance for Undertaking Reviews in Health Care*. York: CRD, 2009.

9. Higgins JGS. *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0* (updated March 2011). Cochrane, 2011.

10. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gotzsche PC, Ioannidis JP et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *J Clin Epidemiol* 2009; 62: e1–34

11. Sterne JA, Hernan MA, Reeves BC, Savovic J, Berkman ND, Viswanathan M et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ* 2016; 355: i4919
12. Ahonen-Siirtola M, Nevala T, Vironen J, Kössi J, Pinta T, Niemeläinen S et al. Laparoscopic versus hybrid approach for treatment of incisional ventral hernia: a prospective randomized multicenter study of 1-month follow-up results. Hernia 2018;22:1015–1022

13. Ahonen-Siirtola M, Nevala T, Vironen J, Kössi J, Pinta T, Niemeläinen S et al. Laparoscopic versus hybrid approach for treatment of incisional ventral hernia: a prospective randomised multicentre study, 1-year results. Surg Endosc 2020;34:88–95

14. Aliotta RE, Gatherwright J, Krpata D, Rosenblatt S, Rosen M, Hirshberg A et al. Two-year patient-related outcome measures (PROM) of primary ventral and incisional hernia repair using a novel three-dimensional composite polyester monofilament mesh: the SymChro registry study. Hernia 2019;23:205–215

15. Gillion JF, Lepere M, Barrat C, Cas O, Dabrowski A, Jurczak F et al. Procedural and clinical outcomes of the components separation technique in the repair of complex abdominal wall hernias: experience from the Cambridge Plastic Surgery Department. Int Surg Today 2019;4(4):757–765

16. Feng MP, Baucom RB, Broman KK, Harris DA, Holzman MD, Huang LG et al. Early repair of ventral incisional hernia may improve quality of life after surgery for abdominal malignancy: a prospective observational cohort study. Hernia 2019;23:81–90

17. Iljin A, Antoszewski B, Zielinski T, Skulimowski A, Szymański D, Strzelczyk J. Sublay or onlay incisional hernia repair along with abdominoplasty: which is better? Long-term results. Hernia 2019;23(4):757–765

18. Licari L, Guercio G, Campanella S, Scerrino G, Bonventre S, Tutino R et al. Clinical and functional outcome after abdominal wall incisional hernia repair: evaluation of quality-of-life improvement and comparison of assessment scales. World J Surg 2019;43:1914–1920

19. Juvany M, Hoyuela C, Carvajal F, Trias M, Martrat A, Ardid J. Early repair of ventral incisional hernia may improve quality of life after surgery for abdominal malignancy: a prospective observational cohort study. Hernia 2019;23:81–90

20. Renard Y, de Mesiter L, Henriques J, de Boissieu P, de Mesiter P, Fingerhut A et al. Absorbable polyglactin vs. non-cross-linked porcine biological mesh for the surgical treatment of incisional hernia. J Gastrentest Surg 2020;24:435–443

21. Bogom M, Montgomery A. Long-term follow-up of retromuscular incisional hernia repairs: recurrence and quality of life: reply. World J Surg 2018;42:2684–2685

22. Sañó F, Tokumura H, Narushima Y, Matsumura N, Sato K, Okazaki Y. The quality of life after laparoscopic ventral and incisional hernia repair with closure and non-closure of fascial defect. Surg Today 2019;49:942–947

23. Adékoun S, Pantelides NM, Hall NR, Praseedom R, Malata CM. Indications and outcomes of the components separation technique in the repair of complex abdominal wall hernias: experience from the Cambridge Plastic Surgery Department. Eplasty 2013;13:e47

24. Ah-Kee EY, Kallachil T, O’Dwyer PJ. Patient awareness and symptoms from an incisional hernia. Int Surg 2014;99:241–246

25. Akinci M, Yilmaz KB, Kulah B, Seker GE, Ugurlu C, Kulacoglu H. Association of ventral incisional hernias with comorbid diseases. Chirurgia 2013;108:807–811

26. Alicuben ET, De Meester SR. Onlay ventral hernia repairs using porcine non-cross-linked dermal biologic mesh. Hernia 2014;18:705–712

