Methodological overview of systematic reviews to establish the evidence base for emergency general surgery

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Background: The evidence for treatment decision-making in emergency general surgery has not been summarized previously. The aim of this overview was to review the quantity and quality of systematic review evidence for the most common emergency surgical conditions.

Methods: Systematic reviews of the most common conditions requiring unplanned admission and treatment managed by general surgeons were eligible for inclusion. The Centre for Reviews and Dissemination databases were searched to April 2014. The number and type (randomized or non-randomized) of included studies and patients were extracted and summarized. The total number of unique studies was recorded for each condition. The nature of the interventions (surgical, non-surgical invasive or non-invasive) was documented. The quality of reviews was assessed using the AMSTAR checklist.

Results: The 106 included reviews focused mainly on bowel conditions (42), appendicitis (40) and gallstone disease (17). Fifty-one (48.1 per cent) included RCTs alone, 79 (74.5 per cent) included at least one RCT and 25 (23.6 per cent) summarized non-randomized evidence alone. Reviews included 727 unique studies, of which 30.3 per cent were RCTs. Sixty-five reviews compared different types of surgical intervention and 27 summarized trials of surgical versus non-surgical interventions. Fifty-seven reviews (53.8 per cent) were rated as low risk of bias.

Conclusion: This overview of reviews highlights the need for more and better research in this field.

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Paper accepted 30 November 2016
Published online in Wiley Online Library (www.bjs.co.uk). DOI: 10.1002/bjs.10476

Introduction

Unplanned, urgent and emergency surgery are terms used to describe the work undertaken by surgeons to manage a diverse and challenging group of pathologies linked by the need for unscheduled, non-elective treatment. Attempts have been made to reach consensus regarding the primary conditions that represent emergency general surgical diagnoses, treated by general surgeons. They may include upper and lower gastrointestinal tract pathology, hepatopancreatobiliary disease, appendicitis, anorectal soft tissue infections and abdominal wall hernias. These conditions comprise a substantial healthcare burden, accounting for 7 per cent of all US hospital admissions (equating to over 4 million inpatient encounters per year) and 50 per cent of a general surgeon’s workload. In the UK, the most frequently performed emergency general surgical operations are incision and drainage of abscess, appendicectomy and cholecystectomy, whereas abdominal infections and bowel obstructions (with or without ischaemia) contribute the majority of operative workload. A recent study from the USA found that the seven most frequent operations, which accounted for 80 per cent of emergency surgical procedures, were partial colectomy, small bowel resection, cholecystectomy, operative management of peptic ulcer disease, lysis of peritoneal adhesions, appendicectomy and laparotomy. Recent reports from the Royal College of Surgeons of England found the delivery of unplanned and urgent general surgical care to be suboptimal with wide variations in outcomes, such as mortality, between hospitals. Similarly, studies from the USA have reported that outcomes of emergency and urgent abdominal surgery are variable and poorly measured. Reports highlighted the urgent need for well designed and conducted research to inform decision-making, underpin national guidelines and influence health policy.
The first step towards generating well designed research is to understand the current volume, quality and breadth of evidence. Evidence may take the form of primary research studies, ideally RCTs assessing effectiveness of treatments, health economic evaluations assessing cost-effectiveness, or diagnostic studies comparing diagnostic procedures. Systematic reviews of evidence enable primary research studies investigating a common question to be summarized and assessed. Overviews of reviews are a recognized method of compiling and assessing the findings from multiple systematic reviews into one accessible and usable summary, which can then be used to identify evidence gaps and prioritize future research. The aim of this study, therefore, was to undertake an overview of systematic reviews in unplanned general surgery to obtain an understanding of the volume and quality of current evidence.

**Methods**

This study is the first part of a larger body of work which includes: an overview of reviews of intervention studies; an overview of reviews of diagnostic studies; and a review of economic evaluation and cost-effectiveness studies in unplanned and urgent general surgery. The review protocol is published in the PROSPERO systematic review register (CRD42015014198). Methods relating to the search strategies and study selection (which were common to all 3 parts of this work), and other methods specific to the intervention reviews, are described below.

**Inclusion criteria**

Systematic reviews of interventions for patients with a condition of interest (see below), requiring unplanned and emergency treatment by general surgeons and published in English, were eligible. A systematic review was defined as one that made a documented attempt to identify studies addressing a research question of interest, with or without a statistical summary of included studies (meta-analysis).

**Participants, conditions and interventions of interest**

Unplanned, urgent and emergency general surgery is a large clinical area. This overview therefore focused on the most common conditions managed by general surgeons in emergency settings, based on data from the Hospital Episode Statistics database in the UK, and the Royal College of Surgeons report. These are inflammatory, obstructive or ischaemic conditions affecting the small or large bowel; appendicitis; gallstone disease; peptic ulcer disease; anorectal soft tissue infections; and abdominal wall hernias. Reviews of acute trauma treated by general surgeons were excluded. All surgical, non-surgical invasive (for example radiological and endoscopic) and non-invasive (such as pharmacological) interventions were included as long as the condition was considered to be managed predominantly by general surgeons. For example, endoscopic or pharmacological interventions for bleeding peptic ulcer disease were excluded (being initially and primarily managed by gastroenterologists), whereas surgical interventions for the same condition were included. Care pathways and interventions for postoperative complications were excluded. Reviews reporting combined details of elective and urgent interventions were excluded unless the results could be extracted separately. Paediatric reviews (patients aged less than 16 years) were excluded. Also excluded were reviews where the sole purpose was to compare patients with different characteristics (such as different disease severity) all undergoing the same intervention.

**Search methods for identification of reviews**

The following databases were searched from inception to April 2014: DARE (Database of Abstracts of Reviews of Effects), NHS EED (NHS Economic Evaluation Database) and HTA (Health Technology Assessments). In addition, the PROSPERO systematic reviews register was searched within the same time frame. Full search strategies are shown in Appendix S1 (supporting information). No language restrictions were imposed at the search stage. Search hits were downloaded to a citation management program and duplicate records removed.

**Data collection and analysis**

**Selection of reviews**

Titles and abstracts of search hits were screened independently by two reviewers with clinical expertise in the conditions of interest. Records with discrepant decisions were rescreened by a senior reviewer whose decision was final. More complex clinical queries were referred to senior members of the research team. Full papers were obtained for all relevant records (including those deemed unclear at the abstract stage) and assessed for inclusion by two reviewers independently, based on prespecified criteria (Appendix S2, supporting information). Disagreements were discussed and, if unresolved, a senior reviewer cast a final decision. When several versions of Cochrane reviews were identified, only the most recent was included. If there was more than one publication of an identical review (for example a Cochrane review and a journal version including the same papers), only the most detailed was included.
Data extraction and management

Data were extracted on a prespecified form that was piloted by two authors (Appendix S3, supporting information). For approximately one-third of papers, data extraction was completed independently by two reviewers. As agreement was good, for subsequent reviews one reviewer extracted the data and another checked the extraction. Disagreements were resolved as described above.

