Meta-analysis of relaparotomy for secondary peritonitis

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Background: **Planned relaparotomy and relaparotomy on demand are two frequently employed surgical treatment strategies for patients with abdominal sepsis.**

Methods: **The available literature was evaluated to compare the efficacy of both surgical treatment strategies. A systematic search for studies comparing planned and on-demand relaparotomy strategies in adult patients with secondary peritonitis was employed. Studies were reviewed independently for design features, inclusion and exclusion criteria, and outcomes. The primary outcome measure was in-hospital mortality.**

Results: **No randomized studies were found; eight observational studies with a total of 1266 patients (planned relaparotomy, 286; relaparotomy on demand, 980) met the inclusion criteria and were included in the meta-analysis. These eight studies were heterogeneous on clinical and statistical grounds ($\chi^2 = 40{\cdot}7$, d.f. = 7, $P < 0{\cdot}001$). Using a random-effects approach, the combined odds ratio for in-hospital mortality was 0·70 (95 per cent confidence interval 0·27 to 1·80) in favour of the on-demand strategy.**

Conclusion: **The combined results of observational studies show a statistically non-significant reduction in mortality for the on-demand relaparotomy strategy compared with the planned relaparotomy strategy when corrected for heterogeneity in a random-effects model. Owing to the non-randomized nature of the studies, the limited number of patients per study, and the heterogeneity between studies, the overall evidence generated by the eight studies was inconclusive.**

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Introduction

Secondary peritonitis or abdominal sepsis is still associated with a high mortality rate of around 30 per cent, despite improvements in antibiotic treatment and intensive care facilities. Surgical treatment of secondary peritonitis is usually threefold, consisting of a laparotomy to eliminate the source of infection, peroperative peritoneal lavage to reduce bacterial load, and the prevention of persistent or recurrent infection. The last of these may be established by continuous postoperative peritoneal lavage, by leaving the abdomen open (laparostomy), or by a repetitive planned or on-demand relaparotomy strategy. Continuous postoperative lavage has failed to gain wide acceptance[1]. On the other hand, the planned and on-demand strategies are commonly used for patients with intra-abdominal infection[2–6].

The main advantages of planned relaparotomy are early detection of persistent infection or infectious complications (potentially beneficial to patient outcome) and limited adhesion formation during early relaparotomy (possibly reducing the risk of surgical complications). The advantage of relaparotomy on demand is that the procedure is limited to patients who do in fact need such treatment, preventing unnecessary operations when infection has resolved during conventional postoperative treatment. Furthermore, the on-demand strategy provides a time lapse that may allow the development of a contained infection accessible to percutaneous interventional techniques. This meta-analysis compared the effect of planned relaparotomy and relaparotomy on demand in patients with secondary peritonitis.

Patients and methods

Inclusion and exclusion criteria

For inclusion, studies were required to assess patients undergoing either a planned relaparotomy or relaparotomy on demand strategy after an initial laparotomy for secondary peritonitis, and they had to compare the planned with the on-demand strategy. In addition, in-hospital mortality data were required to be available. Articles on continuous ambulatory peritoneal dialysis (CAPD) peritonitis, peritonitis due to pancreatitis, and peritonitis in patients aged less than 18 years were excluded. CAPD peritonitis was excluded because the treatment is primarily conservative (antibiotics) and surgical treatment usually consists simply of removal of the CAPD catheter. Pancreatitis was excluded because of its initially non-infectious aetiology and the primarily non-operative treatment, although planned reoperations are performed for debridement of (infected) pancreatic necrosis[7–9]. No restrictions were applied to methodological criteria, but an evaluation of the relationship between methodological quality and outcome was undertaken.

The planned relaparotomy strategy required a decision to be made during the initial operation for secondary peritonitis to perform one or more relaparotomies every 1–3 days until no residual infection was found. The on-demand relaparotomy strategy required the performance of a relaparotomy after the initial laparotomy for peritonitis only when the clinical condition of a patient deteriorated or failed to improve. The index operation was defined as the initial laparotomy of a patient for secondary peritonitis. Secondary peritonitis was defined as intra-abdominal sepsis caused by perforation, infection, ischaemia or necrosis of part of the digestive tract or visceral organ, or peritonitis due to a postoperative complication.

Search strategy

Two authors (B.L., M.A.B.) independently performed a formal computer-assisted search of the medical databases Medline (January 1966 to January 2001, search updated until January 2002), Cochrane Database of Systematic Reviews, Cochrane Clinical Trials Register, Database of Abstracts on Reviews and Effectiveness, Current Controlled Trials, and Embase (January 1988 to January 2001). Keywords and medical subject heading (MeSH) terms used were ‘abdominal sepsis’, ‘secondary peritonitis’, ‘relaparotomy’ and ‘planned relaparotomy’; English and German clinical studies were identified. A manual cross-reference search of the eligible papers was performed to identify additional relevant articles. No unpublished data or data from abstracts were encountered or used.