27. Arer IM, Yabanoglu H, Aytaç HO, Ezer A, Caliskan K. Long-term results of retromuscular hernia repair: a single center experience. Pan Afr Med J 2017;27:132

28. Bogetti P, Boriani F, Gravante G, Milanese A, Ferrando PM, Baglioni E. A retrospective study on mesh repair alone vs. mesh repair plus pedicle flap for large incisional hernias. Eur Rev Med Pharmacol Sci 2012;16:1847–1852

29. Eker H, Hansson B, Buunen M, Janssen I, Pierik R, Hop W et al. Laparoscopic vs open incisional hernia repair: a randomized clinical trial. JAMA Surg 2013;148(3):259–263

30. Ferrarese AG, Martino V, Enrico S, Falcone A, Catalano S, Giovin E et al. Laparoscopic repair of wound defects in the elderly: our experience of 5 years. BMC Surg 2013;13:523

31. Gangurda AG, Palade RS. Surgical treatment of large median incisional hernia using the prosthetic mesh introduced behind the rectus abdominis muscle sheath procedure (Rives-Stoppa procedure). J Med Life 2014;7:412–414

32. Gangurda AG, Palade RS. Tactical and surgical techniques in the surgical treatment of incisional hernias. J Med Life 2014;7:428–432

33. Garcia A, Baldoni A. Complex ventral hernia repair with a human acellular dermal matrix and component separation: a case series. Ann Med Surg (Lond) 2015;4:271–278

34. Lambrecht JR, Vaktskjold A, Trondsen E, Øyen OM, Reiertsen O. Laparoscopic ventral hernia repair: outcomes in primary versus incisional hernias: no effect of defect closure. Hernia 2015;19:479–486

35. Lautsch JC, Rick S, Loh JC, Grone J, Buhr HJ, Ritz JP. Oligosymptomatic vs. symptomatic incisional hernias – who benefits from open repair? Langenbecks Arch Surg 2011;396:179–185

36. Memon AA, Khan A, Zafar H, Murtaza G, Zaidi M. Repair of large and giant incisional hernia with onlay mesh: perspective of a tertiary care hospital of a developing country. Int J Surg 2013;11:41–45

37. Meyer R, Häge A, Zimmermann M, Bruch HP, Keck T, Hoffmann M et al. Is laparoscopic treatment of incisional and recurrent hernias associated with an increased risk for complications? Int J Surg 2015;19:121–127

38. Mommers EHH, Leenders BJM, Leclercq WKG, de Vries Reilingh TS, Charbon JA. A modified Chevrel technique for ventral hernia repair: long-term results of a single centre cohort. Hernia 2017;21:591–600

39. Montori G, Coccolini F, Manfredi R, Ceresoli M, Campanati L, Magnone S et al. One year experience of swine dermal non-crosslinked collagen prostheses for abdominal wall repairs in elective and emergency surgery. World J Emerg Surg 2015;10:28

40. Moreno-Egea A, Campillo-Soto A, Morales-Cuenca G. Does abdominoplasty add morbidity to incisional hernia repair? A randomized controlled trial. Surg Innov 2016;23:474–480

41. Moreno-Egea A, Carrillo-Alcaraz A, Soria-Alejo V. Randomized clinical trial of laparoscopic hernia repair comparing titanium-coated lightweight mesh and medium-weight composite mesh. Surg Endosc 2013;27:231–239

42. Munegato G, Fei L, Schiano di Visconte M, Da Ros D, Moras L, Bellio G. A new technique for tension-free reconstruction in large incisional hernia. Updates Surg 2017;69:485–491

43. Nockolds CL, Hodde JP, Rooney PS. Abdominal wall reconstruction with components separation and mesh reinforcement in complex hernia repair. BMC Surg 2014;14:25

44. Olmi S, Stefano O, Cesana G, Giovanni C, Sagutti L, Luca S et al. Laparoscopic incisional hernia repair with fibrin glue in select patients. JSLS 2010;14:240–245

45. Oprea V, Matei Q, Leucă D, Gheorghescu D, Mic A, Buia F et al. Late results and quality of life after Rives-Stoppa repair for
incisional hernias: a prospective clinical study. *Chirurgia (Bucur)* 2013;108:679–683