The following information was extracted: basic bibliographic details; key review methods; start and end dates of the searches; types and number of included studies (RCTs, non-randomized studies) and patients; the nature of interventions and comparators; and all synthesized outcomes. Where meta-analyses were available, these were documented. Data were entered and stored in a custom-made electronic database.

Assessment of methodological quality of the systematic reviews

Before the review began, three tools for quality assessment of reviews were piloted: Overview Quality Assessment Questionnaire (OQAQ)\(^\text{15}\), AMSTAR (a measurement tool with 11 items, specifically used to assess systematic reviews)\(^\text{16}\), and one proposed by Li and colleagues\(^\text{12}\). AMSTAR was selected as it was developed and validated specifically for the assessment of methodological quality of systematic reviews, and was the easiest to apply (Part G; Appendix S3, supporting information). However, it does not provide guidance on how to integrate the 11 items into an overall risk-of-bias judgement. A previously described method was therefore used\(^\text{17}\) in which reviews were considered to be at low risk of bias, and thus of high methodological quality, if the following four items were satisfied: a comprehensive literature search; assessment of the scientific quality of the included studies; appropriate use of quality assessments in formulating review conclusions; and appropriate use of methods to combine findings. Reviews failing to meet one or more of these criteria were considered to be at high risk of bias. If insufficient details were provided to permit judgement on one or more items, a review was deemed to be at unclear risk\(^\text{17}\). The AMSTAR criteria were applied independently by two reviewers and disagreements resolved through discussion.

Data synthesis

Included reviews were summarized descriptively by each condition, including the number of reviews, and the number and type of included studies (RCTs or non-randomized studies). Conditions of the small and large bowel are heterogeneous, but they were summarized together because in the emergency setting these conditions (such as bowel obstruction, colitis and diverticulitis) are frequently managed by general surgeons. The number of included patients was documented for each review. To examine the overall volume of evidence, the total number of unique primary studies and their design were recorded for each condition (thus avoiding double-counting of the same studies cited in multiple reviews). The nature of the interventions (surgical, non-surgical invasive (endoscopic or radiological) or non-invasive) was documented and mapped by study design to identify evidence gaps. Details about outcomes of specific reviews are not reported here and will be the focus of subsequent disease-specific publications.

Results

Searches identified 4362 hits; 607 were considered potentially relevant and, of these, 555 were obtained and read in full. The remaining 52 papers were not assessed; seven could not be obtained (withdrawn, superseded or could...
Table 1 Descriptions of systematic reviews by condition of interest

| Condition                        | No. of reviews | No. of studies in reviews* | No. of RCTs in reviews | No. of patients in reviews | No. of patients in included RCTs |
|----------------------------------|----------------|-----------------------------|------------------------|-----------------------------|----------------------------------|
| Bowel conditions                 | 42             | 9 (5–16; 0–98)              | 2 (0–4; 0–9)           | 509 (233–878; 0–3975)       | 78 (0–315; 0–1074)               |
| Appendicitis                     | 40             | 10 (5–17; 0–57)             | 5 (1–15; 0–56)         | 1235 (744–2277; 0–57 851)   | 701 (0–1381; 0–5896)             |
| Gallstone disease                | 17             | 5 (3–10; 1–53)              | 3 (1–6; 0–28)          | 488 (272–678; 51–3659)      | 388 (63–595; 0–3659)             |
| Peptic ulcer disease             | 4              | 9 (3–15; 3–15)              | 3 (2–4; 2–4)           | 487 (296–999; 289–1113)     | 252 (178–308; 166–315)          |
| Anorectal soft tissue infection   | 2              | 6 (5–6; 5–6)                | 6 (5–6; 5–6)           | 442 (405–479; 405–479)      | 442 (405–479; 405–479)           |
| Abdominal wall hernia            | 1              | 8                           |                        |                             |                                  |

Values are median (i.q.r.; range). *Includes all types of study design.

Table 2 Characteristics of included reviews and numbers of RCTs by types of intervention

| Types of intervention compared | Surgical treatments | Surgery versus non-surgical invasive treatments | Surgery versus non-invasive treatments | Non-surgical invasive versus non-invasive treatments | Non-surgical invasive treatments | Non-invasive treatments |
|--------------------------------|---------------------|-----------------------------------------------|----------------------------------------|-----------------------------------------------|---------------------------------|-------------------------|
| Bowel conditions (42 reviews, 47 RCTs) | 14 reviews 8 RCTs | 14 reviews 12 RCTs | 4 reviews 0 RCTs | 1 review 0 RCTs | 2 reviews 8 RCTs | 7 reviews 21 RCTs |
| Appendicitis (40 reviews, 106 RCTs)     | 33 reviews 100 RCTs | 11 reviews 47 RCTs | 2 reviews 3 RCTs | 4 reviews 7 RCTs | 0 | 0 |
| Gallstone disease (17 reviews, 57 RCTs) | 11 reviews 47 RCTs | 2 reviews 3 RCTs | 0 | 0 | 0 | 0 |
| Peptic ulcer disease (4 reviews, 4 RCTs) | 4 reviews 4 RCTs | 0 | 0 | 0 | 0 | 0 |
| Anorectal soft tissue infection (2 reviews, 6 RCTs) | 2 reviews 6 RCTs | 0 | 0 | 0 | 0 | 0 |
| Abdominal wall hernia (1 review, 0 RCTs)  | 1 review 0 RCTs | 0 | 0 | 0 | 0 | 0 |
| Total (106 reviews, 220 RCTs)            | 65 reviews 165 RCTs | 16 reviews 15 RCTs | 11 reviews 6 RCTs | 5 reviews 7 RCTs | 2 reviews 8 RCTs | 7 reviews 21 RCTs |

Number of reviews and number of unique RCTs included in reviews are shown. Non-surgical invasive treatments include all endoscopic or radiological procedures; non-invasive treatments include all pharmacological interventions (such as antibiotics, intravenous fluid regimens). *Two RCTs were included in multiple reviews across two different intervention comparisons (surgical versus surgical treatments and surgical versus non-surgical invasive treatments) and were therefore included in both intervention categories. †Review included 25 non-randomized case series (no comparator) reporting outcomes from a total of 315 patients. ‡Surgery versus radiological treatments. §Review included 17 non-randomized case series studies (no comparator) reporting outcomes from a total of 28 patients, of which only 8 single-patient case reports were in emergency settings.