Data collection

Three authors (B.L., M.A.B., J.B.R.) independently assessed selected studies and extracted data on methodology, level of evidence, population, intervention and outcome measures, and judged whether the publication met the stated inclusion criteria. The methodological quality of studies was initially evaluated using the Levels of Evidence for studies on therapies of the NHS Research and Development Centre for Evidence Based Medicine, Oxford, UK (http://www.cebm.jr2.ox.ac.uk), as originally developed by the Canadian Task Force on the Periodic Health Examination[10] in 1979.

Some key methodological issues were assessed in more detail. The allocation of a particular treatment strategy was assessed for randomization, timing and criteria used. Retrospective, prospective and secondary prospective collection of data were analysed, as well as potential adjustment for differences in prognosis. Retrospective data were defined as data extracted from patient charts or routine data sources. Prospective data were defined as specific information whose accumulation started before the index operation in specifically identified patients. Secondary prospective data were defined as for prospective data, but originating from another study or from an ongoing register.

Adjustment for differences in prognosis at the time of the index operation (baseline) was performed by design (randomization or matching), by statistical analysis (stratified analysis or modelling technique) or by exclusion of subgroups. Data on secondary outcome measures were retrieved from the included studies. Disagreements about the inclusion of studies and data extraction were resolved by group discussion. The reporting checklist proposed by the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group[11] was used as a guideline when performing this meta-analysis. Observational studies were defined as effectiveness studies using data from existing databases, cross-sectional studies, case series, case–control studies, or studies with a historical control or a cohort design[11,12].

Statistical analysis

The primary outcome measure was the odds ratio (OR) for in-hospital mortality in the individual studies. An OR of less than 1 signifies a higher risk of dying from the planned relaparotomy than from the on-demand relaparotomy strategy. Statistical heterogeneity of the included studies was assessed with the χ^2 test with $k - 1$ degrees of freedom. Estimates of the efficacy of therapies were expressed as pooled ORs using either the fixed-effects model (according to Mantel–Haenszel)[13] or the random-effects model (according to DerSimonian–Laird)[14], depending on the degree of heterogeneity of the included studies. When significant heterogeneity was found, the random-effects method was used to calculate the pooled OR. P values were calculated with the χ^2 or Fisher exact test as appropriate;

$P < 0{\cdot}05$ was considered statistically significant. Data analysis was performed using Review Manager 4·1 software (Cochrane Collaboration, Oxford, UK) and Statistical Package for the Social Sciences version 9·0 (SPSS®, Chicago, Illinois, USA).

Results

Excluded studies

The initial search yielded 181 articles, of which 161 did not meet the inclusion criteria (*Fig. 1*). The majority of excluded papers covered topics such as indications, diagnostic modalities and scoring systems for peritonitis or relaparotomy. Other excluded articles were review articles, articles on prognostic variables not including data on treatment strategy, those that compared antibiotic strategies or different lavage fluids, and those on treatment strategies for acute pancreatitis. Retrieval and assessment of the 20 candidate papers led to exclusion of a further three[15–17] because of insufficient data on the primary endpoint, and exclusion of another nine because planned relaparotomy[1,6,18–23] or relaparotomy on demand[24] was assessed in isolation, without comparison to the other strategy. No randomized clinical trial or level I evidence was encountered during the search of the literature.

Included studies

The eight articles[25–32] included in the meta-analysis are depicted chronologically in *Table 1*. The total number of patients in these studies was 1266 (planned relaparotomy,