46. Oprea V, Radu VG, Moga D. Transversus abdominis muscle release (TAR) for large incisional hernia repair. *Chirurgia (Bucur)* 2016;111:535–540

47. Colak E, Ozlern N, Kucuk GO, Aktrimur R, Kesmer S, Yildirim K. Prospective randomized trial of mesh fixation with absorbable versus nonabsorbable tack in laparoscopic ventral incisional hernia repair. *Int J Clin Exp Med* 2015;8:21611–21616

48. Ozturk G, MalyaFU, Ersavas C, Ozdenkaya Y, Rektasoglu H, Cipe G et al. A novel reconstruction method for giant incisional hernia: hybrid laparoscopic technique. *J Minim Access Surg* 2015;11:267–270

49. Pajtak A, Stare R, Biskup I, Lukic A, Skorjanec S, Hrzenjak et al. A modified open intraperitoneal mesh (Garestin) technique for incisional ventral hernia repair. *Asim J Surg* 2017;40:278–284

50. Peres MA, Aguiar HR, Andreollo NA. Surgical treatment of sub-costal incisional hernia with polypropylene mesh – analysis of late results. *Rev Col Bras Cir* 2014;41:82–86

51. Poelman MM, Langenhorst BL, Schellekens JF, Schreurs WH. Modified onlay technique for the repair of the more complicated incisional hernias: single-centre evaluation of a large cohort. *Herna* 2010;14:369–374

52. Qadri SJ, Khan M, Wani SN, Nazir SS, Rather A. Laparoscopic and open incisional hernia repair using polypropylene mesh – a comparative single centre study. *Int J Surg* 2010;8:479–483

53. Rogmark P, Petersson U, Bringman S, Eklund A, Ezra E, Sevonius D et al. Short-term outcomes for open and laparoscopic midline incisional hernia repair: a randomized multicenter controlled trial: the proLOVE (prospective randomized trial on open versus laparoscopic operation of ventral eventrations) trial. *Ann Surg* 2013;258:37–45

54. Rogmark P, Petersson U, Bringman S, Ezra E, Osterberg J, Montgomery A. Quality of life and surgical outcome 1 year after open and laparoscopic incisional hernia repair: proLOVE: a randomized controlled trial. *Ann Surg* 2016;263:244–250

55. Romanowska M, Okniński T, Pawlak J. Hybrid technique for postoperative ventral hernias – own experience. *Wideochir Inne Tech Malzowne* 2016;10:534–540

56. Schoenmaeckers EJ, Raymakers JF, Rakic S. Complications of laparoscopic correction of abdominal wall and incisional hernias. *Ned Tijdschr Geneeskd* 2010;154:A2390

57. Strâmbu V, Radu P, Brâncuș M, Garofil D, Iorga C, Iorga R et al. Rives technique, a gold standard for incisional hernias – our experience. *Chirurgia (Bucur)* 2013;108:46–50

58. Bittner JG, Alrefai S, Vy M, Mabe M, Del Prado PAR, Clingempeel NL. Comparative analysis of open and robotic transversus abdominis release for ventral hernia repair. *Surg Endosc* 2018;32:727–734

59. Brescia A, Tomassini F, Berardi G, Pezzatini M, Dall’Oglio A, Pindozzi F et al. Post-incisional ventral hernia repair in patients undergoing chemotherapy: improving outcomes with biological mesh. *World J Surg Oncol* 2016;14:257

60. Broër M, Verdaasdonk E, Karsten T. Components separation technique combined with a double-mesh repair for large midline incisional hernia repair. *World J Surg* 2011;35:2399–2402

61. Han JG, Pang GY, Wang ZJ, Zhao Q, Ma S2. The combined application of human acellular dermal matrix and vacuum wound drainage on incarcerated abdominal wall hernias. *Int J Surg* 2014;12:452–456

