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Effectiveness of Preoperative Medical Consultations by Internal Medicine Physicians: A Systematic Review

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Full Title: **Effectiveness of Preoperative Medical Consultations by Internal Medicine Physicians: A Systematic Review**

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ABSTRACT

Objective: Clinics have been established to provide preoperative medical consultations, and enable the anaesthetist and surgeon to deliver the best surgical outcome for patients. However, there is uncertainty regarding the effect of such clinics on surgical, in-hospital, and longer term outcomes. A systematic review of the literature was conducted to determine the effectiveness of preoperative medical consultations by internal medicine physicians for patients listed for elective surgery.

Design: Systematic searches of MEDLINE, EMBASE, CINAHL, PubMed, Current Contents, and the NHS Centre for Reviews and Dissemination were conducted up to April 30, 2017.

Setting: Elective surgery.

Study selection: Randomised controlled trials and non-randomised comparative studies conducted in adults.

Outcome measures: Length of hospital stay, perioperative morbidity and mortality, costs, and quality of life.

Results: The one randomised trial reported that preadmission preoperative assessment was more effective than the option of an inpatient medical assessment in reducing the frequency of unnecessary admissions with significantly fewer surgical cancellations following admission for surgery. A small reduction in length of stay in patients was also observed. The four non-randomised studies reported increased lengths of stay, costs and postoperative complications in patients who received preoperative assessment. The timing and delivery of the preoperative medical consult in the intervention group differed across the included studies.

Conclusions: Further research is required to inform the design and implementation of coordinated involvement of physicians and surgeons in the provision of care for high risk surgical patients. A standardised approach to perioperative decision making processes should be developed with a clear protocol or guideline for the assessment and management of surgical patients.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The effectiveness of preoperative medical consultation is uncertain due to a lack of high-level comparative evidence.
- The design of services applied to date is heterogeneous, but the consolidation of existing evidence has identified potential elements of preoperative assessment that may contribute to better outcomes, such as eligibility criteria for referral, and the timing and process of assessment.
- Despite the limited evidence base, the presented review assembles and critically appraises the available evidence and draws some preliminary findings that may inform the design and adaptation of new and existing preoperative clinics.

INTRODUCTION

Preoperative medical consultations are an important component in the care of patients undergoing elective surgery. Patients who are at high risk of morbidity and mortality due to pre-existing comorbidities and the severity of surgery,[1] are targeted for preoperative medical consultations by internal medicine physicians. Such consultations involve optimising pre-existing medical conditions (e.g. diabetes mellitus, ischaemic heart disease); assessing and managing risk of morbidity and mortality; initiating interventions intended to decrease perioperative risk (e.g. delirium management, pulmonary preoperative evaluation with postoperative recommendations); and where appropriate, recommending the deferment or cancellation of surgery. This differs to but complements the care provided during a preoperative anaesthetic assessment that every patient receives prior to surgery.

With increasing patient age and complexity of medical conditions, there is a need for comprehensive preoperative evaluation and medical optimisation to enable the anaesthetist and surgeon to deliver the best surgical outcome.[2, 3] The concept of preoperative medical assessment by internal medicine physicians is moving beyond the early adopter stage, with preoperative physician-led clinics being set up across the United States (US) and internationally. In the US, several dedicated preoperative assessment clinics have been established to address this need and provide high quality care.[4] Centers such as the Internal Medicine Perioperative Assessment, Consultation, and Treatment (IMPACT) Center have been included as part of the preoperative evaluation model at the Cleveland Clinic Foundation, with the aim to provide thorough, timely, and cost-effective assessment of surgical patients.[3] In Australia, the Royal Adelaide Hospital and the Queen Elizabeth Hospital have consultant physician-led clinics dedicated to providing medical assessment and management to high risk patients in elective surgery.

There is a strong rationale for the beneficial effects of preoperative medical consultations by internal medicine physicians in reducing post-operative length of stay and complications, and improving longer term recovery and rehabilitation. However, no systematic review of the literature reporting evaluations of preoperative medical consultation has been reported. Thus, we conducted a systematic review of the published literature reporting on preoperative medical consultations by internal medicine physicians in high risk surgical patients.

METHODS

Data sources and searches

Systematic searches of MEDLINE, EMBASE, CINAHL, PubMed, Current Contents, and the NHS Centre for Reviews and Dissemination (including Cochrane Database of Systematic Reviews, Database of Abstracts of Review and Effects, Health Technology Assessment Database, and NHS Economic Evaluation Database) were conducted from database inception to April 30, 2017. A full list of search terms used is provided in the online supplementary appendix 1.

Searches were conducted without language restriction. The reference lists of all included articles were then manually searched for relevant references that may have been missed during the database searches.

Study selection

Studies were selected for inclusion on the basis of the following criteria:

Type of Studies

Randomised controlled trials (RCTs) and non-randomised comparative studies (e.g. quasi-RCTs, controlled before and after studies, and cohort studies) were considered in the review.

Participants

Humans aged 18 years and over scheduled for elective surgery.

Intervention

Preoperative medical consultations by an internal medicine physician or generalist for elective surgical patients. The assessment may take place in any setting, such as on a ward or in an outpatient clinic.

Comparator

Preoperative assessment by an anaesthetist, other existing preoperative assessment process, or no preoperative medical consultation.

Outcomes

- Convalescence (length of hospital stay)
- Perioperative morbidity and mortality (same-day admissions, surgical cancellations, complications, mortality)
- Cost / resource use (cost-effectiveness analyses, cost-savings, resource use)

- Quality of life (generic or disease-specific quality of life survey instruments, patient satisfaction)

Two reviewers (CP, JK) independently screened all titles and abstracts to determine eligibility. Full texts were retrieved for potentially relevant articles. Disagreements were resolved through discussion.

Data extraction and quality assessment

Data were extracted by one reviewer (CP) and checked by a second (JK) using standardised data extraction tables that were developed *a priori*.

The evidence presented in the included studies were classified according to the National Health and Medical Research Council (NHMRC) Evidence Hierarchy.[5] Study quality was assessed using the Cochrane Collaboration's tool for assessing risk of bias in RCTs (Chapter 8[6], Table 8.5a) and in non-randomised studies (Chapter 13[6], Table 13.2a). All studies were assessed based on the four main sources of systematic bias in studies of the effects of healthcare, namely selection bias, performance bias, detection bias and attrition bias. Discrepancies were resolved through a consensus process.

Data synthesis and analysis

The heterogeneity of the interventions and the variability of outcome measures precluded meta-analysis. The outcome data from the studies were therefore reported narratively. Differences between intervention and control groups for each outcome measure were reported as difference in means, odds ratio, or risk ratio.

RESULTS

Of the 128 citations screened for eligibility, five met the inclusion criteria; one RCT and four non-randomised comparative studies (one prospective and three retrospective). Figure 1 provides a summary of the search results and study selection.

Quality assessment

The quality of the available evidence was poor. Table 1 summarises the risk of bias assessments for the included studies. The one RCT[7] described their randomisation process but did not state their method of allocation concealment. Outcome assessments were not blinded but inter- and intra-observer reliability tests were performed with 100% agreement reported from both tests. Blinding of investigators and patients was not possible due to the nature of the intervention. There were no losses to follow-up. The

external validity of this RCT is uncertain as the study setting differed to the non-experimental setting, for example, the time between admission and surgery was more restrictive in the study.

Three non-randomised studies used concurrent controls, but alternative methods for patient allocation were used. Auerbach et al.[8] included patients prospectively via the Center for Medicare and Medicaid Services criteria, randomly selecting medical records of patients for the public reporting of data regarding adherence to surgical site infection processes. Wijeysundera et al.[9] and Katz et al.[10] collected retrospective data on all consecutive patients in their specified study periods. Propensity scores were used in two of the studies to control for selection bias. Auerbach et al.[8] used propensity scores as weights but only the discriminative power of the propensity score model was reported and not whether covariate balance was achieved. Wijeysundera et al.[9] used propensity score matching analyses and reported covariate balance within the matched pairs (standardised differences were less than 10%). Katz et al.[10] reported significant differences between the medical consult and no consult group for age, ASA status, type of surgery and gender, but did not adjust for these differences in their outcome analysis. The remaining non-randomised study used a pre/post intervention design and included all retrospective patients in the specified time periods.[11] Vazirani et al.[11] used regression models with age, gender, time period (pre or post), and American Society of Anesthesiologists (ASA) classification as covariates to adjust for differences between groups.

Due to the non-randomised comparative study design, outcome assessments were not blinded so there is the potential for error and bias in the collection and interpretation of information. Two studies retained all patients[8, 11] and the remaining two reported losses to follow-up of around 8%.

Table 1 Assessment of risk of bias in included studies

Source of bias	Macpherson & Lofgren, 1994[7]	Auerbach et al., 2007[8]	Wijeysundera et al., 2010[9]	Katz et al., 2005[10]	Vazirani et al., 2012[11]
Selection bias					
Randomisation [RCT]	Permuted blocks of size 2 and 4, stratified by quartiles of anticipated LoS	…	…	…	…
Allocation concealment [RCT]	Not reported	…	…	…	…
Control for confounders [NRS]	…	Patients sampled at random; propensity score weighting	Propensity score matching	Consecutive patients	Regression methods
External validity [RCT & NRS]	Uncertain as study setting was more restrictive than a non-experimental setting	Potential unobserved confounding	Potential unobserved confounding	Potential unobserved confounding	Potential unobserved confounding
Performance bias					
Blinding of participants and/or investigators [RCT]	No	…	…	…	…
Measurement of exposure [NRS]	…	No blinding but 5% of medical record abstractions were reviewed for data validity	No blinding	No blinding	No blinding
Detection bias					
Blinded outcome assessment [RCT & NRS]	No blinding but 100% inter- and intra-observer agreement*	Not reported	Not reported	Not reported	Not reported
Attrition bias					
Completeness of follow-up [RCT & NRS]	Yes	Yes	8,769 (8.4%) patients could not be matched to a control	35 (8.3%) patients with missing medical records	Yes

* A researcher re-abstracted length of stay data on 10 randomly selected records, and a physician not associated with the study abstracted length of stay from the same 10 records.