Characteristics of included reviews

The included 106 reviews focused on bowel conditions (42 reviews)18–59, appendicitis (40)60–99, gallstone disease (17)100–116, peptic ulcer disease (4)117–120, anorectal soft tissue infections (2)121,122 and abdominal wall hernias (1)123. The reviews of bowel conditions encompassed a diverse group of conditions that included bowel obstructions, colitis, ischaemia and diverticulitis. The 106 reviews included a median of 8 studies (i.q.r. 5–15), although two reviews33,66 were empty (no eligible studies were identified). The 106 reviews summarized results from 727 unique papers, of which 220 were RCTs (30·3 per cent). Seventy-nine reviews (74·5 per cent) included at least one RCT, 51 (48·1 per cent) included exclusively RCTs and 25 (23·6 per cent) summarized solely non-randomized evidence. The highest number of included RCTs was in reviews of appendicitis (106 of 176 included studies in this category); there were just four unique RCTs in peptic ulcer disease, and none in abdominal wall hernia. The median number of patients included in the reviews varied between conditions, from eight for abdominal wall hernia to 1235 for appendicitis. The median number of patients in the RCTs included in the reviews also varied, from zero for abdominal wall hernia to 701 for appendicitis. Detailed descriptions of the systematic reviews by condition are provided in Table 1.
Interventions summarized in the reviews

Most reviews summarized studies comparing different types of surgical treatment (65 reviews, 165 unique RCTs) (Table 2). For some conditions (peptic ulcer disease, anorectal soft tissue infections and abdominal wall hernia) no other types of review were identified. Just seven reviews (including 21 unique RCTs) compared different types of non-invasive treatment, all for bowel conditions managed by general surgeons. Reviews of non-surgical invasive treatments (such as endoscopic or radiological interventions) were identified only for bowel and gallstone disease, and few reviews examined the evidence for surgical versus non-surgical treatment (whether invasive or non-invasive).

Methodological quality of reviews

The methodological quality of the reviews was variable, meeting between one and ten AMSTAR items (median 7, i.q.r. 5–9). Just over half (57, 53 per cent) met all four of the key AMSTAR items and were thus considered at low risk of bias. Common reasons for being assessed as high risk were failure to apply quality assessment of included studies (31, 29 per cent), not conducting a comprehensive literature search (16, 15 per cent), and using inappropriate methods to combine the studies statistically, or combining when it was not appropriate to do so (30, 28 per cent). The majority of reviews (85 of 106, 80 per cent) included one or more meta-analyses. Most reviews (11 of 17) about gallstone disease were rated as low risk of bias, as were the two reviews of anorectal soft tissue infection; the sole hernia review was rated as high risk of bias. Detailed assessments of methodological quality are shown in Table 3.

Discussion

This synthesis included 106 systematic reviews summarizing evidence for unplanned, urgent and emergency general surgery. Although good numbers of reviews were available for bowel conditions and appendicitis (42 and 40 respectively), the summarized evidence for the treatment of emergency hernias and anorectal soft tissue infections was sparse. Evidence from RCTs was most prevalent in reviews of gallstone disease and appendicitis, and least prevalent in bowel conditions. Similarly, gallstone disease and appendicitis had the highest number of large RCTs (over 500 participants). The quality of included reviews was variable, with just over half being rated as low risk of bias. There was a paucity of RCTs comparing surgery and non-surgical interventions (whether these were invasive or non-invasive). It is recommended that future research is prioritized in the areas where there are limited numbers of well designed and conducted RCTs and systematic reviews.

Understanding the state of current evidence and areas where it is lacking is a valuable exercise to map the evidence base, and inform commissioning of primary and secondary research. It also highlights the need to provide educational research opportunities for general surgeons themselves. The observed lack of evidence may be representative of an unfamiliarity with trials, collaborative working and...
the need for high-quality evidence. Provision of facilities for research training and opportunities to participate in well designed studies is therefore recommended. Over the past decade this issue has partially been addressed by the Royal College of Surgeons surgical trials initiative. Several multicentre trainee-led studies have been successfully designed, conducted and reported. Once these trainees complete their surgical training the opportunity for more research will escalate, and the collective experiences and knowledge will equip the surgical community to undertake more difficult trials in the emergency general surgical setting.

Overviews of evidence are an important tool for prioritization of any future research. Overviews of systematic reviews may provide opportunities for considerable cost savings if their findings are used to focus future research efforts and reduce research waste (for example by identifying that a question has already been answered and does not require further research). The quality of primary studies and their syntheses should be considered in this process. Historically, RCTs have not been undertaken readily in surgery because of methodological issues with blinding and intervention complexity. These are compounded in the emergency surgical setting, with particular challenges to recruitment and data collection. Although little is known about how to optimize data collection in this setting, a recent study has examined the feasibility of collecting patient-reported outcome data during unplanned hospital admissions. It found that, with specific research support during the working week, good baseline response rates to questionnaires could be achieved.

Another area for further work is to identify whether there are primary RCTs in the areas where no reviews were identified. It is possible that RCTs have been undertaken but not yet reviewed. In some areas the reason for a lack of reviews will be the lack of primary studies, and future work should focus on conducting good-quality RCTs to provide answers to clinical questions.

Non-English-language studies were excluded for logistical reasons and this means that some reviews were likely missed. However, multiple reviews were identified for most topics, usually with overlapping trials. It is thus reasonable to assume that most topics for which reviews are conducted will have at least one review published in English. Some reviews had been published multiple times but the duplicate publications were not always identical. Duplicate publications were removed where possible, but when the two publications differed, both were included.

The evidence base for the care of some patients requiring emergency treatment by general surgeons is poor. Evidence for emergency hernia repair and treatment of anorectal abscess is currently particularly sparse. There is also a lack of comparative evidence to inform clinical decisions regarding invasive versus non-invasive interventions in this setting, where patients may be high risk and may benefit from less invasive treatment options. Although these types of trial may be particularly difficult to undertake, they are key to influencing practice and should be encouraged. It is therefore recommended that focused and better multicentre studies are undertaken.