62. Hopson SB, Miller LE. Open ventral hernia repair using ProGrip self-gripping mesh. *Int J Surg* 2015;23:137–140

63. Hornby ST, McDermott FD, Coleman M, Ahmed Z, Bunni J, Bunting D et al. Female gender and diabetes mellitus increase the risk of recurrence after laparoscopic incisional hernia repair. *Ann R Coll Surg Engl* 2015;97:115–119

64. Lambrecht JR, Skuby M, Tronsden E, Vaktksjold A, Øyen OM. Laparoscopic repair of incisional hernia in solid organ-transplanted patients: the method of choice? *Transpl Int* 2014;27:712–720

65. Ion D, Stoian RV, Bolocan A, Cucu A, Serban MB, Paduraru DN. Is prosthetic repair of the abdominal wall in clean-contaminated surgical interventions possible? *Chirurgia (Bucur)* 2013;108:855–858

66. Itani KM, Hur K, Kim LT, Anthony T, Berger DH, Reda D et al. Comparison of laparoscopic and open repair with mesh for the treatment of ventral incisional hernia: a randomized trial. *Arch Surg* 2010;145:322–328

67. Jensen KK, Munim K, Kjaer M, Jorgensen LN. Abdominal wall reconstruction for incisional hernia optimizes truncal function and quality of life: a prospective controlled study. *Ann Surg* 2017;265:1235–1240

68. Khansa I, Janis JE. Abdominal wall reconstruction using retrorectus self-adhering mesh: a novel approach. *Plast Reconstr Surg Glob Open* 2016;4:e1145

69. Köckerling F, Schug-Paß C, Reinpold, J, Heimdemer, B. Is pooled data analysis of ventral and incisional hernia repair acceptable? *Front Surg* 2015;2:19

70. Köhler G, Weitzendorfer M, Kalcher V, Emmanuel K. Synthetic mesh repair for incisional hernia treatment in high-risk patients for surgical site occurrences. *Am Surg* 2015;81(4):387–394

71. Kong W, Wang J, Mao Q, Ren L, Zhang S, Yao D et al. Early- versus late-onset prosthetic mesh infection: more than time alone. *Indian J Surg* 2015;77:1154–1158

72. Kumar V, Rodrigues G, Ravi C, Kumar S. A comparative analysis on various techniques of incisional hernia repair – experience from a tertiary care teaching hospital in South India. *Indian J Surg* 2013;75:271–273

73. Ladurner R, Chiapponi C, Linhuber Q, Mussack T. Long-term outcome and quality of life after open incisional hernia repair – light versus heavy weight meshes. *BMC Surg* 2011;11:25

74. Zhu X, Tian W, Li J, Sun P, Pei L, Wang S. Repair of concomitant incisional and parastomal hernias using a hybrid technique: a series of 32 patients. *Med Sci Monit* 2015;21:2079–2083

75. Zafar H, Zaidi M, Qadir I, Memon AA. Emergency incisional hernia repair: a difficult problem waiting for a solution. *Ann Surg Innov Res* 2012;6:1

76. Venclauskas L, Maleckas A, Kiudelis M. One-year follow-up after incisional hernia treatment: results of a prospective randomized study. *Hernia* 2010;14:575–582

77. Vannelli A, Battaglia L, Rampa M, Boati P, Putorti A, Pelleriti D et al. Wall defects after abdominoperineal resection: a modified tension-free technique. *Tumori* 2011;97:323–327