Ellipses indicate not applicable.

RCT, randomised controlled trials; NRS, non-randomised studies; LoS, length of stay.

Description of included studies

For the RCT, the mean ages of the patients were 65.3 years for the intervention group and 65.7 years for the comparator group. There were no significant differences between groups for number of medications on admission, cardiac risk index category and ASA score. Patients in the comparator group could still receive a preoperative medical consult, if necessary, but only as an inpatient (i.e. only after admission for surgery), compared with the intervention group who attended an outpatient clinic within three weeks of surgery (Figure 2). A range of surgical procedures across multiple specialties were included, with no significant differences in the proportion of patients in each surgical service.

For the non-randomised comparative studies, patients in the comparator group in one study[8] received consultation from an internist on days other than the intervention or from another specialty but the actual timing of the consult was not reported (Table 2). Comparator groups in the remaining studies received either preoperative anaesthetic assessment only or did not receive any preoperative medical consultation, though no further details were reported (Table 2). The timing of the preoperative medical consult and the specialist who provided the consult for the intervention group differed across the four studies (Figure 2). Age ranged from a mean 61.4 years to a mean 70.1 years in the intervention group and a median 58 years to a mean 67.3 years in the comparator group. A range of surgical procedures across multiple specialties were included. Three of the studies focused on clinical outcome measures and the other focused on reviewing the medical consultation process (e.g. reason for consult, consultants' recommendations).

Effectiveness of intervention

Table 3 provides a summary of the effectiveness of preoperative medical consultations by an internal medicine physician for a range of outcomes, as described below.

Surgical cancellations

RCT:

A similar proportion of patients in each group did not undergo surgery (24.4% for a medical consult within 3 weeks and 23.5% for a medical consult after admission but before surgery). Of the surgical cancellations that occurred after the admission for surgery, the patients who received a medical consult after admission (control group) had a higher proportion of cancellations (6.6% higher, 95% CI 0.5% to 12.7%).

Non-randomised comparative studies:

One non-randomised comparative study reported on surgical cancellations.[11] There were no significant differences in the number of surgical cancellations between patients who received an anaesthetic consult and those who received a medical consult.

Length of hospital stay

RCT:

Across all patients, the preoperative length of stay was reduced in the intervention group (1.3 day reduction, 95% CI -1.8 to -0.8), but there was no significant difference between the intervention and control groups for the postoperative and overall length of stay.

Non-randomised comparative studies:

Length of stay was reported in three of the non-randomised comparative studies.[8, 9, 11] After adjustment for observed potential confounding, a medical consult on or around the day of surgery compared with a medical or other specialty consult in two or more days before surgery resulted in a 13% increase in length of stay (95% CI 2% to 26%).[8] A longer length of stay (0.67-day increase, 95% CI 0.59 to 0.76) was also reported in patients who received a medical consult within 4 months of surgery, compared with no medical consult.[9] There were no significant differences in overall length of stay between the medical and anaesthetic consults but patients who were ASA 3 or higher had a significantly shorter length of stay with a medical consult.[11]

Table 2 Characteristics of included studies

Study & setting	Study type	Population	Intervention	Comparator	N (patients)
Macpherson & Lofgren, 1994[7] Pennsylvania, USA	Level II, randomised controlled trial	>50 years of age, referred from a surgeon, lived within 100 miles of study hospital The most common procedures included upper airway endoscopy under general anaesthetic for head and neck cancer, hip and knee arthroplasty, cataract extraction, transurethral resection of the prostate, and laminectomy	**Medical preoperative evaluation clinic (outpatient)** Consult provided by internist OR third-year internal medicine resident supervised by attending internist	**Internal medicine evaluation, if necessary (inpatient)** Consult provided by internist OR third-year internal medicine resident supervised by attending internist	176 (intervention) 179 (comparator)
Auerbach et al., 2007[8] California, USA	Level III-2, prospective observational cohort study with concurrent controls	>18 years of age, underwent one of the following surgeries (emergency or elective): colon surgery, cardiac bypass or valve procedures, hip or knee arthroplasty, hysterectomy, vascular surgery	**Medical consult on day before, day of, or first day after surgery** Consult provided by attending physician, fellow (for sub-specialty services, e.g. cardiology), OR third-year internal medicine resident	**Medical consult on days other than intervention or from non-internal medicine services** Consult provided by internist or other specialist	117 (intervention) 1,165 (comparator)
Wijeysundera et al., 2010[9] Ontario, Canada	Level III-2, retrospective observational cohort study with concurrent controls	>40 years of age, underwent one of the following elective surgical procedures: abdominal aortic aneurysm repair, carotid endarterectomy, peripheral vascular bypass, total hip or knee replacement, large bowel surgery, liver resection, whipple procedure, pneumonectomy, pulmonary lobectomy, gastrectomy, oesophagectomy, nephrectomy, cystectomy	**Preoperative medical consultation (identified by Ontario Health Insurance Plan claim)** Consult provided by cardiologist, general internist, endocrinologist, geriatrician, OR nephrologist	**No preoperative medical consultation** No other comparator details reported	104,695 (intervention) 165,171 (comparator)
Katz et al., 2005[10] New York, USA	Level III-2, retrospective observational cohort study with concurrent controls	>50 years of age, underwent elective non-cardiac surgery	**Medical consult (as noted in patients' medical records)** Consult provided by internist OR family practitioner	**No medical consult noted in patients' medical records** No other comparator details reported	138* (intervention) 249 (comparator)

Vazirani et al., 2012[11] California, USA	Level III-3, pre-post retrospective comparative study	All patients in the Veterans Health Administration database covering the following surgical specialties: ophthalmology, orthopaedics, urology, general surgery	**Hospitalist-run preoperative clinic (outpatient)** Consult provided by mid-level providers with hospitalist oversight	**Preoperative anaesthetic clinic (outpatient)** Consult provided by mid-level providers with anaesthesiologist oversight	2,565 (intervention) 2,658 (comparator)

* 146 consults.

Table 3 Summary of effectiveness of physician-led preoperative assessment by outcome

Outcome and study	Intervention	Comparator	Difference*
Length of stay (days)			
Macpherson & Lofgren, 1994[7] (mean)			
All patients			
Pre-admission for surgery	1.6	2.9	-1.3 (-0.8 to-1.8)
Admission for surgery	3.6	3.0	0.6 (-0.6 to 1.8)
Total	5.5	6.0	-0.5 (-2.0 to 1.1)
Patients who had surgery			
Pre-admission for surgery	1.9	3.0	-1.1 (-0.5 to-1.6)
Admission for surgery	4.8	3.9	0.9 (-0.6 to 2.4)
Total	7.1	7.0	0.1 (-1.7 to 2.0)
Auerbach et al., 2007[8] (median, IQR)			
Before adjustment	10 (7 - 18)	6 (4 - 9)	87% (63% to 115%)†
After adjustment	NR	NR	13% (2% to 26%)†
Wijeysundera et al., 2010[9] (mean)	9.07	8.39	0.67 (0.59 to 0.76)
Vazirani et al., 2012[11]			
Mean (SD)	5.28 (9.24)	9.87 (25.4)	NR
ASA classification			
No disturbance	NR	NR	-1.31 (SE 5.90), p=0.82
Mild	NR	NR	-2.52 (SE 1.39), p=0.07
Severe	NR	NR	-4.22 (SE 0.96), p<0.01
Life-threatening	NR	NR	-19.70 (SE 3.81), p<0.01
Costs (USD)			
Auerbach et al., 2007[8] (median)			
Before adjustment	155,020 (101,473 - 292,951)	74,237 (53,824 - 126,927)	116% (88% to 148%)†
After adjustment	NR	NR	24% (14% to 36%)†
Postoperative complications			
Auerbach et al., 2007[8] (n, %)			