Collaborators

J. Savović (J.S.)*†, N. Blencowe (N.S.B.)* and J. Blazeby (J.M.B.)*‡, designed the study, wrote the protocol and together led the project, which was conceived by J.M.B.* J.S. and N.S.B. designed the screening and data extraction forms. N.S.B. developed systematic literature searches. J.S. oversaw the review process, resolved discrepancies, constructed tables and figures and wrote the main body of the manuscript. N.S.B., Sean Strong (S.S.)* and Noah Howes (N.H.)* screened abstracts and full papers, resolved discrepancies and checked data extractions. N.S.B. and S.S. made substantial contributions to the writing of the manuscript and tables. J.S., K. Chalmers (K.C.)* and K. Whale* designed the database for data collection and carried out full paper screening and data extraction. K.C. also completed data analyses, managed the database for the review and contributed to the manuscript. N.H., J. Crichton*, L. Gould*, S. Kariyawasam*, J. Mason*, V. Pegna*, S. Richards’, C. Rowlands* and D. Stevens* wrote sections of the study protocol and contributed to the study design, screened abstracts and full papers, extracted data, resolved discrepancies and checked data extractions. All authors read and approved the final manuscript.

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Acknowledgements

The authors thank A. Jones for data entry work and A. Richards for literature searching. This study received infrastructure support from the Medical Research Council ConDuCT-II Hub (Collaboration and innovation for Difficult and Complex randomized controlled Trials In Invasive procedures – MR/K025643/1) and the Bristol Royal College of Surgeons of England Surgical Trials Centre. J.S.
was funded partly by a NIHR Collaboration for Leadership in Applied Health Research and Care West. N.S.B. is a NIHR Clinical Lecturer and J.M.B. a NIHR Senior Investigator. The views expressed are those of the authors and not necessarily those of the National Health Service, the NIHR or the Department of Health.

Disclosure: The authors declare no conflict of interest.

References

1. Shafi S, Aboutanos MB, Agarwal S Jr, Brown CV, Crandall M, Feliciano DV et al. Emergency general surgery: definition and estimated burden of disease. J Trauma Acute Care Surg 2013; 74: 1092–1097.
2. Gale SC, Shafi S, Dombrovskiy VY, Arumugam D, Crystal JS. The public health burden of emergency general surgery in the United States: a 10-year analysis of the Nationwide Inpatient Sample 2001 to 2010. J Trauma Acute Care Surg 2014; 77: 202–208.
3. Royal College of Surgeons of England. Emergency Surgery: Standards for Unscheduled Surgical Care. RCSENG – Professional Standards and Regulation, 2011. https://www.rcseng.ac.uk/library-and-publications/college-publications/docs/emergency-surgery-standards-for-unscheduled-care/ [accessed 9 January 2017].
4. Scott JW, Olufajo OA, Brat GA, Rose JA, Zogg CK, Haider AH et al. Use of national burden to define operative emergency general surgery. JAMA Surg 2016; 151: e160480.
5. Royal College of Surgeons of England, Department of Health. The Higher Risk Surgical Patient: Towards Improved Care for a Forgotten Group. RCSENG – Professional Standards and Regulation, 2011. https://www.rcseng.ac.uk/library-and-publications/college-publications/docs/the-higher-risk-general-surgical-patient/ [accessed 9 January 2017].
6. Saunders DI, Murray D, Pichel AC, Varley S, Peden CJ; UK Emergency Laparotomy Network. Variations in mortality after emergency laparotomy: the first report of the UK Emergency Laparotomy Network. Br J Anaesth 2012; 109: 368–375.
7. Becher RD, Hoth JJ, Miller PR, Mowery NT, Chang MC, Meredith JW. A critical assessment of outcomes in emergency versus nonemergency general surgery using the American College of Surgeons National Surgical Quality Improvement Program database. Am Surg 2011; 77: 951–959.
8. Becher RD, Meredith JW, Chang MC, Hoth JJ, Beard HR, Miller PR. Creation and implementation of an emergency general surgery registry modeled after the National Trauma Data Bank. J Am Coll Surg 2012; 214: 156–163.
9. Singh JA, Christensen R, Wells GA, Suarez-Almazor ME, Buchbinder R, Lopez-Olivo MA et al. Biologics for rheumatoid arthritis: an overview of Cochrane reviews. Cochrane Database Syst Rev 2009; (4):CD007848.
10. Cochrane Collaboration. Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0, 2011. http://handbook.cochrane.org/ [accessed 9 January 2017].
11. Keus F, Gooszen HG, van Laarhoven CJ. Open, small-incision, or laparoscopic cholecystectomy for patients with symptomatic cholecystolithiasis. An overview of Cochrane Hepato-Biliary Group reviews. Cochrane Database Syst Rev 2010; (1):CD008318.
12. Li T, Vedula SS, Scherer R, Dickersin K. What comparative effectiveness research is needed? A framework for using guidelines and systematic reviews to identify evidence gaps and research priorities. Ann Intern Med 2012; 156: 367–377.
13. University of York Centre for Reviews and Dissemination. Evidence in Emergency Non-Trauma Gastrointestinal Surgery: Synthesis of Systematic Reviews; 2015. http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42015014198 [accessed 9 January 2017].
14. Health and Social Care Information Centre. Hospital Episode Statistics, Admitted Patient Care, England – 2012–13; 2013. http://content.digital.nhs.uk/catalogue/PUB12566 [accessed 9 January 2017].
15. Oxman AD, Guyatt GH, Singer J, Goldsmith CH, Hutchison BG, Milner RA et al. Agreement among reviewers of review articles. J Clin Epidemiol 1991; 44: 91–98.
16. Shea BJ, Hamel C, Wells GA, Bouter LM, Kristjansson E, Grimshaw J et al. AMSTAR is a reliable and valid measurement tool to assess the methodological quality of systematic reviews. J Clin Epidemiol 2009; 62: 1013–1020.
17. Potter S, Browning D, Savovic J, Holcombe C, Blazeby JM. Systematic review and critical appraisal of the impact of acellular dermal matrix use on the outcomes of implant-based breast reconstruction. Br J Surg 2015; 102: 1010–1025.
18. Abbas SM, Bissett IP, Parry BR. Meta-analysis of oral water-soluble contrast agent in the management of adhesive small bowel obstruction. Br J Surg 2007; 94: 404–411.
19. Watt A, Faragher I, Griffin T, Rieger N, Maddern G. Self-expanding metallic stents for relieving malignant colorectal obstruction: a systematic review. Ann Surg 2007; 246: 24–30.
20. Khanna A, Ognibene SJ, Koniaris LG. Embolization as first-line therapy for diverticulosis-related massive lower gastrointestinal bleeding: evidence from a meta-analysis. J Gastrointest Surg 2005; 9: 343–352.
21. Salem L, Flum DR. Primary anastomosis or Hartmann’s procedure for patients with diverticular peritonitis: a systematic review. Dis Colon Rectum 2004; 47: 1953–1964.
22. Kam MH, Tang CL, Chan E, Lim JF, Eu KW. Systematic review of intraoperative colon irrigation vs. manual decompression in obstructed left-sided colorectal emergencies. Int J Colorectal Dis 2009; 24: 1031–1037.
23 Sagar J. Colorectal stents for the management of malignant colonic obstructions. Cochrane Database Syst Rev 2011; (11):CD007378.