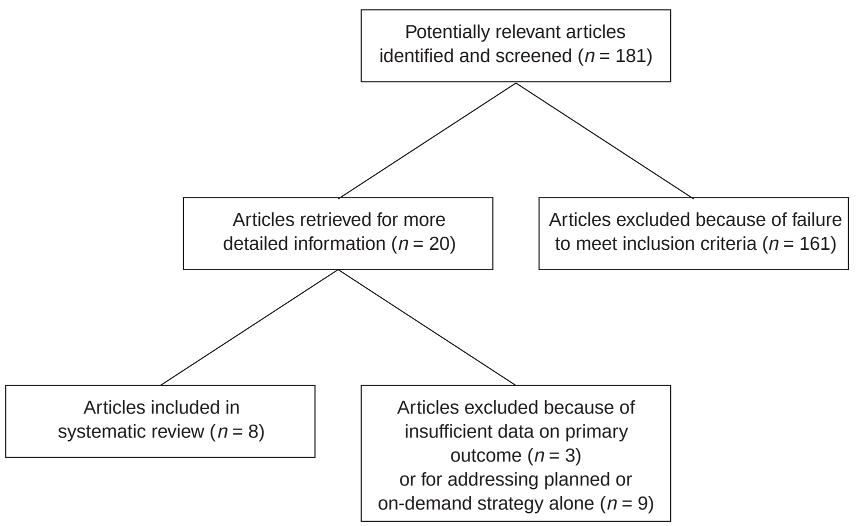

Fig. 1 Number of articles identified and evaluated during the review process

Table 1 General characteristics of included studies involving 1266 patients

Reference	Year	Country	No. of hospitals	Inclusion period	No. of patients: Planned (*n* = 286)	No. of patients: On demand (*n* = 980)
Penninckx *et al.*[30]	1983	Belgium	1	Not given	31	11
Andrus *et al.*[25]	1986	USA	1	1980–1985	34	43
Penninckx *et al.*[31]	1990	Belgium	1	Not given	44	9
Wittmann *et al.*[32]	1994	USA	12	1987	95	260
Hau *et al.*[27]	1995	Germany, Switzerland, Austria	18	1992–1993	38	38
Koperna and Schulz[28]*	1996	Austria	1	1992–1995	9	83
Grunau *et al.*[26]	1996	Germany	1	1989–1993	13	35
Koperna and Schulz[29]*	2000	Austria	1	1986–1996	22	501

*Different hospitals involved

286; relaparotomy on demand, 980), in whom 283 deaths (101 and 182 respectively) occurred. The median (range) number of patients in the on-demand strategy groups was 41 (9–501), which was higher than that of 33 (9–95) in the planned relaparotomy groups.

Clinical characteristics

The median ages in the planned and on-demand groups were similar: 53·8 and 54·0 years respectively. The male : female ratio was 1·06 in the relaparotomy on demand group and 0·87 in the planned relaparotomy group. The severity of disease was expressed by means of the Acute Physiology And Chronic Health Evaluation (APACHE) II score in four studies[26–28,32] and as an Acute Physiology Score (APS) in one study[25]. The median (range) APACHE II score was higher in the planned relaparotomy group at 15·9 (10·0–17·6) than in the on-demand relaparotomy group at 10·5 (10·0–11·8), as was the APS (21·0 *versus* 18·0). One study[31] calculated the Mannheim Peritonitis Index (MPI) score and reported similar scores for the planned and on-demand strategies (32·4 and 32·2 respectively).

Specific clinical and design characteristics of the included studies are shown in *Table 2*. The treated population ranged from patients with severe generalized peritonitis to those with intra-abdominal infection due to a postoperative complication. The median (range) percentage of patients with postoperative peritonitis was 33·6 (18·2–43·2) per cent in the planned relaparotomy group and 31·1 (9·2–51·2) per cent in the on-demand group. The median (range) percentage of patients in whom elimination of the focus of the peritonitis was successful was 86·8 (46·2–100) per cent in the planned relaparotomy group and 88·6 (86·8–89·2) per cent in the on-demand group, but this was assessed in only three studies. Two studies[25,30] excluded patients with appendicitis as a causative focus of peritonitis, whereas Koperna and Schulz[28] excluded patients with primary, pancreatic or traumatic peritonitis. In three studies no well described definition was available for the relaparotomy on demand strategy. The time interval between index operation and relaparotomy in the planned relaparotomy group in the various studies ranged from 24 h to 3 days.

Design

Assessment of the allocation of the treatment strategy showed that there were no randomized studies included in this meta-analysis (*Table 2*). Timing of allocation of the treatment strategy was at the time of the index operation in all but one study (in which timing was unclear). When the decision for a particular treatment strategy was made at the index operation, two studies reported explicit clinical criteria for the choice of treatment strategy, and in two studies the allocation was performed by surgeon (one study) or by institution (one study). In the majority of studies no details were provided on the allocation criteria used. Data collection was performed retrospectively in three studies, prospectively in three studies and secondarily prospectively in two. Adjustment for differences in prognosis was performed by exclusion of subgroups in two studies, and by stratified analysis, statistical modelling and design through matching in one study each. No adjustment for prognosis was performed in three studies.

Mortality

Mortality was expressed as in-hospital deaths in all reports. The median (range) mortality rate in the eight studies was 33 (21–77) per cent for the planned strategy and 22 (12–89) per cent for the on-demand strategy. The relative risk of both treatment strategies in individual studies ranged from 6 to 78 per cent. The test for heterogeneity of the included studies was highly significant ($\chi^2 = 40{\cdot}7$, d.f. =7, $P < 0{\cdot}001$). The effectiveness of both treatment strategies, as measured by in-hospital mortality rate, resulted in a pooled OR of 0·70 in favour of the relaparotomy on demand strategy, but with a large 95 per cent confidence interval (c.i.) ranging from 0·27 to 1·80 ($P = 0{\cdot}5$) using the random-effects model (*Fig. 2*). Stratified analysis of the five prospective studies[25–28,32] produced an OR of 0·52 (95 per cent c.i. 0·27 to 1·00; $P = 0{\cdot}05$). The four studies[26–29] published from 1995 onwards produced an OR of 0·21 (95 per cent c.i. 0·09 to 0·53; $P < 0{\cdot}001$). All other stratified analyses revealed no significant results.