Before adjustment	60 (51.3)	322 (27.6)	OR 2.76 (1.88 to 4.04)
After adjustment	NR	NR	OR 1.51 (0.98 to 2.32)
Wijeysundera et al., 2010[9] (n, %)			
In-hospital acute stroke	436 (0.5)	399 (0.4)	RR 1.09 (0.95 to 1.25)
Admission to monitored bed	13,012 (13.6)	12,338 (12.9)	RR 1.05 (1.03 to 1.08)
Mechanical ventilation	5,822 (6.1)	5,055 (5.3)	RR 1.15 (1.11 to 1.19)
Mortality			
Wijeysundera et al., 2010[9] (n, %)			
30-day	1,363 (1.4)	1,177 (1.2)	RR 1.16 (1.07 to 1.25)
1-year	5,664 (5.9)	5,221 (5.4)	RR 1.08 (1.04 to 1.12)
Katz et al., 2005[10] (n, %)			
Unexpected ICU/death	2 (1.4)	4 (1.6)	p=0.9046
Vazirani et al., 2012[11] (n, %)	4 (0.4)	14 (1.3)	OR 0.31 (0.10 to 0.99)
Surgical cancellations			
Macpherson & Lofgren, 1994[7] (n, %)			
During admission	10 (5.7)	22 (12.3)	-6.6% (-0.5% to -12.7%)
Did not undergo surgery	43 (24.4)	42 (23.5)	NR
Vazirani et al., 2012[11] (n, %)			
Total	368 (14.3)	400 (15.0)	NR
Medically avoidable‡	18 (4.9)	34 (8.5)	p=0.065
Patient satisfaction			
Macpherson & Lofgren, 1994[7]			
MOS SF-22 (higher score indicates better health)			
Health perceptions	38.8	33.1	NS
Pain	55.3	59.8	NS
Physical function	45.7	44.1	NS
Social function	62.3	61.2	NS
Mental health	63.0	58.0	NS
Questionnaire adapted from RAND§ (%)			
Satisfaction with care	73	66	NS

Dissatisfaction with care	39	47	NS
Rated care as very good or excellent	64	54	NS
Rated care as better than most or best	62	54	NS
Overall, very or extremely satisfied	66	58	NS

*Difference reported as mean difference (95% confidence interval of the difference) unless otherwise specified; †Cost and length of stay data were log transformed to normalise data with percentage differences attributable to consultation calculated using the following equation: 100 x (e^{β} - 1); ‡As opposed to unavoidable, patient-related causes ; §Patient satisfaction questionnaire adapted from the RAND Corporation.

ASA, American Society of Anesthesiologists; ICU, intensive care unit; IQR, interquartile range; MOS SF-22, Medical Outcomes Study Short Form-22; NR, not reported; NS, not significant, actual p-value not reported; OR, odds ratio; RR, relative risk; SD, standard deviation; SE, standard error; USD, United States Dollar.

Costs

RCT:

The RCT did not report on costs.

Non-randomised comparative studies:

Only one non-randomised comparative study reported on costs.[8] There was a 24% increase in costs for patients who received a medical consult on or around the day of surgery compared with those who received a medical or other specialty consult in two or more days before surgery, with increases ranging from 14% to 36%.

Postoperative complications

RCT:

The RCT did not report on postoperative complications.

Non-randomised comparative studies:

The complication rate varied across the two non-randomised comparative studies [8, 9], depending on the type of complication. The odds of complications after postoperative day two for patients receiving a medical consult on or around the day of surgery was 1.51 times greater than for patients receiving a medical or other specialty consult in two or more days before surgery (95% CI 0.98 to 2.32) [8]. Suspected infection, cardiac, pulmonary and other medical complications were the most commonly reported complications.

Patients who received a medical consult within 4 months of surgery were more likely to be admitted to a monitored bed (RR 1.05, 95% CI 1.03 to 1.08) and receive mechanical ventilation (RR 1.15, 95% CI 1.11 to 1.19) than those who did not have a medical consult.[9]

Mortality

RCT:

The RCT did not report on mortality.

Non-randomised comparative studies:

The risk of death was significantly more likely in patients who received a medical consult within 4 months of surgery, 16% more likely at 30 days and 8% more likely at 1-year, than those who did not have a medical

consult.[9] However, when compared with an anaesthetic consult, the likelihood of death in patients who received a medical consult was significantly lower (69% less likely).[11]

Patient satisfaction

RCT:

No significant differences in quality of life and quality of care measures at 2 months post-randomisation were reported between patients who received a medical consult in the 3 weeks prior to admission, and following admission.

Non-randomised comparative studies:

None of the non-randomised comparative studies reported on patient satisfaction.

Review of the medical consultation process

In the non-randomised study of preoperative assessment in the four weeks prior to admission,[10] medical records were reviewed to determine the characteristics of the medical consults. The specialty of the requesting physician and the reason for medical consult could not be determined for the majority of the consults (51% and 64%, respectively). Of the remaining, requests for a medical consult were either from surgeons (46%) or other internists or family practitioners (3%), and the main reasons for requesting a medical consult were for clearance (19%) or evaluation (14%). Other reasons included risk assessment (0.7%) and re-assessment (0.7%). Patients' diagnoses were listed in 83% of the consults, with 3% diagnosing a medical condition not previously identified in the admitting history. In terms of recommendations, no recommendations were reported in 43% of the consults, 34% "cleared" the patient for surgery, and 20% provided a risk assessment such as "minimal increased risk" or "no increased risk". Of the 178 preoperative, intraoperative and postoperative recommendations made, documentation in the medical records indicated that 73% were followed, 9% were not followed, and in 18% it could not be determined.

DISCUSSION

The effectiveness of preoperative medical consultation is uncertain due to a lack of high-level comparative evidence. The one RCT[7] identified reported medical consultations in an outpatient setting were effective in reducing surgical cancellations following admission for surgery compared with medical consultations in an inpatient setting. The RCT also reported a small reduction in length of stay for patients who received

preadmission preoperative medical consultations, noting that the active control (inpatient medical consults) may have reduced the effect size relative to a non-active control. The observational studies reported mixed results regarding length of stay[8, 9, 11] and mortality[9, 11], and increased costs[8] and postoperative complications[8, 9] in patients who received preoperative medical consults, but these results must be interpreted with caution due to the potential for bias and confounding.

As well as differences in the comparator arms, the reviewed studies varied with respect to the timing and delivery of the preoperative medical consultation, which precluded the pooling of results. One study evaluated the effect of medical consults on the day before or day of surgery,[8] whilst differences in the timing of preadmission consults may be driven by varying waiting times across forms of elective surgery (e.g. cancer versus non-cancer procedures) and geographical locations. In general, it might be hypothesised that consultations undertaken close to the date of surgery provide less time for optimisation. A recent review of guidelines pertaining to preoperative medical management suggested that consults may be most beneficial when sought at least 4 weeks prior to elective surgery, and when there is a clear understanding of the planned procedure and its associated risks.[12]

The form of preoperative medical consult also varied across the included studies, with minimal detail from each of the studies on the actual services provided as part of the intervention. It was not clear in any of the included studies if the consultant providing the intervention was also involved in the postoperative care of the patient. A one-off consult with recommendations but no patient follow-up may be less effective than a coordinated approach to shared decision making between specialists and physicians for perioperative management. Katz et al.[10] provided some insight into the reasons for requesting a consult but were limited by the information documented in the medical records. However, Wijeysundera et al.[9] noted that the internists in their study actively guided preoperative care, such as increasing cardiac testing and initiating beta-blocker therapy, and did not simply clear patients for surgery.

The co-management concept of surgeons managing a patient's surgery and surgery-related issues and the internal medicine physician or geriatrician managing a patient's medical conditions is rational.[13] The results of the review do not confirm nor reject the hypothesis that preoperative medical consultation provides important benefits. The findings suggest that there is significant uncertainty around the overall

effect of such services, as well as illustrating the variation in the design and implementation of preoperative assessment.

Currently, there are no clear recommendations regarding the selection of patients who require medical consultation.[14] Given limited resources, patients at high risk of morbidity and mortality should be prioritised for a medical consultation but substantial practice variation exists.[15] The decision to refer a patient for preoperative consultation is at the discretion of the treating surgeon and influenced by the surgeon's personal preference for the intervention, patient preference, patient characteristics and medical history. Auerbach et al.[8] reported increases in postoperative complications with a medical consult but the consults may have been requested for an impending or suspected complication, which would make it difficult to discern whether a consult reduced the risk of complications. Thus, confounding by indication is a major source of bias in the non-randomised comparative studies.[16] Auerbach et al.[8] used propensity scores as weights to adjust for confounding but the authors indicated that patterns of consultation and other unmeasured confounding factors in the patient's medical history or illness may have biased their results. Wijeysundera et al.[9] also stated that their data sources may have lacked sufficient detail for adequate risk adjustment. A key potential confounder that may not be adequately represented in the reported studies is frailty, which has been shown to be a predictor of surgical morbidity and mortality, and may also be an important factor in the decision to refer for preoperative medical consultation.[17-19] Well designed and conducted RCTs can remove potential confounding, but issues remain around the feasibility of such trials and the generalisability of the findings. Having a no-consultation arm in the trial for a patient identified as high risk would be a major challenge, and strict trial conditions cannot be easily translated into clinical practice. In the RCT in this review, patients in the comparator group could still receive a preoperative medical consult as an inpatient, if necessary, and the strict trial conditions on the timing between admission and surgery may not reflect the application of the intervention in routine clinical practice.

Evidence directly linking preoperative interventions with a reduction in perioperative risk are lacking. Given the multidisciplinary care of patients in a hospital setting, it is difficult to assess whether one particular aspect of care provided directly impacts on a particular outcome. The design of services applied to date is

heterogeneous, but the consolidation of existing evidence has identified potential elements of preoperative assessment that may contribute to better outcomes, for example, eligibility criteria for referral, and the timing and process of assessment. In the absence of robust evidence, preoperative medical consultations are likely to remain ad hoc in terms of implementation and design. Qualitative data may provide an in-depth understanding of the processes of care and the perceived value of preoperative consultation. Future research should aim to clearly describe the level of involvement of the internal medicine physician in the surgical decision making process and their relationship with the surgical team. A better understanding of the mechanisms of preoperative medical consultations and the complex decision making processes involved may help explain the relationship between medical consultations and outcomes. Further research is also required to determine the characteristics of patients who would benefit most from medical consultation.

