National Institute for Health and Care Excellence

Final

Perioperative care in adults

[M] Evidence review for postoperative recovery in specialist areas

NICE guideline NG180

Evidence reviews underpinning recommendation 1.5.1 and the research recommendation in the NICE guideline

August 2020

Final

This evidence review was developed by the National Guideline Centre

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1 Postoperative management and recovery

1.1 Review question: What is the clinical and cost effectiveness of postoperative recovery in specialist areas, including intensive care, for adults?

1.2 Introduction

Decisions about post-operative destinations for patients undergoing surgery usually fall into two categories. Straightforward, clear-cut decisions where the complexity of the patient comorbidities, the magnitude of the surgery, or both, mandate that the patient requires a higher level of post-operative scrutiny and thus requires a specialist area (high dependency or intensive care) rather than a routine ward. Similarly the lack of the same clearly directs the patient to routine care in a ward environment with no requirement for particular or bespoke observation.

The second category however is much more complex. Patients with varying degrees of complexity undergoing routine procedures, or well patients undergoing complex or major surgeries and any combination of the same form a large population group where decisions about post-operative care requirements become opaque and difficult to define. Clinicians have an obligation not only to clarify how best to manage this group of patients from a care point of view but furthermore must make decisions about appropriateness of resource allocation. Particularly when the resource is limited and comes at a significant financial cost. Specialist areas are both.

Although the first category of patients allow fairly easy decision making on specialist area allocation, this second larger group suffers from a lack of a uniform standards and there exists no national guidance to support such decisions. Usually subjective, non-uniform decisions are taken about this group of patients which leads to two sequelae. Over-triage of resources occurs with significant financial implications. Or under-triage takes place where patients later need to be moved to specialist areas whilst having potentially suffered avoidable complications.

It is thus necessary to determine the patient population that will benefit from recovery in specialist areas thereby allowing appropriate triage of patients to correct areas in the hospital and responsible resource allocation during perioperative planning for what is an expensive and limited resource.

1.3 PICO table

For full details see the review protocol in appendix A.

Table 1: PICO characteristics of review question

Population	Adults 18 years and over having major surgery.
Intervention	Postoperative recovery in specialist areas • level 2 (high dependency unit, post-anaesthesia care unit) • level 3 (intensive care unit)
Comparison	• each other • level 0 (postoperative recovery on a surgical ward) • level 1 (postoperative recovery on a surgical ward with access to a critical care outreach team)

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Outcomes	Critical outcomes: • health-related quality of life • mortality • adverse events and complications (Clavien-Dindo, postoperative morbidity score (POMS)) • unplanned intensive care unit admission/readmission Important outcomes: • length of hospital stay • hospital readmission • postponed/cancelled surgery • patient/family/carer experience of care
Study design	Randomised controlled trials (RCTs), systematic reviews of RCTs. Observational studies if no RCT evidence is identified.

1.4 Clinical evidence

1.4.1 Included studies

Four studies were included in the review.[1, 3, 16, 17] these are summarised in Table 2 below. Evidence from these studies is summarised in the clinical evidence summary below (Table 3).

See also the study selection flow chart in appendix C, study evidence tables in appendix D, forest plots in appendix E and GRADE tables in appendix F.

1.4.2 Excluded studies

See the excluded studies list in appendix I.

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1.4.3 Summary of clinical studies included in the evidence review

Table 2: Summary of studies included in the evidence review

Study	Intervention and comparison	Population	Outcomes	Comments
Arshad 2014[1]	**ICU:** patients were taken directly to the ICU after surgery. Patients often remained sedated and on mechanical ventilation until deemed ready for weaning by the ICU and primary teams. The head and neck surgical staff instructed the ICU nurse as to the location and appearance of the flap and the appropriate Doppler signal. N=119 **PACU/specialist area:** after the patient came out of the operating room, he/she went directly to the post-anaesthesia care unit (PACU) off of mechanical ventilation. Then the floor nurse responsible for the patient's care would come to the PACU and assess the flap appearance and Doppler signal with the surgeons. The patient would then be transferred to the specialty floor after discharge from the PACU. N=125	High risk; elective Patients undergoing free flap surgery for head and neck defects. Mean age: 59 years USA	• Mortality • Length of hospital stay (days) • Complications • unplanned intensive care unit admission/ readmission	Retrospective cohort study; before and after implementation of specialist area. A specialty specific floor was defined as a dedicated ward of the hospital where patients with head and neck cancer typically recover postoperatively.

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Study	Intervention and comparison	Population	Outcomes	Comments
Curran 1998[3]	**ICU**: Post-operative admission to ITU N=31 **Surgical ward:** No admission to the ITU (no more information) N=30	High risk; elective & emergency All general surgical and vascular patients who had an operation lasting longer than 90 minutes or who were aged ≥70 years having a major surgery during the winter period from December to February, and meeting the criteria for perioperative enhanced delivery. Mean age (SEM): 71 years (2.6) UK	• Mortality • Complications • Length of hospital stay	Retrospective cohort study Criteria for enhancement of oxygen delivery. Operation planned to exceed 90minutes and has ≥one of: • Previous severe cardiorespiratory illness — acute myocardial infarction, chronic obstructive pulmonary disease, or stroke • Respiratory failure: PaO2 <8.0 kPa on FIO2 >0.4 or mechanical ventilation > 48 hours • Shock (MAP <60mmHg, CVP <15mmHG, urine output <20ml h, cold and clammy) • Acute abdominal catastrophe with haemodynamic instability (e.g. peritonitis, perforated viscus, pancreatitis) • Acute massive blood loss > 8 units • Age > 70 years with limited physiological reserve in one or more vital organs • Acute renal failure: urea > 20 mmol/l or creatinine > 260 mmol/l • Extensive surgery for carcinoma (e.g. oesophagectomy, gastrectomy cystectomy) • Late-stage vascular disease involving aorta

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Study	Intervention and comparison	Population	Outcomes	Comments
				Patients not admitted to ITU had the lowest mean number of criteria. Patients admitted to ITU also had a higher ASA and POSSUM score. These differences were significant.
Swart 2012[16]	**ICU:** Critical care provided more frequent monitoring than ward care, including hourly determination of pulse, blood pressure, pulse oximetry, respiratory rate and urine output. There was an increased nurse and doctor to patient ratio on the CCU. The intended CCU stay was for the first postoperative night. N=51 **Surgical ward:** Patients received postoperative care in the surgical ward. N=39	High risk; elective care Patients aged ≥45 years scheduled for elective open colorectal resection. Mean age (SD): 72.9 years (8.1) UK	• Mortality • Complications • Length of hospital stay	Prospective cohort study Patients expected to require postoperative critical care were excluded.
Swart 2017[17]	**HDU:** Planned HDU postoperative care. Postoperative care was provided on a 10-bed critical care unit (a combined adult general intensive care and HDU)	Low/intermediate risk; elective surgery Cohort of patients undergoing elective colorectal surgery, whose planned postoperative care was determined by their	• Mortality • Unplanned intensive care unit admission/ readmission • Post-operative	Prospective cohort study For predicted 30 day mortalities of 1–3% (i.e. intermediate risk), an HDU bed was booked but surgery could proceed if an HDU bed was unavailable on the day of the operation.