Alternative endpoints

Available data on secondary outcome measures in the individual studies were scarce. Only for alternative endpoints such as the multiple organ failure (MOF), infectious complications, number of relaparotomies, duration of mechanical ventilation, intensive care unit stay and hospital stay could some data be extracted. Both Penninckx *et al.*[30] and Wittmann *et al.*[32] found a lower mortality rate for patients with MOF in the planned relaparotomy group than in the relaparotomy on demand group. Hau *et al.*[27] described a significantly lower incidence of MOF in the on-demand group than in the planned group (24 *versus* 50 per cent respectively; $P = 0{\cdot}01$), as well as fewer infectious complications in the on-demand strategy group (40 *versus* 69 per cent; $P = 0{\cdot}01$). In the planned relaparotomy group there was a mean of 2·9 relaparotomies per patient, and for relaparotomy on demand the mean was 0·5. Data on duration of mechanical ventilation, intensive care unit stay

Table 2 Clinical and design characteristics of individual studies

		Relaparotomy strategy definition		Allocation					
Reference	Patient population	Planned	On demand	Randomized	Timing	Criteria*	Data collection	Adjustment†	Endpoints other than in-hospital mortality
Penninckx *et al.*[30]	Severe generalized peritonitis from colonic or intestinal origin. Excl: appendicitis	Relaparotomy every 2–3 days	Relaparotomy when signs of sepsis reappear	No	At index	No details	Retrospective	Exclusion of subgroups	Multiorgan failure No. of relaparotomies
Andrus *et al.*[25]	Generalized intraperitoneal infection. Excl: appendicitis	Relaparotomy for more than 500 ml fluid in abdomen, until negative culture	Expectantly	No	At index	By surgeon	?Prospective	Stratified analysis	Hospital stay No. of laparotomies
Penninckx *et al.*[31]	Generalized peritonitis of colonic origin	Relaparotomy every 2 days	Relaparotomy when signs of sepsis persist or reappear	No	At index	No details	Retrospective	Exclusion of subgroups	Multiorgan failure No. of relaparotomies
Wittmann *et al.*[32]	Advanced intra-abdominal infection	One or more relaparotomies	No details	No	At index	By institution and clinical criteria provided	Prospective	Statistical model	Multiorgan failure No. of laparotomies
Hau *et al.*[27]	Intra-abdominal infection	Reoperation	No details	No	At index	No details	Secondary prospective	By design: matching	Multiorgan failure
Koperna and Schulz[28]	Secondary bacterial peritonitis. Excl: primary, pancreatic or traumatic peritonitis	Reoperation in less than 48 h	Reoperation for clinical deterioration or failure to improve	No	At index	No details	Prospective	No adjustment	—
Grunau *et al.*[26]	Postoperative intra-abdominal infection	Reoperation every 24–48 h, planned at index operation	No details	No	Unclear	No details	Secondary prospective	No adjustment	—
Koperna and Schulz[29]	Secondary peritonitis	Reoperation in less than 48 h	Reoperation for clinical deterioration or failure to improve	No	At index	Clinical criteria	Retrospective	No adjustment	—

*Description of allocation criteria when the decision was made during the index operation: no details provided (no details); explicitly stated clinical criteria (clinical criteria); by surgeon or institution (if one surgeon or institution employed planned relaparotomy strategy and others on-demand relaparotomy strategy). †To adjust for differences in prognosis at baseline (index operation) the following methods were employed: by design (randomization or matching); during statistical analysis (stratified analysis or modelling technique); exclusion of subgroups; no form of adjustment. Excl, excluded patients

Reference	Year	No. of deaths: On demand	No. of deaths: Planned	OR
Penninckx *et al.*[30]	1983	8 of 11	9 of 31	6·52 (1·40, 30·31)
Andrus *et al.*[25]	1986	25 of 43	21 of 34	0·86 (0·34, 2·16)
Penninckx *et al.*[31]	1990	8 of 9	14 of 44	17·14 (1·95, 150·67)
Wittmann *et al.*[32]	1994	54 of 260	24 of 95	0·78 (0·45, 1·35)
Hau *et al.*[27]	1995	5 of 38	8 of 38	0·57 (0·17, 1·93)
Grunau *et al.*[26]	1996	8 of 35	10 of 13	0·09 (0·02, 0·40)
Koperna and Schulz[28]	1996	14 of 83	3 of 9	0·41 (0·09, 1·82)
Koperna and Schulz[29]	2000	60 of 501	12 of 22	0·11 (0·05, 0·27)
Total		182 of 980	101 of 286	0·70 (0·27, 1·80)