CONCLUSION

Preoperative medical consultations for patients with complex care requirements and in poor health is an intuitive health service development. To date, such services appear to have been developed and implemented on a limited and ad hoc basis, resulting in varied service designs and a lack of evidence on the value of preoperative assessment. With an ageing population and increasing rates of chronic disease, the management of high risk surgical patients is likely to become an increasingly important issue. The available evidence indicates that the timing of the preoperative medical consultation, a collaborative approach to patient care, and the decision making processes for surgery are potentially important factors that should be considered when designing a preoperative medical consultation service. Providing continuity of multidisciplinary care from the decision to operate through to rehabilitation and recovery is certainly logical and intuitive. However, further research is required to inform the value, and the optimal design and implementation of coordinated involvement of physicians and surgeons in the provision of care for high risk surgical patients. A standardised approach to perioperative decision making processes should be developed with a clear protocol or guideline for the assessment and management of surgical patients.

Contributorship statement: All authors (CP, CG, RF, JK) contributed substantially to the conception and design of the study; and the acquisition, analysis, and interpretation of data. CP drafted the work and all authors (CP, CG, RF, JK) provided critical revision for important intellectual content. All authors (CP, CG, RF, JK) approve of the final version to be published; and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated or resolved.

Competing interests: Dr Catherine Gibb is a consultant physician in the High Risk Clinic at the Royal Adelaide Hospital and Queen Elizabeth Hospital. The remaining authors declare no conflict of interest.

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Data sharing statement: Data used in the analysis were extracted from peer-reviewed publications. No additional unpublished data were generated or collected in the study.

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FIGURE LEGENDS

Figure 1 Summary of search results and study selection

Figure 2 The timing of the preoperative medical consult in each included study

Figure 2 legend: *Macpherson & Lofgren [7] compared pre-admission medical consults (outpatient clinic) to post-admission preoperative medical consults (inpatient), and Auerbach et al. [8] compared a medical consult on the day before, day of, or day after surgery to a medical or other specialty consult on days other than the intervention (i.e. two or more days before surgery).

ONLINE SUPPLEMENTARY APPENDIX

Appendix 1. Search Strategies.

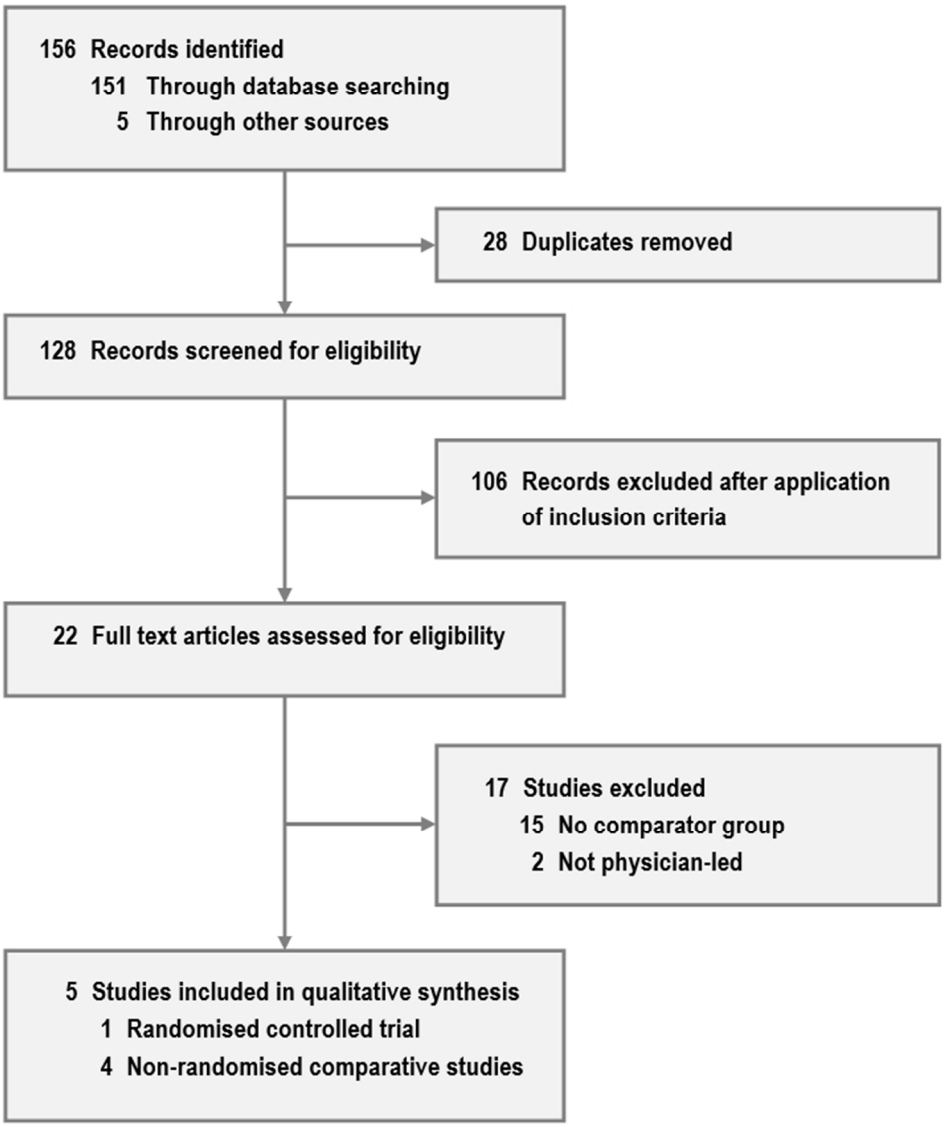

Figure 1. Summary of search results and study selection

200x231mm (96 x 96 DPI)

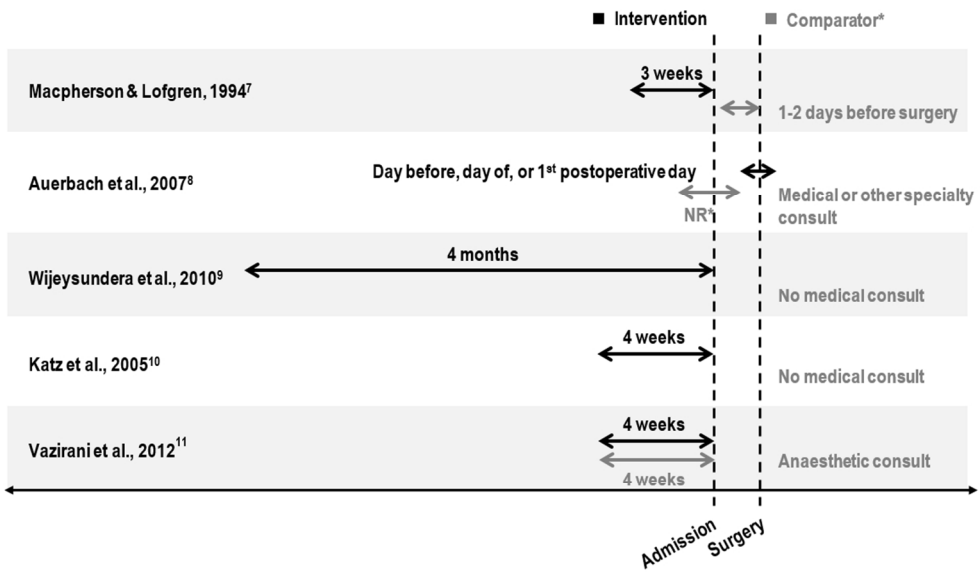

Figure 2. The timing of the preoperative medical consult in each included study

312x179mm (96 x 96 DPI)

Online supplementary material

Appendix 1. Search Strategies

Search strategy for **Centre for Reviews and Dissemination**

#1 MeSH descriptor: [preoperative care] explode all trees
#2 MeSH descriptor: [referral and consultation] explode all trees
#3 (#1 AND #2)

Search strategy for **PubMed**

#1 preoperative[All Fields]
#2 medical[All Fields]
#3 ("referral and consultation"[MeSH Terms] OR ("referral"[All Fields] AND "consultation"[All Fields]) OR "referral and consultation"[All Fields] OR "consultation"[All Fields])
#4 ("surgical procedures, elective"[MeSH Terms] OR ("surgical"[All Fields] AND "procedures"[All Fields] AND "elective"[All Fields]) OR "elective surgical procedures"[All Fields] OR ("elective"[All Fields] AND "surgery"[All Fields]) OR "elective surgery"[All Fields])
#5 (#1 AND #2 AND #3 AND #4)
#6 preoperative[Title]
#7 “medical consultation”[Title]
#8 (#6 AND #7)
#9 “preoperative evaluation”[All Fields]
#10 “internal medicine”[All Fields]
#11 (#9 AND #10)

#12 (“Hospitalists”[MeSH] OR “internal medicine”[MeSH]) AND “preoperative evaluation”[All Fields]

Search strategy for **EMBASE (Elsevier)**

#1 ‘preoperative care’/exp OR ‘preoperative care’
#2 'elective surgery'/exp OR 'elective surgery'
#3 ‘referral and consultation’/exp OR ‘referral and consultation’
#4 (#1 AND #2 AND #3)

Search strategy for **CINAHL (EBSCO host)**

S1 MW ‘preoperative care’
S2 MW ‘elective surgery’
S3 MW medical OR MW ‘referral and consultation’
S4 (S1 AND S2 AND S3)