24 Kucukmetin A, Naik R, Galal K, Bryant A, Dickinson HO. Palliative surgery versus medical management for bowel obstruction in ovarian cancer. Cochrane Database Syst Rev 2010; (7):CD007792.

25 Abbas S, Bissett IP, Parry BR. Oral water soluble contrast for the management of adhesive small bowel obstruction. Cochrane Database Syst Rev 2007; (3):CD004651.

26 Suo T, Gu X, Andersson R, Ma H, Zhang W, Deng W et al. Oral traditional Chinese medicine for adhesive small bowel obstruction. Cochrane Database Syst Rev 2012; (5):CD008836.

27 Constantinides VA, Tekkis PP, Athanasiou T, Aziz O, Purkayastha S, Remzi FH et al. Primary resection with anastomosis vs. Hartmann's procedure in nonelective surgery for acute colonic diverticulitis: a systematic review. Dis Colon Rectum 2006; 49: 966–981.

28 de Korte N, Unlu G, Boermeester MA, Cuesta MA, Vrouenraets BC, Stockmann HB. Use of antibiotics in uncomplicated diverticulitis. Br J Surg 2011; 98: 761–767.

29 Tan CJ, Dasari BV, Gardiner K. Systematic review and meta-analysis of randomized clinical trials of self-expanding metallic stents as a bridge to surgery versus emergency surgery for malignant left-sided large bowel obstruction. Br J Surg 2012; 99: 469–476.

30 Feuer DJ, Broadley KE. Surgery for the resolution of symptoms in malignant bowel obstruction in advanced gynaecological and gastrointestinal cancer. Cochrane Database Syst Rev 2000; (3):CD002764.

31 Abbas S. Resection and primary anastomosis in acute complicated diverticulitis, a systematic review of the literature. Int J Colorectal Dis 2007; 22: 351–357.

32 Khot UP, Lang AW, Murali K, Parker MC. Systematic review of the efficacy and safety of colorectal stents. Br J Surg 2002; 89: 1096–1102.

33 Cirocchi R, Abrahà I, Farinella E, Montedori A, Sciannameo F. Laparoscopic versus open surgery in small bowel obstruction. Cochrane Database Syst Rev 2010; (2):CD007511.

34 Branco BC, Barm paras G, Schnüriger B, Inaba K, Chan LS, Demetriades D. Systematic review and meta-analysis of the diagnostic and therapeutic role of water-soluble contrast agent in adhesive small bowel obstruction. Br J Surg 2010; 97: 470–478.

35 Feuer DJ, Broadley KE, Shepherd JH, Barton DP. Systematic review of surgery in malignant bowel obstruction in advanced gynaecological and gastrointestinal cancer. Gynecol Oncol 1999; 75: 313–322.

36 Ghosheh B, Salameh JR. Laparoscopic approach to acute small bowel obstruction: review of 1061 cases. Surg Endosc 2007; 21: 1945–1949.

37 Feuer DJ, Broadley KE. Systematic review and meta-analysis of corticosteroids for the resolution of malignant bowel obstruction in advanced gynaecological and gastrointestinal cancers. Ann Oncol 1999; 10: 1035–1041.

38 Tilney HS, Lovegrove RE, Purkayastha S, Sains PS, Weston-Petrides GK, Darzi AW et al. Comparison of colonic stenting and open surgery for malignant large bowel obstruction. Surg Endosc 2007; 21: 225–233.

39 Zhang Y, Shi J, Shi B, Song CY, Xie WF, Chen YX. Self-expanding metallic stent as a bridge to surgery versus emergency surgery for obstructive colorectal cancer: a meta-analysis. Surg Endosc 2012; 26: 110–119.

40 Zhang Y, Shi J, Shi B, Song CY, Xie WF, Chen YX. Comparison of efficacy between uncovered and covered self-expanding metallic stents in malignant large bowel obstruction: a systematic review and meta-analysis. Color Dis 2012; 14: e367–e374.

41 Breitenstein S, Rickenbacher A, Berdajs D, Puhan M, Clavien PA, Demartines N. Systematic evaluation of surgical strategies for acute malignant left-sided colonic obstruction. Br J Surg 2007; 94: 1451–1460.

42 Toorenvliet BR, Swank H, Schoones JW, Hamming JF, Bemelman WA. Laparoscopic peritoneal lavage for perforated colonic diverticulitis: a systematic review. Color Dis 2010; 12: 862–867.

43 Bartels SA, Gardenbroek TJ, Ubink DT, Buskens CJ, Tanis PJ, Bemelman WA. Systematic review and meta-analysis of laparoscopic versus open colec tomy with end ileostomy for non-toxic colitis. Br J Surg 2013; 100: 726–733.

44 Bhangu A, Nepogodiev D, Gupta A, Torrance A, Singh P; West Midlands Research Collaborative. Systematic review and meta-analysis of outcomes following emergency surgery for Clostridium difficile colitis. Br J Surg 2012; 99: 1501–1513.

45 Cennamo V, Luigiano C, Coocolini F, Fabbri C, Bassi M, De Caro G et al. Meta-analysis of randomized trials comparing endoscopic stenting and surgical decompression for colorectal cancer obstruction. Int J Colorectal Dis 2013; 28: 855–863.

46 Cirocchi R, Farinella E, Trastulli S, Desiderio J, Listorti C, Boselli C et al. Safety and efficacy of endoscopic colonic stenting as a bridge to surgery in the management of intestinal obstruction due to left colon and rectal cancer: a systematic review and meta-analysis. Surg Oncol 2013; 22: 14–21.

47 Cirocchi R, Trastulli S, Desiderio J, Listorti C, Boselli C, Parisi A et al. Treatment of Hinchen stage III–IV diverticulitis: a systematic review and meta-analysis. Int J Colorectal Dis 2013; 28: 447–457.

48 Currie A, Christmas C, Aldean H, Mohab sheri M, Bloom IT. Systematic review of self-expanding stents in the management of benign colorectal obstruction. Colorectal Dis 2014; 16: 239–245.

49 De Ceglie A, Filiberti R, Baron TH, Ceppi M, Conio M. A meta-analysis of endoscopic stenting as bridge to surgery versus emergency surgery for left-sided colorectal cancer obstruction. Crit Rev Oncol Hematol 2013; 88: 387–403.
50 Huang X, Lv B, Zhang S, Meng L. Preoperative colonic stents versus emergency surgery for acute left-sided malignant colonic obstruction: a meta-analysis. J Gastrointest Surg 2014; 18: 584–591.