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Study	Intervention and comparison	Population	Outcomes	Comments
	N=68 **Ward:** Planned Ward postoperative care. Postoperative care was provided on a 24-bed colorectal surgical ward. N=139	predicted 30 day mortality. People with a 1-3% risk of 30 day mortality were included for analysis. Mean age (SD): 72 years (7) UK	complications	

See appendix D for full evidence tables.

1.4.4 Quality assessment of clinical studies included in the evidence review

Table 3: Clinical evidence summary: ICU compared to PACU for adults undergoing surgery – high risk; elective surgery

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with Control	Risk difference with ICU compared to PACU (95% CI)
Mortality	244 (1 study)	⨁⨁⊖⊖ LOW1 due to study design	Not estimable	Moderate	
				0 per 1000	-

(a) Downgraded by 2 increments if the majority of the evidence was from studies with observational/non-randomised study design.

Table 4: Clinical evidence summary: ICU compared to surgical ward for adults undergoing surgery – high risk; elective & emergency surgery

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with Control	Risk difference with ICU compared to surgical ward (95% CI)
Mortality	61 (1 study)	⨁⊖⊖⊖ VERY LOW1,2	RR 3.39 (0.76 to	Moderate	
				226 per	540 more per 1000

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Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with Control	Risk difference with ICU compared to surgical ward (95% CI)
		due to imprecision	15.02)	1000	(from 54 fewer to 1000 more)
Post-operative complications	61 (1 study)	⨁⨁⊖⊖ LOW1 due to study design	RR 1.94 (1.25 to 3)	Moderate	
				433 per 1000	407 more per 1000 (from 108 more to 866 more)

(a) Downgraded by 2 increments if the majority of the evidence was from studies with observational/non-randomised study design.
(b) Downgraded by 1 increment if the confidence interval crossed one MID or by 2 increments if the confidence interval crossed both MIDs.

Table 5: Clinical evidence summary: ICU compared to surgical ward for adults undergoing surgery – high risk; elective surgery

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with Control	Risk difference with ICU compared to surgical ward (95% CI)
Mortality	90 (1 study)	⨁⊖⊖⊖ VERY LOW1,2 due to study design and imprecision	RR 1.53 (0.14 to 16.26)	Moderate	
				26 per 1000	14 more per 1000 (from 22 fewer to 397 more)
Post-operative complications	90 (1 study)	⨁⨁⊖⊖⊖ LOW1 due to study design	Peto OR 0.08 (0.02 to 0.4)	Moderate	
				179 per 1000	165 fewer per 1000 (from 108 to 176 fewer)

(a) Downgraded by 2 increments if the majority of the evidence was from studies with observational/non-randomised study design.
(b) Downgraded by 1 increment if the confidence interval crossed one MID or by 2 increments if the confidence interval crossed both MIDs.

Table 6: Clinical evidence summary: HDU compared to surgical ward for adults undergoing surgery – low/intermediate risk; elective surgery

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with Surgical ward	Risk difference with Low risk - HDU (95% CI)
Mortality	207 (1 study)	⨁⊖⊖⊖ VERY LOW1,2	RR 0.68 (0.07 to	Moderate	
				22 per	7 fewer per 1000

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Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with Surgical ward	Risk difference with Low risk - HDU (95% CI)
	30 days	due to study design and imprecision	6.43)	1000	(from 20 fewer to 119 more)
Post-operative complication: emergency laparotomy	207 (1 study) postoperatively	⨁⨁⨁⊖ MODERATE1,3 due to study design and large effect	OR 0.2 (0.06 to 0.65)	Moderate	
				101 per 1000	79 fewer per 1000 (from 33 fewer to 94 fewer)

(a) Downgraded by 2 increments if the majority of the evidence was from studies with observational/non-randomised study design.
(b) Downgraded by 1 increment if the confidence interval crossed one MID or by 2 increments if the confidence interval crossed both MIDs.
(c) Upgraded by 1 increment if the magnitude of effect is large (OR = 2-5 or OR = 0.5-0.2) or by 2 increments if the magnitude of effect is very large (OR > 5 or OR < 0.2)

See appendix F for full GRADE tables.

Table 7: Evidence not suitable for GRADE analysis: ICU compared to PACU/specialty ward – high risk; elective surgery

Outcome	Study (no. of participants)	Risk of bias	PACU results	ICU results	*P* value
Length of hospital stay (days)	Arshad 2014 (244)	High	Median: 8	Median: 9	0.008
Complications	Arshad 2014 (244)	High	Median: 1	Median: 1	0.67
Unplanned intensive care unit admission/readmission	Arshad 2014 (244)	High	Eleven patients in the non-ICU protocol were secondarily transferred to the ICU because of flap failure.		not reported

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Table 8: Evidence not suitable for GRADE analysis: ICU compared to surgical ward – high risk; elective & emergency surgery

Outcome	Study (no. of participants)	Risk of bias	Surgical ward results	ICU results	*P* value
Length of hospital stay (days)	Curran 1998 (61)	Very high	Median (range): 17 (2-49)	Median (range): 21 (1-121)	not reported

Table 9: Evidence not suitable for GRADE analysis: ICU compared to surgical ward – high risk; elective surgery

Outcome	Study (no. of participants)	Risk of bias	Surgical ward results	ICU results	*P* value
Length of hospital stay (days)	Swart 2012 (90)	High	Median (range): 13 (6-61)	Median (range): 12 (5-41)	not reported

Table 10: Evidence not suitable for GRADE analysis: HDU compared to surgical ward – low/intermediate risk; elective surgery

Outcome	Study (no. of participants)	Risk of bias	PACU results	ICU results	*P* value
Unplanned intensive care unit admission/readmission	Swart 2017 (207)	High	22/139 patients in the non-HDU protocol were secondarily transferred to the HDU. The most common medical or non-surgical reason for unplanned critical care admission was pneumonia.		0.00015

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1.5 Economic evidence

1.5.1 Included studies

Two health economic studies were identified with the relevant comparison and have been included in this review.[7, 17] These are summarised in the health economic evidence profiles below (Table 11 - Table 12) and the health economic evidence table in appendix H.