Search strategy for **Current Contents Connect (Web of Science)**

#1 TOPIC: ’preoperative care’
#2 TOPIC: ’elective surgery’
#3 TOPIC: ’referral and consultation’
#4 (#1 AND #2 AND #3)

Search strategy for **MEDLINE (Ovid)**

#1 exp “preoperative care”/

#2 exp “surgical procedures, elective”/
#3 exp “referral and consultation”/
#4 (#1 AND #2 AND #3)

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5 - 6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	-
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5 - 6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Supporting information
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5 - 6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5 - 6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	-
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6 - 7 & Figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7 - 12 (Table 2)
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	7 - 9 (Table 1)
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	9 - 17 (Table 3)
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	-
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	6 - 7
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	-
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	17 - 20
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	17 - 20
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	20
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	21

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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BMJ Open

Effectiveness of Preoperative Medical Consultations by Internal Medicine Physicians: A Systematic Review

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Primary Subject Heading:	Medical management
Secondary Subject Heading:	Surgery, Health services research
Keywords:	preoperative medical consult, internal medicine physicians, elective surgery, systematic review

Full Title: **Effectiveness of Preoperative Medical Consultations by Internal Medicine Physicians: A Systematic Review**

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Keywords: preoperative medical consult; internal medicine physicians; elective surgery; systematic review

ABSTRACT

Objective: Clinics have been established to provide preoperative medical consultations, and enable the anaesthetist and surgeon to deliver the best surgical outcome for patients. However, there is uncertainty regarding the effect of such clinics on surgical, in-hospital, and longer term outcomes. A systematic review of the literature was conducted to determine the effectiveness of preoperative medical consultations by internal medicine physicians for patients listed for elective surgery.

Design: Systematic searches of MEDLINE, EMBASE, CINAHL, PubMed, Current Contents, and the NHS Centre for Reviews and Dissemination were conducted up to April 30, 2017.

Setting: Elective surgery.

Study selection: Randomised controlled trials and non-randomised comparative studies conducted in adults.

Outcome measures: Length of hospital stay, perioperative morbidity and mortality, costs, and quality of life.

Results: The one randomised trial reported that preadmission preoperative assessment was more effective than the option of an inpatient medical assessment in reducing the frequency of unnecessary admissions with significantly fewer surgical cancellations following admission for surgery. A small reduction in length of stay in patients was also observed. The three non-randomised studies reported increased lengths of stay, costs and postoperative complications in patients who received preoperative assessment. The timing and delivery of the preoperative medical consult in the intervention group differed across the included studies.

Conclusions: Further research is required to inform the design and implementation of coordinated involvement of physicians and surgeons in the provision of care for high risk surgical patients. A standardised approach to perioperative decision making processes should be developed with a clear protocol or guideline for the assessment and management of surgical patients.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The effectiveness of preoperative medical consultation is uncertain due to a lack of high-level comparative evidence.
- The design of services applied to date is heterogeneous, but the consolidation of existing evidence has identified potential elements of preoperative assessment that may contribute to better outcomes, such as eligibility criteria for referral, and the timing and process of assessment.
- Despite the limited evidence base, the presented review assembles and critically appraises the available evidence and draws some preliminary findings that may inform the design and adaptation of new and existing preoperative clinics.

INTRODUCTION

Preoperative medical consultations are an important component in the care of patients undergoing elective surgery. Patients who are at high risk of morbidity and mortality due to pre-existing comorbidities and the severity of surgery,[1] are targeted for preoperative medical consultations by internal medicine physicians. Such consultations involve optimising pre-existing medical conditions (e.g. diabetes mellitus, ischaemic heart disease); assessing and managing risk of morbidity and mortality; initiating interventions intended to decrease perioperative risk (e.g. delirium management, pulmonary preoperative evaluation with postoperative recommendations); and where appropriate, recommending the deferment or cancellation of surgery. This differs to but complements the care provided during a preoperative anaesthetic assessment that every patient receives prior to surgery.

With increasing patient age and complexity of medical conditions, there is a need for comprehensive preoperative evaluation and medical optimisation to enable the anaesthetist and surgeon to deliver the best surgical outcome.[2, 3] The concept of preoperative medical assessment by internal medicine physicians is moving beyond the early adopter stage, with preoperative physician-led clinics being set up across the United States (US) and internationally. In the US, several dedicated preoperative assessment clinics have been established to address this need and provide high quality care.[4] Centers such as the Internal Medicine Perioperative Assessment, Consultation, and Treatment (IMPACT) Center have been included as part of the preoperative evaluation model at the Cleveland Clinic Foundation, with the aim to provide thorough, timely, and cost-effective assessment of surgical patients.[3] In Australia, the Royal Adelaide Hospital and the Queen Elizabeth Hospital have consultant physician-led clinics dedicated to providing medical assessment and management to high risk patients in elective surgery.

There is a strong rationale for the beneficial effects of preoperative medical consultations by internal medicine physicians in reducing post-operative length of stay and complications, and improving longer term recovery and rehabilitation. However, no systematic review of the literature reporting evaluations of preoperative medical consultation has been reported. Thus, we conducted a systematic review of the published literature reporting on preoperative medical consultations by internal medicine physicians in high risk surgical patients.

METHODS

Data sources and searches

Systematic searches of MEDLINE, EMBASE, CINAHL, PubMed, Current Contents, and the NHS Centre for Reviews and Dissemination (including Cochrane Database of Systematic Reviews, Database of Abstracts of Review and Effects, Health Technology Assessment Database, and NHS Economic Evaluation Database) were conducted from database inception to April 30, 2017. A full list of search terms used is provided in the online supplementary appendix 1.

Searches were conducted without language restriction. The reference lists of all included articles were then manually searched for relevant references that may have been missed during the database searches.

Study selection

Studies were selected for inclusion on the basis of the following criteria:

Type of Studies

Randomised controlled trials (RCTs) and non-randomised comparative studies (e.g. quasi-RCTs, controlled before and after studies, and cohort studies) were considered in the review.

Participants

Humans aged 18 years and over scheduled for elective surgery.

Intervention

Preoperative medical consultations by an internal medicine physician or generalist for elective surgical patients. The assessment may take place in any setting, such as on a ward or in an outpatient clinic.

Comparator

Preoperative assessment by an anaesthetist, other existing preoperative assessment process, or no preoperative medical consultation.

Outcomes

- Convalescence (length of hospital stay)
- Perioperative morbidity and mortality (same-day admissions, surgical cancellations, complications, mortality)
- Cost / resource use (cost-effectiveness analyses, cost-savings, resource use)

- Quality of life (generic or disease-specific quality of life survey instruments, patient satisfaction)

Two reviewers (CP, JK) independently screened all titles and abstracts to determine eligibility. Full texts were retrieved for potentially relevant articles. Disagreements were resolved through discussion.

Data extraction and quality assessment

Data were extracted by one reviewer (CP) and checked by a second (JK) using standardised data extraction tables that were developed *a priori*.

The evidence presented in the included studies were classified according to the National Health and Medical Research Council (NHMRC) Evidence Hierarchy.[5] Study quality was assessed using the Cochrane Collaboration's tool for assessing risk of bias in RCTs (Chapter 8[6], Table 8.5a) and in non-randomised studies (Chapter 13[6], Table 13.2a). All studies were assessed based on the four main sources of systematic bias in studies of the effects of healthcare, namely selection bias, performance bias, detection bias and attrition bias. Discrepancies were resolved through a consensus process.

Data synthesis and analysis

The heterogeneity of the interventions and the variability of outcome measures precluded meta-analysis. The outcome data from the studies were therefore reported narratively. Differences between intervention and control groups for each outcome measure were reported as difference in means, odds ratio, or risk ratio.

RESULTS

Of the 128 citations screened for eligibility, four met the inclusion criteria; one RCT and three non-randomised comparative studies (one prospective and two retrospective). Figure 1 provides a summary of the search results and study selection.

Quality assessment

The quality of the available evidence was poor. Table 1 summarises the risk of bias assessments for the included studies. The one RCT[7] described their randomisation process but did not state their method of allocation concealment. Outcome assessments were not blinded but inter- and intra-observer reliability tests were performed with 100% agreement reported from both tests. Blinding of investigators and patients was not possible due to the nature of the intervention. There were no losses to follow-up. The

external validity of this RCT is uncertain as the study setting differed to the non-experimental setting, for example, the time between admission and surgery was more restrictive in the study.

Two non-randomised studies used concurrent controls, but alternative methods for patient allocation were used. Auerbach et al.[8] included patients prospectively via the Center for Medicare and Medicaid Services criteria, randomly selecting medical records of patients for the public reporting of data regarding adherence to surgical site infection processes. Katz et al.[9] collected retrospective data on all consecutive patients in their specified study periods. Auerbach et al.[8] used propensity scores as weights to control for selection bias but only the discriminative power of the propensity score model was reported and not whether covariate balance was achieved. Katz et al.[9] reported significant differences between the medical consult and no consult group for age, ASA status, type of surgery and gender, but did not adjust for these differences in their outcome analysis. The remaining non-randomised study used a pre/post intervention design and included all retrospective patients in the specified time periods.[10] Vazirani et al.[10] used regression models with age, gender, time period (pre or post), and American Society of Anesthesiologists (ASA) classification as covariates to adjust for differences between groups.