51 Li MZ, Lian L, Xiao LB, Wu WH, He YL, Song XM. Laparoscopic versus open adhesiolysis in patients with adhesive small bowel obstruction: a systematic review and meta-analysis. Am J Surg 2012; 204: 779–786.

52 Liang TW, Sun Y, Wei YC, Yang DX. Palliative treatment of malignant colorectal obstruction caused by advanced malignancy: a self-expanding metallic stent or surgery? A systematic review and meta-analysis. Surg Today 2014; 44: 22–33.

53 Liu Z, Kang L, Li C, Huang M, Zhang X, Wang J. Meta-analysis of complications of colonic stenting versus emergency surgery for acute left-sided malignant colonic obstruction. Surg Laparosc Endosc Percutan Tech 2014; 24: 73–79.

54 Shabanzadeh DM, Wille-Jørgensen P. Antibiotics for complicated diverticulitis. Cochrane Database Syst Rev 2012; (11):CD009092.

55 Stewart DB, Hollenbeak CS, Wilson MZ. Is colectomy for fulminant uncomplicated diverticulitis. Cochrane Database Syst Rev 2017; 12:CD009092.

56 Stewart DB, Hollenbeak CS, Wilson MZ. Is colectomy for fulminant Clostridium difficile colitis life saving? A systematic review. Colorectal Dis 2013; 15: 798–804.

57 Yang Z, Wu Q, Wang F, Ye X, Qi X, Fan D. A systematic review and meta-analysis of randomized trials and prospective studies comparing covered and bare self-expandable metal stents for the treatment of malignant obstruction in the digestive tract. Int J Med Sci 2013; 10: 825–835.

58 Ye GY, Cui Z, Chen L, Zhong M. Colonic stenting vs emergency surgery for acute left-sided malignant colonic obstruction: a systematic review and meta-analysis. World J Gastroenterol 2012; 18: 5608–5615.

59 Zhao XD, Cai BB, Cao RS, Shi RH. Palliative treatment for incurable malignant colorectal obstructions: a meta-analysis. World J Gastroenterol 2013; 19: 5565–5574.

60 Ansaloni L, Catena F, Coccolini F, Ercolani G, Gazzotti F, Pasqualini E et al. Surgery versus conservative antibiotic treatment in acute appendicitis: a systematic review and meta-analysis of randomized controlled trials. Dig Surg 2011; 28: 210–221.

61 Sajid MS, Khan MA, Cheek E, Baig MK. Needlescopic versus laparoscopic appendectomy: a systematic review. Can J Surg 2009; 52: 129–134.

62 Chung RS, Rowland DY, Li P, Diaz J. A meta-analysis of randomized controlled trials of laparoscopic versus conventional appendectomy. Am J Surg 1999; 177: 250–256.

63 Varadhan KK, Neal KR, Lobo DN. Safety and efficacy of antibiotics compared with appendicectomy for treatment of uncomplicated acute appendicitis: meta-analysis of randomised controlled trials. BMJ 2012; 344: e2156.

64 Gorenvi V, Dintsios CM, Schoenemarck MP, Hagen A. Laparoscopic Versus Open Appendectomy – A Systematic Review of Medical Efficacy and Health Economic Analysis. German Agency for Health Technology Assessment at the German Institute for Medical Documentation and Information: Cologne, 2006.

65 Bennett J, Boddy A, Rhodes M. Choice of approach for appendicectomy: a meta-analysis of open versus laparoscopic appendicectomy. Surg Laparosc Endosc Percutan Tech 2007; 17: 245–255.

66 Rahman I, Rao AM, Ahmed I. Single incision versus conventional multi-incision appendicectomy for suspected appendicitis. Cochrane Database Syst Rev 2011; (7):CD009022.

67 Southgate E, Voussen D, Karthikesalingam A, Markar SR, Black S, Zaidi A. Laparoscopic versus open appendicectomy in older patients. Arch Surg 2012; 147: 557–562.

68 McCall JL, Sharples K, Jadallah F. Systematic review of randomized controlled trials comparing laparoscopic with open appendicectomy. Br J Surg 1997; 84: 1045–1050.

69 Sajid MS, Rimpl J, Cheek E, Baig MK. Use of endo-GIA versus endo-loop for securing the appendicular stump in laparoscopic appendicectomy: a systematic review. Surg Laparosc Endosc Percutan Tech 2009; 19: 11–15.

70 Golub R, Siddiqui F, Pohl D. Laparoscopic versus open appendicectomy: a meta-analysis. J Am Coll Surg 1998; 186: 545–553.

71 Markides G, Subar D, Riyad K. Laparoscopic versus open appendicectomy in adults with complicated appendicitis: systematic review and meta-analysis. World J Surg 2010; 34: 2026–2040.

72 Wei B, Qi C, Chen TF, Zheng ZH, Huang JL, Hu BG et al. Laparoscopic versus open appendicectomy for acute appendicitis: a meta-analysis. Surg Endosc 2011; 25: 1199–1208.

73 Varadhan KK, Humes DJ, Neal KR, Lobo DN. Antibiotic therapy versus appendicectomy for acute appendicitis: a meta-analysis. World J Surg 2010; 34: 199–209.

74 Sauerland S, Lefering R, Holthausen U, Neugebauer E. A meta-analysis of studies comparing laparoscopic with conventional appendicectomy. In Progress in Surgery. Acute Appendicitis: Standard Treatment or Laparoscopic Surgery, Krähenbühl L, Frei E, Klaiber C, Büchler MW (eds). Kluwer Publishers: Dordrecht, 1997: 109–114.

75 Sauerland S, Jaschinski T, Neugebauer EAM. Laparoscopic versus open surgery for suspected appendicitis. Cochrane Database Syst Rev 2010; (10):CD001546.

76 Mason RJ, Moazzam A, Sohn HI, Kakhkhouda N. Meta-analysis of randomized trials comparing antibiotic therapy with appendicectomy for acute uncomplicated (no abscess or phlegmon) appendicitis. Surg Infect (Larchmt) 2012; 13: 74–84.