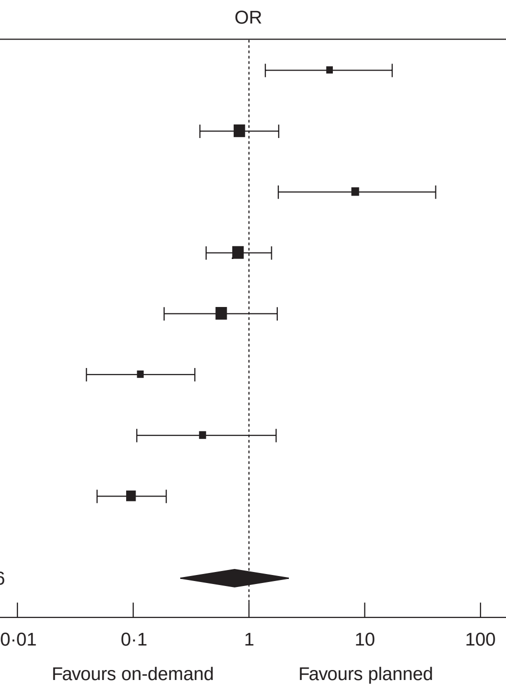

Fig. 2 Individual and pooled odds ratios (ORs) (planned *versus* on-demand relaparotomy) for the eight studies. Pooling was according to the random-effects model. Squares and bars indicate study size and confidence interval, respectively. Elongated diamond represents the confidence interval of 0·27, 1·80. Test for heterogeneity of the eight studies: $\chi^2 = 40{\cdot}7$, d.f. = 7, $P < 0{\cdot}001$; test for overall effect: $P = 0{\cdot}5$

and infectious complications were provided in insufficient detail for comparison of the two treatment strategies; one study[25] described a shorter median(s.d.) hospital stay for relaparotomy on demand than for planned relaparotomy (38(25) *versus* 46(38) days respectively).

Discussion

This meta-analysis showed that the pooled OR of in-hospital mortality is in favour of patients with secondary peritonitis treated by the relaparotomy on demand strategy. However, this apparent advantage over the planned strategy was not statistically significant because of the heterogeneity of the studies. Stratified analysis showed that the combined OR for the prospective studies, as well as for the studies published from 1995 onwards, was significantly in favour of the on-demand strategy, albeit in a subgroup analysis.

Meta-analysis of observational studies is a method of assessing the efficacy of a particular treatment. As opposed to randomized clinical trials, the methodological design of observational studies lacks randomization, resulting in heterogeneity of patient population, design and outcome[11,33]. In such circumstances the effects of confounding and publication bias must be attended to when performing any meta-analysis[34,35]. A non-randomized allocation of patients implies that surgeons prefer a treatment strategy because they believe a certain patient needs a particular treatment, thereby mixing prognosis with treatment decisions. The amount of evidence generated by the available studies was limited because of their small size, their non-randomized allocation, and the substantial differences between studies in the components of the on-demand strategy. Because of the non-randomized allocation, there is a high risk that treatment decisions are related to prognosis (confounding by indication)[36,37]. Statistical adjustment for important prognostic factors requires sufficiently large studies and sufficiently detailed publication of data. In general, the eight available studies lacked the details needed to perform such an adjustment.

The χ^2 test showed a significant heterogeneity between the included studies; variations in study design, allocation of the intervention, and definition of treatment strategy used lead to potential heterogeneity. Analysis of patient characteristics showed that only for the severity of disease, as expressed by various scoring systems, was there a possible disadvantage for patients in the planned relaparotomy groups. Other patient characteristics were equally distributed between the groups, but it must be emphasized that lack of data within the individual studies made sufficient retrieval for cumulative analysis difficult. The random-effects model was deployed to correct for heterogeneity in order to calculate the pooled OR. This model assumes a different underlying effect for each study, taking this into account as an additional source of variation[38]. Calculation of the pooled OR using the fixed-effects model in such cases would result in an artificially narrow 95 per cent confidence interval, whereas the random-effects model gives a more realistic confidence interval.