Due to the non-randomised comparative study design, outcome assessments were not blinded so there is the potential for error and bias in the collection and interpretation of information. Two studies retained all patients[8, 10] and the remaining reported losses to follow-up of around 8%.

Table 1 Assessment of risk of bias in included studies

Source of bias	Macpherson & Lofgren, 1994[7]	Auerbach et al., 2007[8]	Katz et al., 2005[9]	Vazirani et al., 2012[10]
Selection bias				
Randomisation [RCT]	Permuted blocks of size 2 and 4, stratified by quartiles of anticipated LoS	…	…	…
Allocation concealment [RCT]	Not reported	…	…	…
Control for confounders [NRS]	…	Patients sampled at random; propensity score weighting	Consecutive patients	Regression methods
External validity [RCT & NRS]	Uncertain as study setting was more restrictive than a non-experimental setting	Potential unobserved confounding	Potential unobserved confounding	Potential unobserved confounding
Performance bias				
Blinding of participants and/or investigators [RCT]	No	…	…	…
Measurement of exposure [NRS]	…	No blinding but 5% of medical record abstractions were reviewed for data validity	No blinding	No blinding
Detection bias				
Blinded outcome assessment [RCT & NRS]	No blinding but 100% inter- and intra-observer agreement*	Not reported	Not reported	Not reported
Attrition bias				
Completeness of follow-up [RCT & NRS]	Yes	Yes	35 (8.3%) patients with missing medical records	Yes

* A researcher re-abstracted length of stay data on 10 randomly selected records, and a physician not associated with the study abstracted length of stay from the same 10 records.

Ellipses indicate not applicable.

RCT, randomised controlled trials; NRS, non-randomised studies; LoS, length of stay.

Description of included studies

For the RCT, the mean ages of the patients were 65.3 years for the intervention group and 65.7 years for the comparator group. There were no significant differences between groups for number of medications on admission, cardiac risk index category and ASA score. Patients in the comparator group could still receive a preoperative medical consult, if necessary, but only as an inpatient (i.e. only after admission for surgery), compared with the intervention group who attended an outpatient clinic within three weeks of surgery (Figure 2). A range of surgical procedures across multiple specialties were included, with no significant differences in the proportion of patients in each surgical service.

For the non-randomised comparative studies, patients in the comparator group in one study[8] received consultation from an internist on days other than the intervention or from another specialty but the actual timing of the consult was not reported (Table 2). Comparator groups in the remaining studies received either preoperative anaesthetic assessment only or did not receive any preoperative medical consultation, though no further details were reported (Table 2). The timing of the preoperative medical consult in the intervention groups differed across the three studies (Figure 2). Age ranged from a mean 61.4 years to a mean 70.1 years in the intervention group and a median 58 years to a mean 67.3 years in the comparator group. A range of surgical procedures across multiple specialties were included. Two of the studies focused on clinical outcome measures and the other focused on reviewing the medical consultation process (e.g. reason for consult, consultants' recommendations).

Effectiveness of intervention

Table 3 provides a summary of the effectiveness of preoperative medical consultations by an internal medicine physician for a range of outcomes, as described below.

Surgical cancellations

RCT:

A similar proportion of patients in each group did not undergo surgery (24.4% for a medical consult within 3 weeks and 23.5% for a medical consult after admission but before surgery). Of the surgical cancellations that occurred after the admission for surgery, the patients who received a medical consult after admission (control group) had a higher proportion of cancellations (6.6% higher, 95% CI 0.5% to 12.7%).

Non-randomised comparative studies:

One non-randomised comparative study reported on surgical cancellations.[10] There were no significant differences in the number of surgical cancellations between patients who received an anaesthetic consult and those who received a medical consult.

Length of hospital stay

RCT:

Across all patients, the preoperative length of stay was reduced in the intervention group (1.3 day reduction, 95% CI -1.8 to -0.8), but there was no significant difference between the intervention and control groups for the postoperative and overall length of stay.

Non-randomised comparative studies:

Length of stay was reported in two of the non-randomised comparative studies.[8, 10] After adjustment for observed potential confounding, a medical consult on or around the day of surgery compared with a medical or other specialty consult in two or more days before surgery resulted in a 13% increase in length of stay (95% CI 2% to 26%).[8] There were no significant differences in overall length of stay between the medical and anaesthetic consults but patients who were ASA 3 or higher had a significantly shorter length of stay with a medical consult.[10]

Table 2 Characteristics of included studies

Study & setting	Study type	Population	Intervention	Comparator	N (patients)
Macpherson & Lofgren, 1994[7] Pennsylvania, USA	Level II, randomised controlled trial	>50 years of age, referred from a surgeon, lived within 100 miles of study hospital The most common procedures included upper airway endoscopy under general anaesthetic for head and neck cancer, hip and knee arthroplasty, cataract extraction, transurethral resection of the prostate, and laminectomy	**Medical preoperative evaluation clinic (outpatient)** Consult provided by internist or third-year internal medicine resident supervised by attending internist	**Internal medicine evaluation, if necessary (inpatient)** Consult provided by internist or third-year internal medicine resident supervised by attending internist	176 (intervention) 179 (comparator)
Auerbach et al., 2007[8] California, USA	Level III-2, prospective observational cohort study with concurrent controls	>18 years of age, underwent one of the following surgeries (emergency or elective): colon surgery, cardiac bypass or valve procedures, hip or knee arthroplasty, hysterectomy, vascular surgery	**Medical consult on day before, day of, or first day after surgery** Consult provided by attending physician, and fellow (for sub-specialty services, e.g. cardiology) or third-year internal medicine resident	**Medical consult on days other than intervention or from non-internal medicine services** Consult provided by internist or other specialist	117 (intervention) 1,165 (comparator)
Katz et al., 2005[9] New York, USA	Level III-2, retrospective observational cohort study with concurrent controls	>50 years of age, underwent elective non-cardiac surgery	**Medical consult (as noted in patients' medical records)** Consult provided by internist or family practitioner	**No medical consult noted in patients' medical records** No other comparator details reported	138* (intervention) 249 (comparator)
Vazirani et al., 2012[10] California, USA	Level III-3, pre-post retrospective comparative study	All patients in the Veterans Health Administration database covering the following surgical specialties: ophthalmology, orthopaedics, urology, general surgery	**Hospitalist-run preoperative clinic (outpatient)** Consult provided by mid-level providers with hospitalist oversight	**Preoperative anaesthetic clinic (outpatient)** Consult provided by mid-level providers with anaesthesiologist oversight	2,565 (intervention) 2,658 (comparator)

* 146 consults.

Table 3 Summary of effectiveness of physician-led preoperative assessment by outcome

Outcome and study	Intervention	Comparator	Difference*
Length of stay (days)			
Macpherson & Lofgren, 1994[7] (mean)			
All patients			
Pre-admission for surgery	1.6	2.9	-1.3 (-0.8 to-1.8)
Admission for surgery	3.6	3.0	0.6 (-0.6 to 1.8)
Total	5.5	6.0	-0.5 (-2.0 to 1.1)
Patients who had surgery			
Pre-admission for surgery	1.9	3.0	-1.1 (-0.5 to-1.6)
Admission for surgery	4.8	3.9	0.9 (-0.6 to 2.4)
Total	7.1	7.0	0.1 (-1.7 to 2.0)
Auerbach et al., 2007[8] (median, IQR)			
Before adjustment	10 (7 - 18)	6 (4 - 9)	87% (63% to 115%)†
After adjustment	NR	NR	13% (2% to 26%)†
Vazirani et al., 2012[10]			
Mean (SD)	5.28 (9.24)	9.87 (25.4)	NR
ASA classification			
No disturbance	NR	NR	-1.31 (SE 5.90), p=0.82
Mild	NR	NR	-2.52 (SE 1.39), p=0.07
Severe	NR	NR	-4.22 (SE 0.96), p<0.01
Life-threatening	NR	NR	-19.70 (SE 3.81), p<0.01
Costs (USD)			
Auerbach et al., 2007[8] (median)			
Before adjustment	155,020 (101,473 - 292,951)	74,237 (53,824 - 126,927)	116% (88% to 148%)†
After adjustment	NR	NR	24% (14% to 36%)†
Postoperative complications			
Auerbach et al., 2007[8] (n, %)			
Before adjustment	60 (51.3)	322 (27.6)	OR 2.76 (1.88 to 4.04)

After adjustment	NR	NR	OR 1.51 (0.98 to 2.32)
Mortality			
Katz et al., 2005[9] (n, %)			
Unexpected ICU/death	2 (1.4)	4 (1.6)	p=0.9046
Vazirani et al., 2012[10] (n, %)	4 (0.4)	14 (1.3)	OR 0.31 (0.10 to 0.99)
Surgical cancellations			
Macpherson & Lofgren, 1994[7] (n, %)			
During admission	10 (5.7)	22 (12.3)	-6.6% (-0.5% to -12.7%)
Did not undergo surgery	43 (24.4)	42 (23.5)	NR
Vazirani et al., 2012[10] (n, %)			
Total	368 (14.3)	400 (15.0)	NR
Medically avoidable‡	18 (4.9)	34 (8.5)	p=0.065
Patient satisfaction			
Macpherson & Lofgren, 1994[7]			
MOS SF-22 (higher score indicates better health)			
Health perceptions	38.8	33.1	NS
Pain	55.3	59.8	NS
Physical function	45.7	44.1	NS
Social function	62.3	61.2	NS
Mental health	63.0	58.0	NS
Questionnaire adapted from RAND§ (%)			
Satisfaction with care	73	66	NS
Dissatisfaction with care	39	47	NS
Rated care as very good or excellent	64	54	NS
Rated care as better than most or best	62	54	NS
Overall, very or extremely satisfied	66	58	NS

*Difference reported as mean difference (95% confidence interval of the difference) unless otherwise specified; †Cost and length of stay data were log transformed to normalise data with percentage differences attributable to consultation calculated using the following equation: 100 x (e^{β} - 1); ‡As opposed to unavoidable, patient-related causes ; §Patient satisfaction questionnaire adapted from the RAND Corporation.