1.5.2 Excluded studies

No health economic studies that were relevant to this question were excluded due to assessment of limited applicability or methodological limitations.

See also the health economic study selection flow chart in appendix G.

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1.5.3 Summary of studies included in the economic evidence review

Table 11: Health economic evidence profile: Intensive care unit versus general ward

Study	Applicability	Limitations	Other comments	Incremental cost	Incremental QALYs	Cost effectiveness	Uncertainty
Lindemark 2017[7] (Norway)	Partially applicable[(a)]	Potentially serious limitations [(b)]	• Population: General adult ICU population (acute surgery and planned surgery reported). • Intervention 1: General ward • Intervention 2: Intensive care unit • Cost-utility analysis • Probabilistic decision analytic model based on individuals from the Norwegian Intensive Care Registry. • Lifetime horizon	*Acute surgery:* Incremental (2−1): £13,484 *Planned surgery:* Incremental (2−1): £10,552	*Acute surgery:* Incremental (2−1): 1.7 *Planned surgery:* Incremental (2−1): 1.1	*Acute surgery:* £7,932 per QALY gained *Planned surgery:* £8,794 per QALY gained	Probabilistic sensitivity analysis was conducted by performing 1000 iterations. Scenario analyses involved applying a constant ICU or general ward daily cost and another scenario involved accounting for lifetime health care costs beyond 5 years.

Abbreviations: ICER: incremental cost-effectiveness ratio; ICU: intensive care unit; QALY: quality-adjusted life years; RCT: randomised controlled trial

(a) Norwegian healthcare perspective and 2016 Norwegian Kroners may not be relevant to current UK practice. Health related quality of life was not obtained from patients and unclear what valuation method was used. Discount rate used is not in line with NICE reference case methods and cost of day in ICU and general ward was much higher compared to NHS.

(b) Baseline and treatment effects were not obtained from relevant RCT data but from registry data and SAPS 2 model. Unclear if complications were included in the model. Resource use and costs associated with general ward length of stay was based on assumptions.

(c) 2016 Norwegian Kroner converted to UK pounds[13].Cost components incorporated: Cost of day on ICU or general ward, including nurse and physician salary, overheads, medication and disposables.

Table 12: Health economic evidence profile: High dependency unit versus general ward

Study	Applicability	Limitations	Other comments	Incremental cost	Incremental effects	Cost effectiveness	Uncertainty

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Study	Applicability	Limitations	Other comments	Incremental cost	Incremental effects	Cost effectiveness	Uncertainty
Swart 2017[17](UK)	Partially applicable[(a)]	Potentially serious limitations[(b)]	• Population: People undergoing elective colorectal surgery with a 1-3% risk of 30 day mortality • Intervention 1: General ward • Intervention 2: High dependency unit • Cost-consequences analysis (various health outcomes) • Within-trial analysis of a non-randomised study (Swart 2017[17]) • Follow-up: 30 days	-£350[(c)]	**Mortality:** RR 0.68 (CI: 0.07, 6.43); ARD -7 per 1000 **Postoperative complication - emergency laparotomy:** Peto OR 0.2 (CI: 0.06, 0.65); ARD -79 per 1000	Intervention 2 was cost-saving, and led to lower mortality and complications.	n/a

Abbreviations: ARD = absolute risk difference; OR = odds ratio; RR = risk ratio

(a) UK NHS perspective and costs from 2013 may not reflect current practice. Measure of effect is not in line with NICE reference case methods as the analysis does not report QALYs.

(b) Baseline and treatment effects were based on a single cohort study conducted at one hospital England; analysis may not fully capture all outcomes as overall complications were not reported. Source of unit costs based on the payment by results tariff which may understate actual costs incurred by the NHS.

(c) 2013 UK pounds. Cost components incorporated: Cost of ward bed day, HDU bed day and ICU bed day

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1.5.4 Unit costs

Relevant unit costs are provided below to aid consideration of cost effectiveness.

Table 13: UK costs of hospital stay

Ward	Cost (a)	Average length of stay (b)	HRG Code, description
Intensive care unit (cost per day)	£1,384	3.95	CCU02, CCU06 and CCU08 Surgical adult patients (unspecified specialty), Cardiac surgical adult patients predominate and Thoracic surgical adult patients predominate with 1 or more organs supported
High dependency unit (cost per day)	£707	3.95	CCU02, CCU06 and CCU08 Surgical adult patients (unspecified specialty), Cardiac surgical adult patients predominate and Thoracic surgical adult patients predominate with 0 organs supported
General ward bed day	£407	n/a	Based on elective inpatient excess bed days, all episodes excluding paediatrics

(a) NHS Reference Costs 2017/18[6], weighted average calculated
(b) Hospital episode statistics 2016[12], weighted average calculated

1.6 Evidence statements

1.6.1 Clinical evidence statements

No evidence was found for health-related quality of life, hospital readmission, postponed/cancelled surgery, and patient/family/carer experience of care.

ICU compared to PACU for adults undergoing surgery – high risk; elective

Mortality

One study found no clinically important difference of PACU compared to ICU on mortality (1 study, n=244, low quality evidence).

Outcomes not suitable for GRADE analysis:

One study found a statistically significant benefit with PACU for length of hospital stay compared to ICU (1 study, n=244, high risk of bias).

One study found no statistically significant difference between PACU and ICU for complications (1 study, n=244, high risk of bias).

ICU compared to surgical ward for adults undergoing surgery – high risk; elective & emergency

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Mortality

One study found a clinically important difference in mortality between ICU and surgical ward care. Mortality was significantly higher in people treated in ICU (1 study, n=61, very low quality evidence).

Adverse events

One study found a clinically important difference in post-operative complications between ICU and surgical ward care. Complication rate was significantly higher in people treated in ICU (1 study, n=61, low quality evidence).