78. Udo IA, Bassey EA, Ahasiattai AM. Early outcome of incisional hernia repair using polypropylene mesh: a preliminary report. *Niger Med J* 2014;55:333–337
94. Nguyen D, Shahzad K, Pathak S, Oomen CM, Nunes QM, Smart N. Parietex™ composite mesh versus DynaMesh. Ann R Coll Surg Engl 2016;98:568–573
95. Cavallaro G, Campanile F, Rizzello M, Greco F, Iorio O, Angelis D et al. Laparoscopic incisional hernia repair by lightweight polypropylene mesh with resorbable coating. Technical notes, preliminary results. Chirurgia (Bucur) 2013;108:304–311
96. Clay L, Stark B, Gunnarsson U, Strigård K. Full-thickness skin graft vs. synthetic mesh in the repair of giant incisional hernia: a randomized controlled multicenter study. Hernia 2018;22:325–332
97. Demetrashvili Z, Pipia I, Loladze D, Metreveli T, Ekaladze E, Vennarecci G, Guglielmo N, Pelle F, Felli E, Ettorre GM. The use of Pernaco™ surgical implant for subxiphoid incisional hernia repair in cardiac transplant patients. Int J Surg 2015;21:68–69
98. Pawlak M, Hilgers RD, Bury K, Lehmann A, Owczuk R, Śmietański M. Comparison of two different concepts of mesh and fixation technique in laparoscopic ventral hernia repair: a randomized controlled trial. Surg Endosc 2016;30:1188–1197
99. Ayvazoglu E KM, Yıldırım M, Moray G, Haberal M. Incisional hernia after liver transplantation. Exp Clin Transplant 2017;15:185–189
100. Papa F, Rosca O, Georgescu A, Cannistra C. Reconstruction of the abdominal wall in anatomical plans: pre- and postoperative keys in repairing ‘cold’ incisional hernias. Clujul Med 2016;89:117–121
101. Saeed NIS, Shaikh BA, Baqai F. Comparison between onlay and sublay methods of repair of incisional hernia. J Post Med Inst 2014;28:400–403
102. Sikar HE, Çetin K, Eyvaz K, Kaptanoglu L, Kıcık H. Laparoscopic repair of large supraumbilical hernias. Wiadochir Inne Tech Maloinwazyjne 2017;12:245–250
103. Stojiljković D, Kovacević P, Stojiljković I, Mihajlović A, Stevanović G, Stojiljković P et al. Comparative analysis of autodermal graft and polypropylene mesh use in large incisional hernia defects reconstruction. Vojnosanit Pregl 2013;70(2):182–188.
104. Gondal SH, Anjum IH, Khelifi RAK, Usman B, Saleem, S. Sutureless sublay mesh hernioplasty in incisional hernia repair, a new gold standard in hernioplasty. Pakistan J Medical Health Sci. 2012;6:915–917
105. de Mesquita GHA, Iuamoto LR, Suguita FY, Essu FF, Oliveira LT, Torsani MB et al. Simple technique of subxiphoid hernia correction carries a low rate of early recurrence: a retrospective study. BMC Surg 2017;17:51
106. Nguyen D, Szmolstein S, Ordonez A, Dip F, Rajan M, Menzo EL et al. Unidirectional barbed sutures as a novel technique for laparoscopic ventral hernia repair. Surg Endosc 2016;30:764–769
107. Rogmark P, Smedberg S, Montgomery A. Long-term follow-up of retromuscular incisional hernia repairs: recurrence and quality of life. World J Surg 2018;42:974–980
108. Bueno-Lledó J, Torregrosa A, Arguelles B, Carreño O, García P, Bonafé S et al. Progrip self-gripping mesh in Rives-Stoppa repair: are there any differences in outcomes versus a retromuscular polypropylene mesh fixed with sutures? A ‘case series’ study. Int J Surg Case Rep 2017;34:60–64
109. Hegab B, Abdelfattah MR, Azzam A, Al Sebayel M. The usefulness of laparoscopic hernia repair in the management of incisional hernia following liver transplantation. J Minim Access Surg 2016;12:58–62
110. Kaafarani HM, Kaufman D, Reda D, Itani KM. Predictors of surgical site infection in laparoscopic and open ventral incision herniorrhaphy. J Surg Res 2010;163:229–234
111. Yildirim M, Engin O, Karademir M, Hoser A, Calik B. Is repair of incisional hernias by polypropylene mesh a safe procedure? Med Princ Pract 2010;19:129–132
112. Yannam GR, Gunti TL, High R, Stevens RB, Thompson JS, Morris MC. Experience of laparoscopic incisional hernia repair in cardiac and/or pancreas transplant recipients. Am J Transplant 2011;11:279–286
113. Westphalen AP, Araújo AC, Zacharias P, Rodrigues ES, Fracaro GB, Lopes Filho GJ. Repair of large incisional hernias. To drain or not to drain. Randomized clinical trial. Acta Cir Bras 2015;30:844–851
114. Verhelst J, de Goede B, Kleinrensink GJ, Jeekel J, Lange JF, van Eeghem KHA. Open incisional hernia repair with a self-gripping retromuscular Parietex mesh: a retrospective cohort study. Int J Surg 2015;13:184–188
115. Rickert A, Kienle P, Kuthe A, Baumann P, Engemann R, Kuhlhatz J et al. A randomised, multi-centre, prospective, observer and patient blind study to evaluate a non-absorbable polypropylene mesh vs. a partly absorbable mesh in incisional hernia repair. Langenbecks Arch Surg 2012;397:1225–1234
116. Rogmark P, Ekberg O, Montgomery A. Long-term retromuscular and intraperitoneal mesh size changes within a randomized controlled trial on incisional hernia repair, including a review of the literature. Hernia 2017;21:687–696
117. Lautscher J, Rieck S, Loh J, Grone J, Buhr H, Ritz J-P. Oligosymptomatic vs. symptomatic incisional hernias – who benefits from open repair? Langenbecks Arch Surg 2011;396:179–185
118. Schoenmaeckers EJ, Wassenaar EB, Raymakers JT, Rakic S. Bulging of the mesh after laparoscopic repair of ventral and incisional hernias. JSLS 2010;14:541–546
119. Saeed N, Iqbal S, Shaikh B, Baqai F. Comparison between onlay and sublay methods of mesh repair of incisional hernia. J Postgrad Med Inst 2014;28:400–403
120. Bittner J, El-Hayek K, Strong A, LaPinska M, Yoo J, Pauli E et al. First human use of hybrid synthetic/biologic mesh in ventral hernia repair: a multicenter trial. Surg Endosc 2017;32:1123–1130
121. Matthews JH, Bhandari S, Chapman SJ, Nepogodiev D, Pinkney T, Banghu A. Underreporting of secondary endpoints in randomized trials: cross-sectional, observational study. Ann Surg 2016;264:982–986
122. Pereira JA, Montcusi B, Lopez-Canu M, Hernandez-Granados P, Fresno de Prado L, Miembros del registro EVEREG. Risk factors for bad outcomes in incisional hernia repair: Lessons learned from the National Registry of Incisional Hernia (EVEREG). Cir Esp 2018;96:436–442
123. Nardi M Jr, Millo P, Brachet Contul R, Lorusso R, Uasi A, Grivon M et al. Laparoscopic ventral hernia repair with composite mesh: analysis of risk factors for recurrence in...
185 patients with 5 years follow-up. Int J Surg 2017;40:38–44