Nine studies containing potentially useful data on either the planned relaparotomy or the on-demand relaparotomy strategy were omitted from the meta-analysis because they addressed only one treatment strategy. Separate analysis of these studies showed a median (range) mortality rate of 29 (23–44) per cent for the eight studies addressing the planned strategy[1,6,18–23] and a 14 per cent mortality rate for the study addressing the on-demand strategy[24]. Formally, these studies were not part of the meta-analysis and caution should be used in drawing conclusions from these mortality rates. Uniformity of patient groups, study design, treatment and potential adverse outcome were not taken into account.

There is an evident lack of sensitivity and specificity of Medline searches in general, potentially causing selection bias[39]. To reduce this lacuna in the present search of the literature, a systematic search was performed, retrieving multiple-language articles, and a cross-reference search of eligible publications was undertaken. It is known that studies with negative results are less likely to be published[35,40] and, as a consequence, actual differences in surgical treatment strategies for peritonitis may be smaller than that calculated by accumulation of published data. In the analysis of the included studies, the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) checklist was used. This is the observational meta-analysis equivalent of the QUality Of Reporting Of Meta-analyses (QUOROM) statement of randomized clinical trials, and provides authors with a guideline for reporting the results of such analysis in the hope of improving quality[11,41].

It must be remembered that the studies available here for meta-analysis are of relatively low methodological quality, consisting of level II–IV evidence. This mirrors the reality that the surgical management of secondary peritonitis is founded on low-level evidence. This is emphasized by the lack of detailed data on alternative endpoints in the individual studies. The present meta-analysis reviews the best available evidence. Decision-making on both in the planned relaparotomy and relaparotomy on demand policies in patients with secondary peritonitis remains non-evidence-based and dependent largely on a 'gut feeling'. A planned relaparotomy strategy is frequently employed when the source of infection is not eliminated at the time of the index operation, or in the face of types of contamination or aetiological factors such as faecal soiling or ischaemia. In the relaparotomy on demand strategy, deterioration or lack of improvement is monitored by observing clinical variables, quantitative measurement of changes in organ function, and contrast-enhanced computed tomography (CT). When adhering to the more conservative on-demand strategy, frequent CT imaging to explore the possibility of percutaneous intervention and to direct surgical reintervention may be beneficial[42,43]. Furthermore, the success of the on-demand policy may depend largely on the strict definition and validation of relaparotomy criteria.

In the search for studies comparing the planned and on-demand relaparotomy strategies, no randomized clinical trial was retrieved, although a separate search for review articles on relaparotomy in abdominal sepsis[2,4,5,8,22,44–64] revealed numerous studies that have long emphasized the need for such a trial[8,59,65,66]. There is a great need for a well designed, sufficiently large, randomized trial involving clearly defined patient groups to resolve the uncertainty about the best surgical strategy in patients with abdominal sepsis. Such a multicentre randomized study is currently being carried out in The Netherlands.

References

1 Schein M, Saadia R, Freinkel Z, Decker GA. Aggressive treatment of severe diffuse peritonitis: a prospective study. *Br J Surg* 1988; **75:** 173–6.

2 Bosscha K, van Vroonhoven TJ, van der Werken C. Surgical management of severe secondary peritonitis. *Br J Surg* 1999; **86:** 1371–7.

3 Schein M. Surgical management of intra-abdominal infection: is there any evidence? *Langenbecks Arch Surg* 2002; **387:** 1–7.

4 van Goor H. Surgical treatment of severe intra-abdominal infection. *Hepatogastroenterology* 1997; **44:** 975–81.

5 Wittmann DH, Schein M, Condon RE. Management of secondary peritonitis. *Ann Surg* 1996; **224:** 10–18.

6 van Goor H, Hulsebos RG, Bleichrodt RP. Complications of planned relaparotomy in patients with severe general peritonitis. *Eur J Surg* 1997; **163:** 61–6.

7 Beger HG, Buchler M, Bittner R, Block S, Nevalainen T, Roscher R. Necrosectomy and postoperative local lavage in necrotizing pancreatitis. *Br J Surg* 1988; **75:** 207–12.

8 Nystrom PO, Bax R, Dellinger EP, Dominioni L, Knaus WA, Meakins JL *et al.* Proposed definitions for diagnosis, severity scoring, stratification, and outcome for trials on intra-abdominal infection. Joint Working Party of SIS North America and Europe. *World J Surg* 1990; **14:** 148–58.