Outcomes not suitable for GRADE analysis:

One study found length of hospital stay was statistically significantly less with surgical ward care compared to ICU (1 study, n=61, very high risk of bias)

ICU compared to surgical ward for adults undergoing surgery – high risk; elective

Mortality

One study found a clinically important difference in mortality between ICU and surgical ward care. Mortality was significantly higher in people treated in ICU (1 study, n=90, very low quality evidence).

Adverse events

One study found a clinically important difference in post-operative complications between ICU and surgical ward care. Cardiac complication rate was significantly lower in people treated in ICU (1 study, n=90, low quality evidence).

Outcomes not suitable for GRADE analysis:

One study found not statistically significant difference in length of hospital stay was between surgical ward care and ICU (1 study, n=90, high risk of bias)

1.6.2 Health economic evidence statements

- One cost-utility analysis found that ICU was cost effective compared to a general ward (ICER: £8794 per QALY gained in planned surgery; ICER: £7,932 per QALY gained in acute surgery). This analysis was assessed as partially applicable with potentially serious limitations.
- One cost-consequence analysis found that HDU was cost-saving compared to a general ward (cost saving: £350) and reduced mortality and emergency laparotomy. This analysis was assessed as partially applicable with potentially serious limitations.

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1.7 The committee's discussion of the evidence

Please see recommendation 1.5.1 in the guideline.

1.7.1 Interpreting the evidence

1.7.1.1 The outcomes that matter most

The committee agreed that appropriate triage of patients to specialist recovery areas can reduce postoperative morbidity. As such, all-cause mortality, health-related quality of life, adverse events and complications, and unplanned intensive care admission/readmission were considered as the critical outcomes for decision making. The following outcomes were identified as important for postoperative recovery in specialist areas: length of hospital stay, hospital readmission, postponed/cancelled surgery, and patient/family/carer experience of care.

No evidence was found for health-related quality of life, hospital readmission, postponed/cancelled surgery, and patient/family/carer experience of care.

1.7.1.2 The quality of the evidence

All of the evidence included in this review was derived from non-randomised studies. As such, there was an inherent increased risk of bias associated with the evidence presented and a subsequent lower quality grade associated. The committee suggested that the observational nature of the included studies may have allowed for the comparison of disparate populations, with people receiving care in specialist recovery areas likely to have been less well than those seen in general wards.

The quality of evidence that was suitable for GRADE analysis ranged from very low to low. The majority of the evidence was graded at low quality. This was mostly due to study design and imprecision of results.

Outcomes which were not suitable for GRADE analysis were considered to be a high and very high risk of bias.

1.7.1.3 Benefits and harms

The committee discussed the evidence from three studies on postoperative recovery in specialist areas for high risk patients undergoing elective surgery.

One study compared recovery in an ICU to recovery in a PACU followed by transfer to a specialty recovery ward. The committee agreed that there was no notable difference in mortality or complications between people treated in ICU or PACU/specialty ward. The committee also noted that the evidence showed that length of stay was statistically longer in patients treated in an ICU, but felt the difference observed was not of clinical significance.

A second study retrospectively compared high risk patients treated in and ICU to those seen in a surgical recovery ward. The evidence from this study suggested that those treated in an ICU experienced a greater risk of mortality, perioperative complications and increased length of stay. The committee noted that patients not admitted to ICU met fewer of the criteria considered to demonstrate a necessity of ICU care. Patients admitted to ICU also had higher ASA and POSSUM scores prior to surgery, indicating a difference in baseline health between the two comparison groups. The committee felt these differences were significant and contributed towards the differences in the outcomes.

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The final study compared patients treated in an ICU to those receiving care in a surgical recovery ward after surgery. There was evidence of an increased risk of mortality for patients treated in ICU compared to surgical recovery ward after elective surgery. The study also saw those treated in the ICU were at significantly less risk of experiencing cardiac complications. The committee suggested that this reduced risk of cardiac events echoed their experience of care in specialist areas and could strengthen the support for care in specialty areas for people at increased risk of such complications.

The committee also discussed the evidence from one study on postoperative recovery in specialist areas for low to intermediate risk patients undergoing elective surgery. The evidence from this study showed no significant difference in mortality between patients receiving postoperative care in a HDU or a surgical ward. The study did report that those cared for in the surgical ward were significantly more likely to experience the postoperative complication of anastomotic leak. 16% of those cared for in a surgical ward were subsequently transferred to receive critical care, although the committee highlighted that there was no valid way to compare this result relatively to the HDU group already receiving critical care.

The committee agreed that on the whole, the observational data was too significantly confounded by baseline differences in population health to direct any decision making on the location of post-operative care. The committee discussed the benefits such as improved quality of life and reduced incidence of adverse events with a more focussed care in specialist recovery areas. The committee based a recommendation based on this consensus agreement.

1.7.2 Cost effectiveness and resource use

Two economic evaluations were identified for this question. One study was a cost-utility analysis and one was a cost-consequence analysis.

One economic evaluation from Norway identified compared individuals admitted to intensive care units with individuals hypothetically rejected from ICU and receiving care in a general ward. The study was a cost-utility analysis and the model was run separately for over 30,000 individuals, based on individuals from the Norwegian Intensive Care Registry. Results were presented for both acute and planned surgery. Intensive care unit costs were higher than the general ward costs but also generated more QALYs. The cost per QALY gained was £7,932 and £8,794 for acute and planned surgery, respectively. This study was assessed as partially applicable with potentially serious limitations. This was because it was unclear what valuation method was used to measure quality of life, costs included in the model for ICU and general ward stay were much higher than NHS costs and therefore less applicable and it was unclear if complications were included in the model.

One study conducted a cost-consequence analysis based on a single cohort study in the UK. This study followed people undergoing colorectal surgery with a 1-3% risk of 30 day mortality and admitted them to a general ward or high dependency unit. The study showed that the high dependency unit was cost saving and led to lower mortality and complications. This study was rated as partially applicable with potentially serious limitations. Reasons for this rating included: the measure of effect not being in line with the NICE reference as they did not report QALYs, baseline and treatment effects were based on a single study and a small number of people and the source of unit costs were based on the payment by results tariff which does not capture the actual costs incurred by the NHS.

The committee agreed that the cost-utility analysis presented could not help them make a recommendation with regards to intensive care units as they felt that it demonstrated intensive care was cost-effective for those who needed to be admitted to ICU but did not demonstrate who these patients were. Although the cost-consequence analysis was

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conducted in the UK, it was based on a small study conducted at a single hospital and did not fully capture costs.