112. Kaoutzanis C, Leichtle SW, Mouawad NJ, Welch KB, Lampman RM, Wahl WL et al. Risk factors for postoperative wound infections and prolonged hospitalization after ventral/incisional hernia repair. Hernia 2015;19:113–123

113. Heniford BT, Lincourt AE, Walters AL, Colavita PD, Belyansky I, Kercher KW et al. Carolinas comfort scale as a measure of hernia repair quality of life: a reappraisal utilizing 3788 international patients. Ann Surg 2018;267:171–176

114. Krpata DM, Schmotzer BJ, Flocke S, Jin J, Blatnik JA, Ermlich B et al. Design and initial implementation of HerQLes: a hernia-related quality-of-life survey to assess abdominal wall function. J Am Coll Surg 2012;215:635–642

115. Poulose BK, Roll S, Murphy JW, Matthews BD, Todd Heniford B, Voeller G et al. Design and implementation of the Americas Hernia Society Quality Collaborative (AHSSC): improving value in hernia care. Hernia 2016;20:177–189

116. Patrick DL, Deyo RA. Generic and disease-specific measures in assessing health status and quality of life. Med Care 1989;27:S217–S232

117. Muysoms FE, Miserez M, Berrevoet F, Campanelli G, Champault GG, Chelala E et al. Classification of primary and incisional abdominal wall hernias. Hernia 2009;13:407–414

118. Ventral Hernia Working Group; Breuing K, Butler CE, Fierzoco S, Franz M, Hultman CS, Kilbridge JF et al. Incisional ventral hernias: review of the literature and recommendations regarding the grading and technique of repair. Surgery 2010;148:544–558