9 Smadja C, Bismuth H. Pancreatic debridement in acute

necrotizing pancreatitis: an obsolete procedure? *Br J Surg* 1986; **73:** 408–10.
10 Canadian Task Force on the Periodic Health Examination. The periodic health examination. *Can Med Assoc J* 1979; **121:** 1193–254.
11 Stroup DF, Berlin JA, Morton SC, Olkin I, Williamson GD, Rennie D *et al.* Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. *JAMA* 2000; **283:** 2008–12.
12 Peipert JF, Phipps MG. Observational studies. *Clin Obstet Gynecol* 1998; **41:** 235–44.
13 Mantel N, Haenszel W. Statistical aspects of the analysis of data from retrospective studies of disease. *J Natl Cancer Inst* 1959; **22:** 719–48.
14 DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials* 2002; **7:** 177–88.
15 Anderson ID, Fearon KC, Grant IS. Laparotomy for abdominal sepsis in the critically ill. *Br J Surg* 1996; **83:** 535–9.
16 Christou NV, Barie PS, Dellinger EP, Waymack JP, Stone HH. Surgical Infection Society intra-abdominal infection study. Prospective evaluation of management techniques and outcome. *Arch Surg* 1993; **128:** 193–8.
17 Schein M, Gecelter G, Freinkel W, Gerding H, Becker PJ. Peritoneal lavage in abdominal sepsis. A controlled clinical study. *Arch Surg* 1990; **125:** 1132–5.
18 Bosscha K, Hulstaert PF, Visser MR, van Vroonhoven TJ, van der Werken C. Open management of the abdomen and planned reoperations in severe bacterial peritonitis. *Eur J Surg* 2000; **166:** 44–9.
19 Jiffry BA, Sebastian MW, Amin T, Isbister WH. Multiple laparotomies for severe intra-abdominal infection. *Aust N Z J Surg* 1998; **68:** 139–42.
20 Schein M. Planned reoperations and open management in critical intra-abdominal infections: prospective experience in 52 cases. *World J Surg* 1991; **15:** 537–45.
21 Bartels H, Barthlen W, Siewert JR. The therapeutic results of programmed relaparotomy in diffuse peritonitis. *Chirurg* 1992; **63:** 174–80.
22 Wittmann DH, Aprahamian C, Bergstein JM. Etappenlavage: advanced diffuse peritonitis managed by planned multiple laparotomies utilizing zippers, slide fastener, and Velcro analogue for temporary abdominal closure. *World J Surg* 1990; **14:** 218–26.
23 Teichmann W, Wittmann DH, Andreone PA. Scheduled reoperations (etappenlavage) for diffuse peritonitis. *Arch Surg* 1986; **121:** 147–52.
24 Seiler CA, Brugger L, Forssmann U, Baer HU, Buchler MW. Conservative surgical treatment of diffuse peritonitis. *Surgery* 2000; **127:** 178–84.
25 Andrus C, Doering M, Herrmann VM, Kaminski DL. Planned reoperation for generalized intraabdominal infection. *Am J Surg* 1986; **152:** 682–6.
26 Grunau G, Heemken R, Hau T. Predictors of outcome in patients with postoperative intra-abdominal infection. *Eur J Surg* 1996; **162:** 619–25.
27 Hau T, Ohmann C, Wolmershauser A, Wacha H, Yang Q. Planned relaparotomy *vs* relaparotomy on demand in the treatment of intra-abdominal infections. The Peritonitis Study Group of the Surgical Infection Society-Europe. *Arch Surg* 1995; **130:** 1193–6.
28 Koperna T, Schulz F. Prognosis and treatment of peritonitis. Do we need new scoring systems? *Arch Surg* 1996; **131:** 180–6.
29 Koperna T, Schulz F. Relaparotomy in peritonitis: prognosis and treatment of patients with persisting intraabdominal infection. *World J Surg* 2000; **24:** 32–7.
30 Penninckx FM, Kerremans RP, Lauwers PM. Planned relaparotomies in the surgical treatment of severe generalized peritonitis from intestinal origin. *World J Surg* 1983; **7:** 762–6.
31 Penninckx FM, Kerremans RP, Filez L, Ferdinande P, Schets M, Lauwers P. Planned relaparotomies for advanced, established peritonitis from colonic origin. *Acta Chir Belg* 1990; **90:** 269–74.
32 Wittmann DH, Bansal N, Bergstein JM, Wallace JR, Wittmann MM, Aprahamian C. Staged abdominal repair compares favorably with conventional operative therapy for intra-abdominal infections when adjusting for prognostic factors with a logistic model. *Theor Surg* 1994; **9:** 201–7.
33 Radford MJ, Foody JM. How do observational studies expand the evidence base for therapy? *JAMA* 2001; **286:** 1228–30.
34 Sackett DL. Bias in analytic research. *Journal of Chronic Diseases* 1979; **32:** 51–63.
35 Altman DG. *Designing Research*. London: Chapman & Hall, 1999.
36 Altman DG, Bland JM. Statistics notes. Treatment allocation in controlled trials: why randomise? *BMJ* 1999; **318:** 1209.
37 Miettinen OS. The need for randomization in the study of intended effects. *Stat Med* 1983; **2:** 267–71.
38 Egger M, Smith GD, Phillips AN. Meta-analysis: principles and procedures. *BMJ* 1997; **315:** 1533–7.
39 Dickersin K, Scherer R, Lefebvre C. Identifying relevant studies for systematic reviews. *BMJ* 1994; **309:** 1286–91.
40 Rosenthal R. The 'file drawer problem' and tolerance for null results. *Psychol Bull* 1979; **86:** 638–41.
41 Moher D, Cook DJ, Eastwood S, Olkin I, Rennie D, Stroup DF. Improving the quality of reports of meta-analyses of randomised controlled trials: the QUOROM statement. Quality of Reporting of Meta-analyses. *Lancet* 1999; **354:** 1896–900.
42 Bartels H, Theisen J, Berger H, Siewert JR. Interventional therapy of intra-abdominal abscess: outcome and limits. *Langenbecks Arch Chir Suppl Kongressbd* 1997; **114:** 956–8.
43 Cinat ME, Wilson SE, Din AM. Determinants for successful percutaneous image-guided drainage of intra-abdominal abscess. *Arch Surg* 2002; **137:** 845–9.
44 Bartlett JG. Intra-abdominal sepsis. *Med Clin North Am* 1995; **79:** 599–617.
45 Berger D, Buttenschoen K. Management of abdominal sepsis. *Langenbecks Arch Surg* 1998; **383:** 35–43.
46 Bohnen JM. Operative management of intra-abdominal infections. *Infect Dis Clin North Am* 1992; **6:** 511–23.
47 Bohnen JM, Mustard RA. A critical look at scheduled