The committee felt that it was appropriate to admit adults to ICU if they are definitely high risk, but that there was less clarity around adults who are medium risk (ASA grade 2 or 3). In some circumstances, elective patients can be admitted to ICU when it is not necessary which can result in a longer recovery time for the patient and a waste of a scarce and expensive resource. It was agreed that these patients are better off recovering on a general ward as these cases would result in a high cost to the NHS at no additional benefit. From an emergency surgical perspective, there are adults who would benefit from being in ICU but because there are no beds available, they end up on a general ward and their recovery is disadvantaged. The committee discussed that there are limited beds available in ICU and that adults can end up staying in postoperative recovery longer than necessary until there is an available bed. This can have a negative knock-on effect for those waiting to have surgery as their surgery can be cancelled.

Since 2011/12 the number of people admitted to critical care (HDU and ICU) in the NHS has increased by 22.5% (Hospital admitted patient care activity, 2016-17), however, this is the overall figure for medical and surgical patients. Those that have undergone a surgical or anaesthetic procedure make up 43.2% of critical care unit admissions. The average cost of a day in intensive care for surgery is very high costing £1,384. For those admitted to a high dependency unit the cost is £707 per day. For those remaining on a general ward the estimated average cost is £407 per day. Therefore, there are considerable differences in the costs of each of these recovery areas, emphasising the need to ensure that the correct adults are being sent to intensive care.

The committee made a recommendation for people who are at a high risk of complications or mortality and agreed that this was current good practice. There may be some hospitals or specialities that are not using specialist recovery areas for these people and therefore this may have a substantial resource impact for the NHS due to the large number of people affected. For people who are undergoing surgery who are not at high risk, the committee agreed that further evidence would be required to guide practice when it is uncertain whether people would benefit from a specialist recovery area and made a research recommendation.

1.7.3 Other factors the committee took into account

The committee recognise that monitoring is continued into the postoperative period.

The committee agreed that it is challenging to determine the effectiveness of postoperative care in specialist areas given that most people requiring care in specialist areas will be very unwell and it would be unethical to deny these people the care they may need in ICU. The committee agreed any further research would likely need to be conducted with an ill-defined population of patients who do not clearly fulfil the criteria for level two or above care.

The committee also noted that the decision as to where a person receives postoperative care can be subjective and dependant on other variables such as bed availability in specialist recovery areas. In addition, the committee noted that National Emergency Laparotomy Audit recommends consideration of admission to critical care for all high risk patients with a predicted mortality ≥5%. The committee therefore made a recommendation that people who are at risk of complications or mortality should receive postoperative care in specialist areas. This is consistent with current practice.

It was felt that there are clear examples of when people are well enough to be treated postoperatively in a general ward and when people are unwell to the extent where postoperative treatment within an ICU is necessary. However, there is a large group of patients where it is not clear whether they will benefit from the input of specialist teams in specialist areas. Given this is an expensive and limited resource it would be helpful if there was evidence to guide decision making for this patient population. Specifically because there

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is some variation in current practice regarding where people receive care postoperatively. The committee therefore made a research recommendation.

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Appendices

Appendix A: Review protocols

Table 14: Review protocol: enhanced recovery programmes

ID	Field	Content
0.	PROSPERO registration number	Not registered on PROSPERO
1.	Review title	What is the clinical and cost effectiveness of postoperative recovery in specialist areas, including intensive care, for adults?
2.	Review question	What is the clinical and cost effectiveness of postoperative recovery in specialist areas, including intensive care, for adults?
3.	Objective	To determine the clinical and cost effectiveness of postoperative recovery in specialist areas, including intensive care, for adults.
4.	Searches	• Cochrane Central Register of Controlled Trials (CENTRAL) • Cochrane Database of Systematic Reviews (CDSR) • Embase • MEDLINE The searches may be re-run 6 weeks before the final committee meeting and further studies retrieved for inclusion if relevant. The full search strategies will be published in the final review.
5.	Condition or domain being studied	Perioperative care
6.	Population	Inclusion: Older people 60 years and over having surgery. Exclusion: • children and young people aged 17 years and younger • surgery for burns, traumatic brain injury or neurosurgery • day-case surgery • cardiac surgery
7.	Intervention/Exposure/Test	• postoperative recovery in specialist areas o level 2 (high dependency unit, post-anesthesia care unit) o level 3 (intensive care unit)

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8.	Comparator/Reference standard/Confounding factors	• each other • level 0 (postoperative recovery on a surgical ward) • level 1 (postoperative recovery on a surgical ward with access to a critical care outreach team)
9.	Types of study to be included	Randomised controlled trials (RCTs), systematic reviews of RCTs. Observational studies if no RCT evidence is identified.
10.	Other exclusion criteria	Exclusions: • non-English language studies • cross-over randomised controlled trials • studies published before 2000
11.	Context	n/a
12.	Primary outcomes (critical outcomes)	• health-related quality of life • mortality • patient, family and carer experience of care • adverse events and complications (Clavien-Dindo, postoperative morbidity score (POMS)) • unplanned ICU admission/readmission The committee did not agree to on any established minimal clinically important differences, therefore the default MIDs will be used and any difference in mortality will be considered clinically important.
13.	Secondary outcomes (important outcomes)	• length of hospital stay • hospital readmission • unplanned ICU admission • ICU length of stay (planned and unplanned) The committee did not agree to on any established minimal clinically important differences, therefore the default MIDs will be used and any difference in mortality will be considered clinically important.
14.	Data extraction (selection and coding)	EndNote will be used for reference management, sifting, citations and bibliographies. All references identified by the searches and from other sources will be screened for inclusion. 10% of the abstracts will be reviewed by two reviewers, with any disagreements resolved by discussion or, if necessary, a third independent reviewer. The full text of potentially eligible studies will be retrieved and will be assessed in line with the criteria outlined above. Data extractions performed using EviBase, a platform designed and maintained by the National Guideline Centre (NGC)