ASA, American Society of Anesthesiologists; ICU, intensive care unit; IQR, interquartile range; MOS SF-22, Medical Outcomes Study Short Form-22; NR, not reported; NS, not significant, actual p-value not reported; OR, odds ratio; RR, relative risk; SD, standard deviation; SE, standard error; USD, United States Dollar.

Costs

RCT:

The RCT did not report on costs.

Non-randomised comparative studies:

Only one non-randomised comparative study reported on costs.[8] There was a 24% increase in costs for patients who received a medical consult on or around the day of surgery compared with those who received a medical or other specialty consult in two or more days before surgery, with increases ranging from 14% to 36%.

Postoperative complications

RCT:

The RCT did not report on postoperative complications.

Non-randomised comparative studies:

The odds of complications after postoperative day two for patients receiving a medical consult on or around the day of surgery was 1.51 times greater than for patients receiving a medical or other specialty consult in two or more days before surgery (95% CI 0.98 to 2.32) [8]. Suspected infection, cardiac, pulmonary and other medical complications were the most commonly reported complications.

Mortality

RCT:

The RCT did not report on mortality.

Non-randomised comparative studies:

The likelihood of death in patients who received a medical consult was significantly lower (69% less likely) than those who received an anaesthetic consult.[10]

Patient satisfaction

RCT:

No significant differences in quality of life and quality of care measures at 2 months post-randomisation were reported between patients who received a medical consult in the 3 weeks prior to admission, and following admission.

Non-randomised comparative studies:

None of the non-randomised comparative studies reported on patient satisfaction.

Review of the medical consultation process

In the non-randomised study of preoperative assessment in the four weeks prior to admission,[9] medical records were reviewed to determine the characteristics of the medical consults. The specialty of the requesting physician and the reason for medical consult could not be determined for the majority of the consults (51% and 64%, respectively). Of the remaining, requests for a medical consult were either from surgeons (46%) or other internists or family practitioners (3%), and the main reasons for requesting a medical consult were for clearance (19%) or evaluation (14%). Other reasons included risk assessment (0.7%) and re-assessment (0.7%). Patients' diagnoses were listed in 83% of the consults, with 3% diagnosing a medical condition not previously identified in the admitting history. In terms of recommendations, no recommendations were reported in 43% of the consults, 34% "cleared" the patient for surgery, and 20% provided a risk assessment such as "minimal increased risk" or "no increased risk". Of the 178 preoperative, intraoperative and postoperative recommendations made, documentation in the medical records indicated that 73% were followed, 9% were not followed, and in 18% it could not be determined.

DISCUSSION

The effectiveness of preoperative medical consultation is uncertain due to a lack of high-level comparative evidence. The one RCT[7] identified reported medical consultations in an outpatient setting were effective in reducing surgical cancellations following admission for surgery compared with medical consultations in an inpatient setting. The RCT also reported a small reduction in length of stay for patients who received preadmission preoperative medical consultations, noting that the active control (inpatient medical consults) may have reduced the effect size relative to a non-active control. The observational studies reported mixed results regarding length of stay[8, 10] and mortality[9, 10], and increased costs[8] and postoperative complications[8] in patients who received preoperative medical consults, but these results must be interpreted with caution due to the potential for bias and confounding.

Design limitations in included studies

As well as differences in the comparator arms, the reviewed studies varied with respect to the timing and delivery of the preoperative medical consultation, which precluded the pooling of results. One study evaluated the effect of medical consults on the day before or day of surgery,[8] whilst differences in the timing of preadmission consults may be driven by varying waiting times across forms of elective surgery (e.g. cancer versus non-cancer procedures) and geographical locations. In general, it might be hypothesised that consultations undertaken close to the date of surgery provide less time for optimisation. A recent review of guidelines pertaining to preoperative medical management suggested that consults may be most beneficial when sought at least 4 weeks prior to elective surgery, and when there is a clear understanding of the planned procedure and its associated risks.[11]

The form of preoperative medical consult also varied across the included studies, with minimal detail from each of the studies on the actual services provided as part of the intervention. It was not clear in any of the included studies if the consultant providing the intervention was also involved in the postoperative care of the patient. A one-off consult with recommendations but no patient follow-up may be less effective than a coordinated approach to shared decision making between specialists and physicians for perioperative management. Katz et al.[9] provided some insight into the reasons for requesting a consult but were limited by the information documented in the medical records.

The co-management concept of surgeons managing a patient's surgery and surgery-related issues and the internal medicine physician or geriatrician managing a patient's medical conditions is rational.[12] The results of the review do not confirm nor reject the hypothesis that preoperative medical consultation provides important benefits. The findings suggest that there is significant uncertainty around the overall effect of such services, as well as illustrating the variation in the design and implementation of preoperative assessment.

The role of the general internist compared with other sub-specialists

Internationally, the sub-specialist providing the preoperative medical consultation will vary. Anaesthetists have a different focus and expertise by providing safe anaesthesia and specific perioperative management,[13, 14] which complements the role of the general internist who assesses and optimises the patient's modifiable co-morbidities. Despite a great deal of overlap between geriatrics and general internal

medicine, the focus of a comprehensive geriatric assessment (CGA) may differ to a preoperative medical consultation in some surgical populations. A CGA intervention that focuses on the assessment component only will differ to the focus of a general internist who will assess the patient and recommend specific management plans to optimise modifiable risk factors for adverse postoperative outcomes.[15] For this reason, studies involving a preoperative medical consultation by sub-specialists other than the general internist as the intervention were excluded.

Recommendations for improvements in clinical practice and research design

Currently, there are no clear recommendations regarding the selection of patients who require medical consultation.[16] Given limited resources, patients at high risk of morbidity and mortality should be prioritised for a medical consultation but substantial practice variation exists.[17] The decision to refer a patient for preoperative consultation is at the discretion of the treating surgeon and influenced by the surgeon's personal preference for the intervention, patient preference, patient characteristics and medical history. Auerbach et al.[8] reported increases in postoperative complications with a medical consult but the consults may have been requested for an impending or suspected complication, which would make it difficult to discern whether a consult reduced the risk of complications. Thus, confounding by indication is a major source of bias in the non-randomised comparative studies.[18] Auerbach et al.[8] used propensity scores as weights to adjust for confounding but the authors indicated that patterns of consultation and other unmeasured confounding factors in the patient's medical history or illness may have biased their results. A key potential confounder that may not be adequately represented in the reported studies is frailty, which has been shown to be a predictor of surgical morbidity and mortality, and may also be an important factor in the decision to refer for preoperative medical consultation.[19-21]

Well designed and conducted RCTs can remove potential confounding, but issues remain around the feasibility of such trials and the generalisability of the findings. Having a no-consultation arm in the trial for a patient identified as high risk would be a major challenge, and strict trial conditions cannot be easily translated into clinical practice. In the RCT in this review, patients in the comparator group could still receive a preoperative medical consult as an inpatient, if necessary, and the strict trial conditions on the

timing between admission and surgery may not reflect the application of the intervention in routine clinical practice.

Evidence directly linking preoperative interventions with a reduction in perioperative risk are lacking. Given the multidisciplinary care of patients in a hospital setting, it is difficult to assess whether one particular aspect of care provided directly impacts on a particular outcome. The design of services applied to date is heterogeneous, but the consolidation of existing evidence has identified potential elements of preoperative assessment that may contribute to better outcomes, for example, eligibility criteria for referral, and the timing and process of assessment. In the absence of robust evidence, preoperative medical consultations are likely to remain ad hoc in terms of implementation and design. Qualitative data may provide an in-depth understanding of the processes of care and the perceived value of preoperative consultation. Future research should aim to clearly describe the level of involvement of the internal medicine physician in the surgical decision making process and their relationship with the surgical team. A better understanding of the mechanisms of preoperative medical consultations and the complex decision making processes involved may help explain the relationship between medical consultations and outcomes. Further research is also required to determine the characteristics of patients who would benefit most from medical consultation.

CONCLUSION

Preoperative medical consultations for patients with complex care requirements and in poor health is an intuitive health service development. To date, such services appear to have been developed and implemented on a limited and ad hoc basis, resulting in varied service designs and a lack of evidence on the value of preoperative assessment. With an ageing population and increasing rates of chronic disease, the management of high risk surgical patients is likely to become an increasingly important issue. The available evidence suggests a positive effect of preoperative medical consultation with a general internist compared to standard care, but more conclusive evidence may be needed to persuade hospitals to fund such a service. Alternative forms of preoperative assessment may also need to be considered, such as comprehensive geriatric assessment and there may be scope to optimise the value of such services by closer consideration of referral criteria and the timing of preoperative assessment. Providing continuity of

multidisciplinary care from the decision to operate through to rehabilitation and recovery is certainly logical and intuitive. However, further research is required to inform the value, and the optimal design and implementation of coordinated involvement of physicians and surgeons in the provision of care for high risk surgical patients. A standardised approach to perioperative decision making processes should be developed with a clear protocol or guideline for the assessment and management of surgical patients.