77 Henry MC, Moss RL. Primary versus delayed wound closure in complicated appendicitis: an international
systematic review and meta-analysis. Pediatr Surg Int 2005; 21: 625–630.
78 Simillis C, Symeonides P, Shorthouse AJ, Tekkis PP. A meta-analysis comparing conservative treatment versus acute appendectomy for complicated appendicitis (abscess or phlegmon). Surgery 2010; 147: 818–829.
79 Sauerland S, Lefering R, Holthusen U, Neugebauer EA. Laparoscopic vs conventional appendectomy: a meta-analysis of randomised controlled trials. Langenbeck Arch Chir 1998; 383: 289–295.
80 Temple LK, Litwin DE, McLeod RS. A meta-analysis of laparoscopic versus open appendectomy in patients suspected of having acute appendicitis. Can J Surg 1999; 42: 377–383.
81 Wilms IM, de Hoog DE, de Visser DC, Janzing HM. Appendectomy versus antibiotic treatment for acute appendicitis. Cochrane Database Syst Rev 2011; (11):CD008359.
82 Kim CB, Kim MS, Hong J, Lee HY, Yu SH. Is laparoscopic appendectomy useful for the treatment of acute appendicitis in Korea: a meta-analysis. Yonsei Med J 2004; 45: 7–16.
83 Li X, Zhang J, Sang L, Zhang W, Chu Z, Li X et al. Laparoscopic versus conventional appendectomy: a meta-analysis of randomized controlled trials. BMC Gastroenterol 2010; 10: 129.
84 Kazemier G, in’t Hof KH, Saad S, Bonjer HJ, Sauerland S. Securing the appendiceal stump in laparoscopic appendectomy: evidence for routine stapling? Surg Endosc 2006; 20: 1471–1476.
85 Garbutt JM, Soper NJ, Shannon WD, Botero A, Littenberg B. Meta-analysis of randomized controlled trials comparing laparoscopic and open appendectomy. Surg Laparosc Endosc 1999; 9: 17–26.
86 Markar SR, Venkat-Raman V, Ho A, Karthikesalingam A, Kinross J, Evans J et al. Laparoscopic versus open appendectomy in obese patients. Int J Surg 2011; 9: 451–455.
87 Antoniou SA, Koch OO, Antoniou GA, Lasithiotakis K, Chalkiadakis GE, Pointner R et al. Meta-analysis of randomized trials on single-incision laparoscopic versus conventional laparoscopic appendectomy. Am J Surg 2014; 207: 613–622.
88 Cai YL, Xiong XZ, Wu SJ, Cheng Y, Lu J, Zhang J et al. Single-incision laparoscopic appendectomy versus conventional laparoscopic appendectomy: systematic review and meta-analysis. World J Gastroenterol 2013; 19: 5165–5173.
89 Ciarrocchi A, Amicucci G. Laparoscopic versus open appendectomy in obese patients: a meta-analysis of prospective and retrospective studies. J Minim Access Surg 2014; 10: 4–9.
90 Ding J, Xia Y, Zhang ZM, Liao GQ, Pan Y, Liu S et al. Single-incision versus conventional three-incision laparoscopic appendicecctomy for appendicitis: a systematic review and meta-analysis. J Pediatr Surg 2013; 48: 1088–1098.
91 Gao J, Li P, Li Q, Tang D, Wang DR. Comparison between single-incision and conventional three-port laparoscopic appendectomy: a meta-analysis from eight RCTs. Int J Colorectal Dis 2013; 28: 1319–1327.
92 Gill RS, Shi X, Al-Adra DP, Birch DW, Karimali S. Single-incision appendectomy is comparable to conventional laparoscopic appendectomy: a systematic review and pooled analysis. Surg Laparosc Endosc Percutan Tech 2012; 22: 319–327.
93 Hua J, Gong J, Xu B, Yang T, Song Z. Single-incision versus conventional laparoscopic appendectomy: a meta-analysis of randomized controlled trials. J Gastrointest Surg 2014; 18: 426–436.
94 Li P, Chen ZH, Li QG, Qiao T, Tian YY, Wang DR. Safety and efficacy of single-incision laparoscopic surgery for appendectomies: a meta-analysis. World J Gastroenterol 2013; 19: 4072–4082.
95 Markar SR, Karthikesalingam A, Di Franco F, Harris AM. Systematic review and meta-analysis of single-incision versus conventional multiport appendicectomy. Br J Surg 2013; 100: 1709–1718.
96 Ohtani H, Tamamori Y, Arimoto Y, Nishiguchi Y, Maeda K, Hirakawa K. Meta-analysis of the results of randomized controlled trials that compared laparoscopic and open surgery for acute appendicitis. J Gastrointest Surg 2012; 16: 1929–1939.
97 Pisanu A, Porceddu G, Reccia I, Saha A, Uccheddu A. Meta-analysis of studies comparing single-incision laparoscopic appendectomy and conventional multiport laparoscopic appendectomy. J Surg Res 2013; 183: e49–e59.
98 Qiu J, Yuan H, Chen S, He Z, Wu H. Single-port laparoscopic appendectomy versus conventional laparoscopic appendectomy: evidence from randomized controlled trials and nonrandomized comparative studies. Surg Laparosc Endosc Percutan Tech 2014; 24: 12–21.
99 Wilarsumee C, Sukrat B, McEvoy M, Attria J, Thakkinstian A. Systematic review and meta-analysis of safety and efficacy of single-incision versus open appendectomy for suspected appendicitis in pregnancy. Br J Surg 2012; 99: 1470–1478.
100 Antoniou SA, Antoniou GA, Makridis C. Laparoscopic treatment of Mirizzi syndrome: a systematic review. Surg Endosc 2010; 24: 33–39.
101 Papi C, Catarci M, D’Ambrosio L, Gili L, Koch M, Grassi GB et al. Timing of cholecystectomy for acute calculous cholecystitis: a meta-analysis. Am J Gastroenterol 2004; 99: 147–155.
102 Uy MC, Daez ML, Sy PP, Banex VP, Espinosa WZ, Talingdan-Te MC. Early ERCP in acute gallstone pancreatitis without cholangitis: a meta-analysis. JOP 2009; 10: 299–305.
103 Gurusamy K, Samraj K, Gluud C, Wilson E, Davidson BR. Meta-analysis of randomized controlled trials on the safety and effectiveness of early versus delayed laparoscopic
cholecystectomy for acute cholecystitis. *Br J Surg* 2010; 97: 141–150.

104 Petrov MS, van Santvoort HC, Besselink MG, van der Heijden GJ, van Erpecum KJ, Gooszen HG. Early endoscopic retrograde cholangiopancreatography versus conservative management in acute biliary pancreatitis without cholangitis: a meta-analysis of randomized trials. *Ann Surg* 2008; 247: 250–257.

105 Tse F, Yuan Y. Early routine endoscopic retrograde cholangiopancreatography strategy versus early conservative management strategy in acute gallstone pancreatitis. *Cochrane Database Syst Rev* 2012; (5):CD009779.