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15.	Risk of bias (quality) assessment	Risk of bias will be assessed using the appropriate checklist as described in Developing NICE guidelines: the manual. • Systematic reviews: Risk of Bias in Systematic Reviews (ROBIS) • Randomised Controlled Trial: Cochrane RoB (2.0) • Non randomised study, including cohort studies: Cochrane ROBINS-I • Case control study: CASP case control checklist • Controlled before-and-after study or Interrupted time series: Effective Practice and Organisation of Care (EPOC) RoB Tool • Cross sectional study: JBI checklist for cross sectional study • Case series: Institute of Health Economics (IHE) checklist for case series 10% of all evidence reviews are quality assured by a senior research fellow. This includes checking: • papers were included /excluded appropriately • a sample of the data extractions • correct methods are used to synthesise data • a sample of the risk of bias assessments Disagreements between the review authors over the risk of bias in particular studies will be resolved by discussion, with involvement of a third review author where necessary.
16.	Strategy for data synthesis	Pairwise meta-analyses will be performed using Cochrane Review Manager (RevMan5). GRADEpro will be used to assess the quality of evidence for each outcome, taking into account individual study quality and the meta-analysis results. The 4 main quality elements (risk of bias, indirectness, inconsistency and imprecision) will be appraised for each outcome. Publication bias is tested for when there are more than 5 studies for an outcome. The risk of bias across all available evidence was evaluated for each outcome using an adaptation of the 'Grading of Recommendations Assessment, Development and Evaluation (GRADE) toolbox' developed by the international GRADE working group http://www.gradeworkinggroup.org/ • Where meta-analysis is not possible, data will be presented and quality assessed individually per outcome.

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		• CERQual will be used to synthesise data from qualitative studies. • WinBUGS will be used for network meta-analysis, if possible given the data identified. • List any other software planned to be used. Heterogeneity between the studies in effect measures will be assessed using the I^2 statistic and visually inspected. An I^2 value greater than 50% will be considered indicative of substantial heterogeneity. Sensitivity analyses will be conducted based on pre-specified subgroups using stratified meta-analysis to explore the heterogeneity in effect estimates. If this does not explain the heterogeneity, the results will be presented pooled using random-effects.		
17.	Analysis of sub-groups	Strata: • high risk (defined by SORT, P-POSSUM, NSQIP, CPET) • low risk • emergency surgery • elective surgery Subgroups: • older adults (over 60)		
18.	Type and method of review	☒	Intervention	
		☐	Diagnostic	
		☐	Prognostic	
		☐	Qualitative	
		☐	Epidemiologic	
		☐	Service Delivery	
		☐	Other (please specify)	
19.	Language	English		
20.	Country	England		
21.	Anticipated or actual start date	To be added		
22.	Anticipated completion date	To be added		
23.	Stage of review at time of this submission	Review stage	Started	Completed
		Preliminary searches	☐	☐
		Piloting of the study selection process	☐	☐
		Formal screening of search results against eligibility criteria	☐	☐

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		Data extraction	☐	☐
		Risk of bias (quality) assessment	☐	☐
		Data analysis	☐	☐
24.	Named contact	5a. Named contact National Guideline Centre 5b Named contact e-mail perioperativecare@nice.org.uk 5e Organisational affiliation of the review National Institute for Health and Care Excellence (NICE) and the National Guideline Centre		
25.	Review team members	From the National Guideline Centre: Ms Kate Ashmore Ms Kate Kelley Ms Sharon Swaine Mr Ben Mayer Ms Maria Smyth Mr Vimal Bedia Mr Audrius Stonkus Ms Madelaine Zucker Ms Margaret Constanti Ms Annabelle Davis Ms Lina Gulhane		
26.	Funding sources/sponsor	This systematic review is being completed by the National Guideline Centre which receives funding from NICE.		
27.	Conflicts of interest	All guideline committee members and anyone who has direct input into NICE guidelines (including the evidence review team and expert witnesses) must declare any potential conflicts of interest in line with NICE's code of practice for declaring and dealing with conflicts of interest. Any relevant interests, or changes to interests, will also be declared publicly at the start of each guideline committee meeting. Before each meeting, any potential conflicts of interest will be considered by the guideline committee Chair and a senior member of the development team. Any decisions to exclude a person from all or part of a meeting will be documented. Any changes to a member's		

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		declaration of interests will be recorded in the minutes of the meeting. Declarations of interests will be published with the final guideline.	
28.	Collaborators	Development of this systematic review will be overseen by an advisory committee who will use the review to inform the development of evidence-based recommendations in line with section 3 of Developing NICE guidelines: the manual. Members of the guideline committee are available on the NICE website.	
29.	Other registration details	n/a	
30.	Reference/URL for published protocol	n/a	
31.	Dissemination plans	NICE may use a range of different methods to raise awareness of the guideline. These include standard approaches such as: • notifying registered stakeholders of publication • publicising the guideline through NICE's newsletter and alerts • issuing a press release or briefing as appropriate, posting news articles on the NICE website, using social media channels, and publicising the guideline within NICE.	
32.	Keywords	Perioperative care, ICU, HDU, ward, recovery	
33.	Details of existing review of same topic by same authors	n/a	
34.	Current review status	☐	Ongoing
		☒	Completed but not published
		☐	Completed and published
		☐	Completed, published and being updated
		☐	Discontinued
35..	Additional information	n/a	
36.	Details of final publication	www.nice.org.uk	

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Table 15: Health economic review protocol

Review question	All questions – health economic evidence
Objectives	To identify health economic studies relevant to any of the review questions.
Search criteria	• Populations, interventions and comparators must be as specified in the clinical review protocol above. • Studies must be of a relevant health economic study design (cost–utility analysis, cost-effectiveness analysis, cost–benefit analysis, cost–consequences analysis, comparative cost analysis). • Studies must not be a letter, editorial or commentary, or a review of health economic evaluations. (Recent reviews will be ordered although not reviewed. The bibliographies will be checked for relevant studies, which will then be ordered.) • Unpublished reports will not be considered unless submitted as part of a call for evidence. • Studies must be in English.
Search strategy	A health economic study search will be undertaken using population-specific terms and a health economic study filter – see appendix B below.
Review strategy	Studies not meeting any of the search criteria above will be excluded. Studies published before 2003, abstract-only studies and studies from non-OECD countries or the USA will also be excluded. Each remaining study will be assessed for applicability and methodological limitations using the NICE economic evaluation checklist which can be found in appendix H of Developing NICE guidelines: the manual (2014).[9] **Inclusion and exclusion criteria** • If a study is rated as both 'Directly applicable' and with 'Minor limitations' then it will be included in the guideline. A health economic evidence table will be completed and it will be included in the health economic evidence profile. • If a study is rated as either 'Not applicable' or with 'Very serious limitations' then it will usually be excluded from the guideline. If it is excluded then a health economic evidence table will not be completed and it will not be included in the health economic evidence profile. • If a study is rated as 'Partially applicable', with 'Potentially serious limitations' or both then there is discretion over whether it should be included. **Where there is discretion** The health economist will make a decision based on the relative applicability and quality of the available evidence for that question, in discussion with the guideline committee if required. The ultimate aim is to include health economic studies that are helpful for decision-making in the context of the guideline and the current NHS setting. If several studies are considered of sufficiently high applicability and methodological quality that they could all be included, then the health economist, in discussion with the committee if required, may decide to include only the most applicable studies and to selectively exclude the remaining studies. All studies excluded on the basis of applicability or methodological limitations will be listed with explanation in the excluded health economic studies appendix below. The health economist will be guided by the following hierarchies. *Setting:* • UK NHS (most applicable). • OECD countries with predominantly public health insurance systems (for example, France, Germany, Sweden). • OECD countries with predominantly private health insurance systems (for example, Switzerland).