Contributorship statement: All authors (CP, CG, RF, JK) contributed substantially to the conception and design of the study; and the acquisition, analysis, and interpretation of data. CP drafted the work and all authors (CP, CG, RF, JK) provided critical revision for important intellectual content. All authors (CP, CG, RF, JK) approve of the final version to be published; and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated or resolved.

Competing interests: Dr Catherine Gibb is a consultant physician in the High Risk Clinic at the Royal Adelaide Hospital and Queen Elizabeth Hospital. The remaining authors declare no conflict of interest.

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Data sharing statement: Data used in the analysis were extracted from peer-reviewed publications. No additional unpublished data were generated or collected in the study.

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FIGURE LEGENDS

Figure 1 Summary of search results and study selection

Figure 2 The timing of the preoperative medical consult in each included study

Figure 2 legend: *Macpherson & Lofgren [7] compared pre-admission medical consults (outpatient clinic) to post-admission preoperative medical consults (inpatient), and Auerbach et al. [8] compared a medical consult on the day before, day of, or day after surgery to a medical or other specialty consult on days other than the intervention (i.e. two or more days before surgery).

ONLINE SUPPLEMENTARY APPENDIX

Appendix 1. Search Strategies.

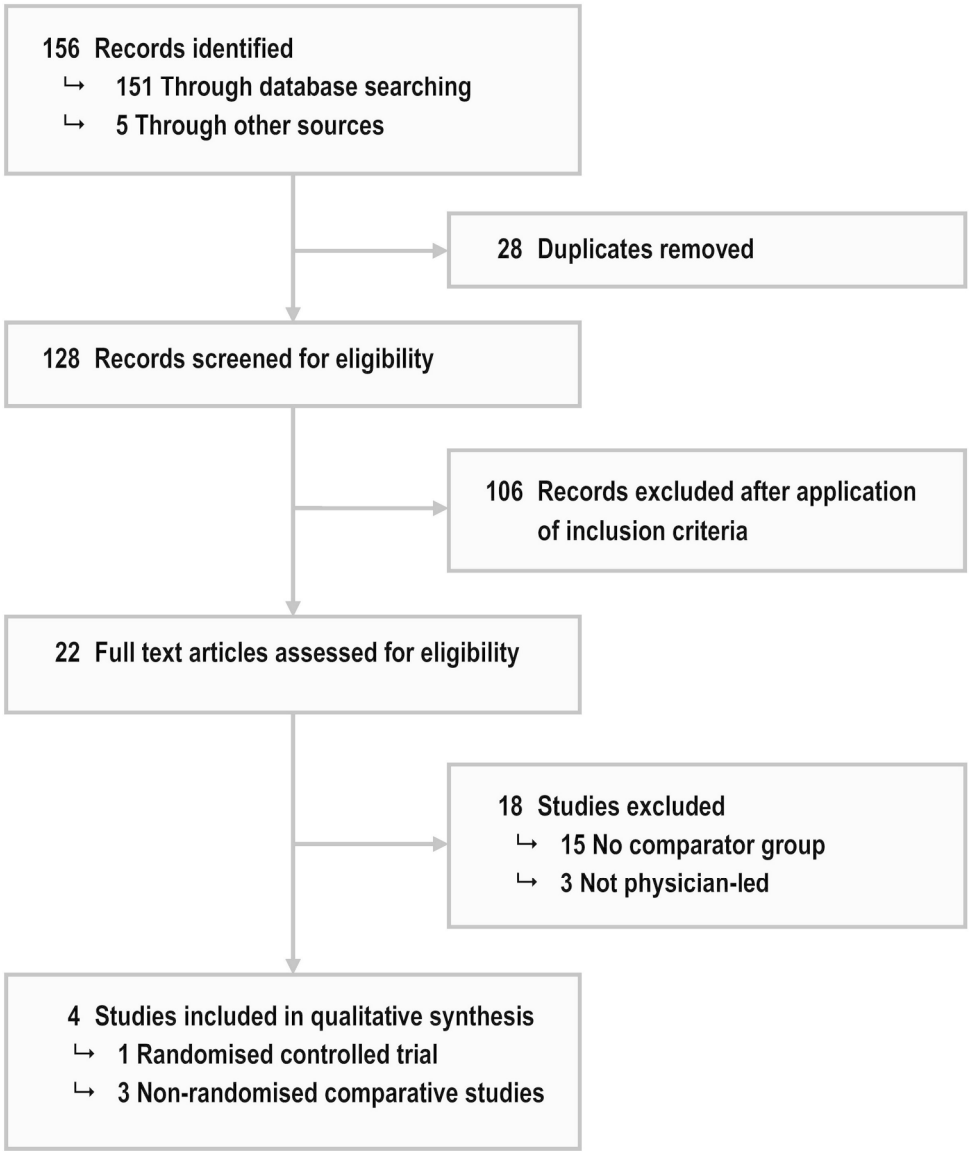

Figure 1. Summary of search results and study selection

209x251mm (300 x 300 DPI)

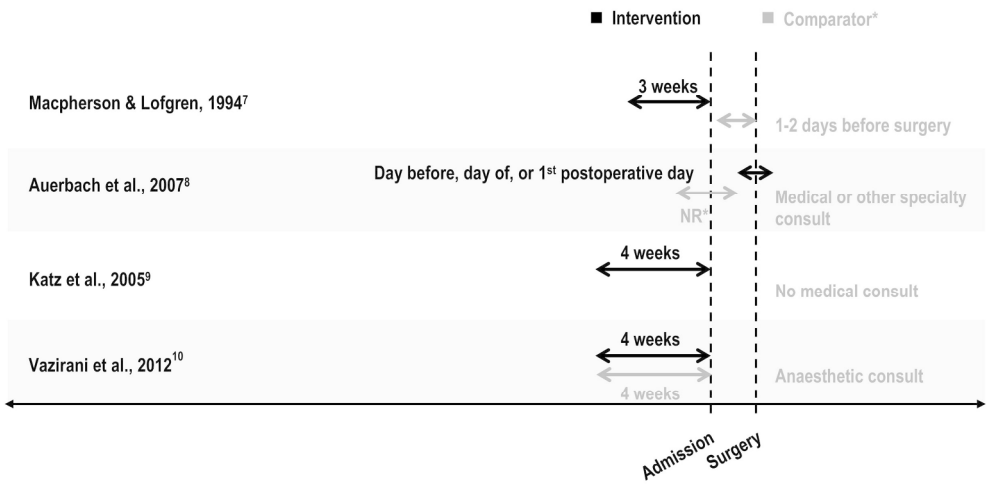

Figure 2. The timing of the preoperative medical consult in each included study

209x104mm (300 x 300 DPI)

Online supplementary material

Appendix 1. Search Strategies

Search strategy for **Centre for Reviews and Dissemination**

#1 MeSH descriptor: [preoperative care] explode all trees
#2 MeSH descriptor: [referral and consultation] explode all trees
#3 (#1 AND #2)

Search strategy for **PubMed**

#1 preoperative[All Fields]
#2 medical[All Fields]
#3 ("referral and consultation"[MeSH Terms] OR ("referral"[All Fields] AND "consultation"[All Fields]) OR "referral and consultation"[All Fields] OR "consultation"[All Fields])
#4 ("surgical procedures, elective"[MeSH Terms] OR ("surgical"[All Fields] AND "procedures"[All Fields] AND "elective"[All Fields]) OR "elective surgical procedures"[All Fields] OR ("elective"[All Fields] AND "surgery"[All Fields]) OR "elective surgery"[All Fields])
#5 (#1 AND #2 AND #3 AND #4)
#6 preoperative[Title]
#7 “medical consultation”[Title]
#8 (#6 AND #7)
#9 “preoperative evaluation”[All Fields]
#10 “internal medicine”[All Fields]
#11 (#9 AND #10)

#12 (“Hospitalists”[MeSH] OR “internal medicine”[MeSH]) AND “preoperative evaluation”[All Fields]

Search strategy for **EMBASE (Elsevier)**

#1 ‘preoperative care’/exp OR ‘preoperative care’
#2 'elective surgery'/exp OR 'elective surgery'
#3 ‘referral and consultation’/exp OR ‘referral and consultation’
#4 (#1 AND #2 AND #3)

Search strategy for **CINAHL (EBSCO host)**

S1 MW ‘preoperative care’
S2 MW ‘elective surgery’
S3 MW medical OR MW ‘referral and consultation’
S4 (S1 AND S2 AND S3)

Search strategy for **Current Contents Connect (Web of Science)**

#1 TOPIC: ’preoperative care’
#2 TOPIC: ’elective surgery’
#3 TOPIC: ’referral and consultation’
#4 (#1 AND #2 AND #3)

Search strategy for **MEDLINE (Ovid)**

#1 exp “preoperative care”/

#2 exp “surgical procedures, elective”/
#3 exp “referral and consultation”/
#4 (#1 AND #2 AND #3)

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5 - 6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	-
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5 - 6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Supporting information
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5 - 6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5 - 6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	-
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6 - 7 & Figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7 - 12 (Table 2)
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	7 - 9 (Table 1)
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	9 - 17 (Table 3)
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	-
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	6 - 7
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	-
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	16 - 20
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	16 - 20
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	19 - 20
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	20

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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