relaparotomy for secondary bacterial peritonitis. *Surg Gynecol Obstet* 1991; **172**(Suppl)**:** 25–9.
48 Farthmann EH, Schoffel U. Principles and limitations of operative management of intraabdominal infections. *World J Surg* 1990; **14:** 210–17.
49 Gallinaro RN, Polk HC Jr. Intra-abdominal sepsis: the role of surgery. *Baillieres Clin Gastroenterol* 1991; **5:** 611–37.
50 Geroulanos S. Infectious complications and risks in abdominal surgery; early recognition and prevention. *Hepatogastroenterology* 1991; **38:** 261–71.
51 Hackford AW. Intra-abdominal sepsis: a medical–surgical dilemma. *Clin Ther* 1990; **12**(Suppl B)**:** 43–53.
52 Herman CM. Abdominal sepsis in the surgical intensive care unit. *Surg Annu* 1984; **16:** 1–12.
53 Hirshberg A, Stein M, Adar R. Reoperation. Planned and unplanned. *Surg Clin North Am* 1997; **77:** 897–907.
54 McClean KL, Sheehan GJ, Harding GK. Intraabdominal infection: a review. *Clin Infect Dis* 1994; **19:** 100–16.
55 Munson JL. Management of intra-abdominal sepsis. *Surg Clin North Am* 1991; **71:** 1175–85.
56 Nathens AB, Rotstein OD. Therapeutic options in peritonitis. *Surg Clin North Am* 1994; **74:** 677–92.
57 Reith HB. Therapy of peritonitis today. Surgical management and adjuvant therapy strategies. *Langenbecks Arch Chir* 1997; **382**(Suppl 1)**:** S14–17.
58 Rotstein OD, Meakins JL. Diagnostic and therapeutic challenges of intraabdominal infections. *World J Surg* 1990; **14:** 159–66.
59 Schein M, Hirshberg A, Hashmonai M. Current surgical management of severe intraabdominal infection. *Surgery* 1992; **112:** 489–96.
60 Schein M, Saadia R, Decker GG. The open management of the septic abdomen. *Surg Gynecol Obstet* 1986; **163:** 587–92.
61 Schein M. Management of severe intra-abdominal infection. *Surg Annu* 1992; **24:** 47–68.
62 Velmahos GC, Degiannis E, Souter I. Relaparotomies for abdominal sepsis – why, when, how? A collective review. *S Afr J Surg* 1998; **36:** 52–6.
63 Wilson SE, Faulkner K. Impact an anatomical site on bacteriological and clinical outcome in the management of intra-abdominal infections. *Am Surg* 1998; **64:** 402–7.
64 Merrell RC. The abdomen as source of sepsis in critically ill patients. *Crit Care Clin* 1995; **11:** 255–72.
65 Schein M. 'Planned' or 'on demand' relaparotomy for severe intra-abdominal infection. *S Afr J Surg* 1987; **25:** 108–9.
66 Meakins JL, Solomkin JS, Allo MD, Dellinger EP, Howard RJ, Simmons RL. A proposed classification of intra-abdominal infections. Stratification of etiology and risk for future therapeutic trials. *Arch Surg* 1984; **119:** 1372–8.

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