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	• Studies set in non-OECD countries or in the USA will be excluded before being assessed for applicability and methodological limitations. *Health economic study type:* • Cost–utility analysis (most applicable). • Other type of full economic evaluation (cost–benefit analysis, cost-effectiveness analysis, cost–consequences analysis). • Comparative cost analysis. • Non-comparative cost analyses including cost-of-illness studies will be excluded before being assessed for applicability and methodological limitations. *Year of analysis:* • The more recent the study, the more applicable it will be. • Studies published in 2003 or later but that depend on unit costs and resource data entirely or predominantly from before 2003 will be rated as 'Not applicable'. • Studies published before 2003 will be excluded before being assessed for applicability and methodological limitations. *Quality and relevance of effectiveness data used in the health economic analysis:* • The more closely the clinical effectiveness data used in the health economic analysis match with the outcomes of the studies included in the clinical review the more useful the analysis will be for decision-making in the guideline. For example, economic evaluations based on observational studies will be excluded, when the clinical review is only looking for RCTs,

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Appendix B: Literature search strategies

The literature searches for this review are detailed below and complied with the methodology outlined in Developing NICE guidelines: the manual 2014, updated 2018.[9]

For more detailed information, please see the Methodology Review.

B.1 Clinical search literature search strategy

Searches were constructed using a PICO framework where population (P) terms were combined with Intervention (I) and in some cases Comparison (C) terms. Outcomes (O) are rarely used in search strategies for interventions as these concepts may not be well described in title, abstract or indexes and therefore difficult to retrieve. Search filters were applied to the search where appropriate.

Table 16: Database date parameters and filters used

Database	Dates searched	Search filter used
Medline (OVID)	[All years] 1946 – 30 May 2019	Exclusions Randomised controlled trials Systematic review studies Observational studies
Embase (OVID)	[All years] 1974 – 30 May 2019	Exclusions Randomised controlled trials Systematic review studies Observational studies
The Cochrane Library (Wiley)	[All years] Cochrane Reviews to 2019 Issue 5 of 12 CENTRAL to 2019 Issue 5 of 12 DARE, and NHSEED to 2015 Issue 2 of 4 HTA to 2016 Issue 4 of 4	None

Medline (Ovid) search terms

1.	postoperative care/ or exp Postoperative Period/ or exp perioperative nursing/
2.	((postoperative* or postop* or post-op* or post-surg* or postsurg*) adj3 (care* or caring or treat* or nurs* or monitor* or recover* or medicine)).ti,ab.
3.	((care* or caring or treat* or nurs* or recover* or monitor*) adj3 after adj3 (surg* or operat* or anaesthes* or anesthes*)).ti,ab.
4.	or/1-3
5.	limit 4 to English language
6.	(exp child/ or exp pediatrics/ or exp infant/) not (exp adolescent/ or exp adult/ or exp middle age/ or exp aged/)
7.	5 not 6
8.	letter/
9.	editorial/
10.	news/
11.	exp historical article/
12.	Anecdotes as Topic/
13.	comment/

14.	case report/
15.	(letter or comment*).ti.
16.	or/8-15
17.	randomized controlled trial/ or random*.ti,ab.
18.	16 not 17
19.	animals/ not humans/
20.	exp Animals, Laboratory/
21.	exp Animal Experimentation/
22.	exp Models, Animal/
23.	exp Rodentia/
24.	(rat or rats or mouse or mice).ti.
25.	or/18-24
26.	7 not 25
27.	Intensive care units/
28.	Coronary care units/
29.	Recovery room/
30.	Respiratory care units/
31.	((intensive or depend*) adj3 (care or caring or unit*)).ti,ab.
32.	(ICU* or SICU* or MICU* or ITU* or CCU* or CICU* or CVICU* or PACU*).ti,ab.
33.	((care or caring or coronary or respiratory) adj3 unit*).ti,ab.
34.	(outreach or out reach).ti,ab.
35.	(recover* adj2 (ward* or room*)).ti,ab.
36.	(surg* adj2 ward*).ti,ab.
37.	(anesthesia or anaesthesia or postanesthesia or postanaesthesia).ti,ab.
38.	or/27-37
39.	26 and 38
40.	randomized controlled trial.pt.
41.	controlled clinical trial.pt.
42.	randomi#ed.ab.
43.	placebo.ab.
44.	randomly.ab.
45.	clinical trials as topic.sh.
46.	trial.ti.
47.	or/40-46
48.	Meta-Analysis/
49.	Meta-Analysis as Topic/
50.	(meta analy* or metanaly* or metaanaly* or meta regression).ti,ab.
51.	((systematic* or evidence*) adj2 (review* or overview*)).ti,ab.
52.	(reference list* or bibliograph* or hand search* or manual search* or relevant journals).ab.
53.	(search strategy or search criteria or systematic search or study selection or data extraction).ab.
54.	(search* adj4 literature).ab.
55.	(medline or pubmed or cochrane or embase or psychlit or psyclit or psychinfo or psycinfo or cinahl or science citation index or bids or cancerlit).ab.
56.	cochrane.jw.