106 Moretti A, Papic C, Aratari A, Festa V, Tango M, Koch M et al. Is early endoscopic retrograde cholangiopancreatography useful in the management of acute biliary pancreatitis? A meta-analysis of randomized controlled trials. *Dig Liver Dis* 2008; 40: 379–385.

107 Gurusamy KS, Samraj K. Routine abdominal drainage for uncomplicated open cholecystectomy. *Cochrane Database Syst Rev* 2007; (2):CD006003.

108 Gurusamy KS, Samraj K, Fusai G, Davidson BR. Early versus delayed laparoscopic cholecystectomy for biliary colic. *Cochrane Database Syst Rev* 2008; (4):CD007196.

109 Siddiqui T, MacDonald A, Chong PS, Jenkins JT. Early versus delayed laparoscopic cholecystectomy for acute cholecystitis: a meta-analysis of randomized clinical trials. *Am J Surg* 2008; 195: 40–47.

110 Winbladh A, Gullstrand P, Svansvik J, Sandstrom P. Systematic review of cholecystostomy as a treatment option in acute cholecystitis. *HPB (Oxford)* 2009; 11: 183–193.

111 Lau H, Lo CY, Patil NG, Yuen WK. Early versus delayed-interval laparoscopic cholecystectomy for acute cholecystitis: a meta-analysis. *Surg Endosc* 2006; 20: 82–87.

112 Gurusamy KS, Davidson C, Gluud C, Davidson BR. Early versus delayed laparoscopic cholecystectomy for people with acute cholecystitis. *Cochrane Database Syst Rev* 2013; (6):CD005440.

113 Gurusamy KS, Nagendran M, Davidson BR. Early versus delayed laparoscopic cholecystectomy for acute gallstone pancreatitis. *Cochrane Database Syst Rev* 2013; (9):CD010326.

114 Gurusamy KS, Rossi M, Davidson BR. Percutaneous cholecystostomy for high-risk surgical patients with acute calculous cholecystitis. *Cochrane Database Syst Rev* 2013; (8):CD007088.

115 Randial Pérez LJ, Fernando Parra J, Aldana Dimas G. The safety of early laparoscopic cholecystectomy (<48 hours) for patients with mild gallstone pancreatitis: a systematic review of the literature and meta-analysis. *Cir Esp* 2014; 92: 107–113.

116 van Baal MC, Besselink MG, Bakker OJ, van Santvoort HC, Schaapderfer AF, Niewenhuuijs VB et al. Timing of cholecystectomy after mild biliary pancreatitis: a systematic review. *Ann Surg* 2012; 255: 860–866.

117 Lunevicius R, Morkevicius M. Systematic review comparing laparoscopic and open repair for perforated peptic ulcer. *Br J Surg* 2005; 92: 1195–1207.

118 Lau H. Laparoscopic repair of perforated peptic ulcer: a meta-analysis. *Surg Endosc* 2004; 18: 1013–1021.

119 Antoniou SA, Antoniou GA, Koch OO, Pointner R, Granderath FA. Meta-analysis of laparoscopic versus open repair of perforated peptic ulcer, *JSLS* 2013; 17: 15–22.

120 Sanabria A, Villegas MI, Morales Uribe CH. Laparoscopic repair for perforated peptic ulcer disease. *Cochrane Database Syst Rev* 2013; (2):CD004778.

121 Quah HM, Tang CL, Eu KW, Chan SY, Samuel M. Meta-analysis of randomized clinical trials comparing drainage alone vs primary sphincter-cutting procedures for anorectal abscess-fistula. *Int J Colorectal Dis* 2006; 21: 602–609.

122 Malik AI, Nelson RL, Tou S. Incision and drainage of perianal abscess with or without treatment of anal fistula. *Cochrane Database Syst Rev* 2010; (7):CD006827.

123 Deeba S, Purkayastha S, Darzi A, Zacharakis E. Obturator hernias: a review of the laparoscopic approach. *J Minim Access Surg* 2011; 7: 201–204.

124 Moher D, Glasziou P, Chalmers I, Nasser M, Bossuyt PM, Korevaar DA et al. Increasing value and reducing waste in biomedical research: who’s listening? *Lancet* 2016; 387: 1573–1586.

125 Royal College of Surgeons. The Rosetrees and the RCS Surgical Trials Initiative. https://www.rcseng.ac.uk/standards-and-research/research/surgical-trials-initiative/ [accessed 9 January 2017].

126 Bhangu A, Kolias AG, Pinkney T, Hall NJ, Fitzgerald JE. Surgical research collaboratives in the UK. *Lancet* 2013; 382: 1091–1092.

127 Pinkney TD, Calvert M, Bartlett DC, Gheorghe A, Redman V, Dowswell G et al.; West Midlands Research Collaborative; ROSSINI Trial Investigators. Impact of wound edge protection devices on surgical site infection after laparotomy: multicentre randomised controlled trial (ROSSINI Trial). *BMJ* 2013; 347: f3035.

128 Strong S, Blencowe N, Bhangu A; National Surgical Research Collaborative. How good are surgeons at identifying appendicitis? Results from a multi-centre cohort study. *Int J Surg* 2015; 15: 107–112.

129 United Kingdom National Surgical Research Collaborative, Bhangu A. Safety of short, in-hospital delays before surgery for acute appendicitis: multicentre cohort study, systematic review, and meta-analysis. *Ann Surg* 2014; 259: 894–903.

130 National Surgical Research Collaborative. Multicentre observational study of performance variation in provision and outcome of emergency appendicectomy. *Br J Surg* 2013; 100: 1240–1252.

131 Rowlands C, Griffiths SN, Blencowe NS, Brown A, Hollowood A, Hornby ST et al. Surgical ward rounds in England: a trainee-led multi-centre study of current practice. *Patient Saf Surg* 2014; 8: 11.
Stevens DJ, Blencowe NS, McElnay PJ, Macefield RC, Savović J, Avery KN et al. A systematic review of patient-reported outcomes in randomized controlled trials of unplanned general surgery. World J Surg 2016; 40: 267–276.

Mason J, Blencowe NS, McNair AGK, Stevens DJ, Avery KN, Pullyblank AM et al. Investigating the collection and assessment of patient-reported outcome data amongst unplanned surgical hospital admissions: a feasibility study. Pilot Feasibility Stud 2015; 1: 16.

Supporting information

Additional supporting information may be found in the online version of this article:

Appendix S1 Search strategy (Word document)
Appendix S2 Study selection form (Word document)
Appendix S3 Data extraction form (Word document)
Appendix S4 List of excluded studies with reasons (Word document)