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57.	((multiple treatment* or indirect or mixed) adj2 comparison*).ti,ab.
58.	or/48-57
59.	Epidemiologic studies/
60.	Observational study/
61.	exp Cohort studies/
62.	(cohort adj (study or studies or analys* or data)).ti,ab.
63.	((follow up or observational or uncontrolled or non randomi#ed or epidemiologic*) adj (study or studies or data)).ti,ab.
64.	((longitudinal or retrospective or prospective or cross sectional) and (study or studies or review or analys* or cohort* or data)).ti,ab.
65.	Controlled Before-After Studies/
66.	Historically Controlled Study/
67.	Interrupted Time Series Analysis/
68.	(before adj2 after adj2 (study or studies or data)).ti,ab.
69.	or/59-68
70.	exp case control study/
71.	case control*.ti,ab.
72.	or/70-71
73.	69 or 72
74.	Cross-sectional studies/
75.	(cross sectional and (study or studies or review or analys* or cohort* or data)).ti,ab.
76.	or/74-75
77.	69 or 76
78.	69 or 72 or 76
79.	39 and (47 or 58 or 78)

Embase (Ovid) search terms

1.	*postoperative care/ or *postoperative period/ or *perioperative nursing/ or *surgical patient/
2.	((postoperative* or postop* or post-op* or post-surg* or postsurg*) adj3 (care* or caring or treat* or nurs* or monitor* or recover* or medicine)).ti,ab.
3.	((care* or caring or treat* or nurs* or recover* or monitor*) adj3 after adj3 (surg* or operat* or anaesthes* or anesthes*)).ti,ab.
4.	or/1-3
5.	limit 4 to English language
6.	(exp child/ or exp pediatrics/) not (exp adult/ or exp adolescent/)
7.	5 not 6
8.	letter.pt. or letter/
9.	note.pt.
10.	editorial.pt.
11.	case report/ or case study/
12.	(letter or comment*).ti.
13.	or/8-12
14.	randomized controlled trial/ or random*.ti,ab.
15.	13 not 14
16.	animal/ not human/
17.	nonhuman/

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18.	exp Animal Experiment/
19.	exp Experimental Animal/
20.	animal model/
21.	exp Rodent/
22.	(rat or rats or mouse or mice).ti.
23.	or/15-22
24.	7 not 23
25.	*intensive care unit/ or exp coronary care unit/ or *medical intensive care unit/ or *neurological intensive care unit/ or *surgical intensive care unit/
26.	((intensive or depend*) adj3 (care or caring or unit*)).ti,ab.
27.	(ICU* or SICU* or MICU* or ITU* or CCU* or CICU* or CVICU*).ti,ab.
28.	((care or caring or coronary or respiratory) adj3 unit*).ti,ab.
29.	(outreach or out reach).ti,ab.
30.	(recover* adj2 (ward* or room*)).ti,ab.
31.	(surg* adj2 ward*).ti,ab.
32.	(anesthesia or anaesthesia or postanesthesia or postanaesthesia).ti,ab.
33.	or/25-32
34.	24 and 33
35.	random*.ti,ab.
36.	factorial*.ti,ab.
37.	(crossover* or cross over*).ti,ab.
38.	((doubl* or singl*) adj blind*).ti,ab.
39.	(assign* or allocat* or volunteer* or placebo*).ti,ab.
40.	crossover procedure/
41.	single blind procedure/
42.	randomized controlled trial/
43.	double blind procedure/
44.	or/35-43
45.	systematic review/
46.	Meta-Analysis/
47.	(meta analy* or metanaly* or metaanaly* or meta regression).ti,ab.
48.	((systematic* or evidence*) adj2 (review* or overview*)).ti,ab.
49.	(reference list* or bibliograph* or hand search* or manual search* or relevant journals).ab.
50.	(search strategy or search criteria or systematic search or study selection or data extraction).ab.
51.	(search* adj4 literature).ab.
52.	(medline or pubmed or cochrane or embase or psychlit or psyclit or psychinfo or psycinfo or cinahl or science citation index or bids or cancerlit).ab.
53.	cochrane.jw.
54.	((multiple treatment* or indirect or mixed) adj2 comparison*).ti,ab.
55.	or/45-54
56.	Epidemiologic studies/
57.	Observational study/
58.	exp Cohort studies/
59.	(cohort adj (study or studies or analys* or data)).ti,ab.

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60.	((follow up or observational or uncontrolled or non randomi#ed or epidemiologic*) adj (study or studies or data)).ti,ab.
61.	((longitudinal or retrospective or prospective or cross sectional) and (study or studies or review or analys* or cohort* or data)).ti,ab.
62.	Controlled Before-After Studies/
63.	Historically Controlled Study/
64.	Interrupted Time Series Analysis/
65.	(before adj2 after adj2 (study or studies or data)).ti,ab.
66.	or/56-65
67.	exp case control study/
68.	case control*.ti,ab.
69.	or/67-68
70.	66 or 69
71.	Cross-sectional studies/
72.	(cross sectional and (study or studies or review or analys* or cohort* or data)).ti,ab.
73.	or/71-72
74.	66 or 73
75.	66 or 69 or 73
76.	34 and (44 or 55 or 75)

Cochrane Library (Wiley) search terms

#1.	MeSH descriptor: [Postoperative Care] this term only
#2.	MeSH descriptor: [Postoperative Period] this term only
#3.	MeSH descriptor: [Perioperative Nursing] this term only
#4.	(or #1-#3)
#5.	((postoperative* or postop* or post-op* or post-surg* or postsurg*) near/3 (care* or caring or treat* or nurs* or monitor* or recover* or medicine)):ti,ab
#6.	((care* or caring or treat* or nurs* or recover* or monitor*) near/3 (after) near/3 (surg* or operat* or anaesthes* or anesthes*)):ti,ab
#7.	(or #4-#6)
#8.	MeSH descriptor: [Intensive Care Units] this term only
#9.	MeSH descriptor: [Coronary Care Units] this term only
#10.	MeSH descriptor: [Recovery Room] this term only
#11.	MeSH descriptor: [Respiratory Care Units] this term only
#12.	((intensive or depend*) near/3 (care or caring or unit*)):ti,ab
#13.	(ICU* or SICU* or MICU* or ITU* or CCU* or CICU* or CVICU* or PACU*):ti,ab
#14.	((care or caring or coronary or respiratory) near/3 unit*):ti,ab
#15.	(outreach or out reach):ti,ab
#16.	(recover* near/2 (ward* or room* or unit*)):ti,ab
#17.	(surg* near/2 ward*):ti,ab
#18.	(anesthesia or anaesthesia or postanesthesia or postanaesthesia):ti,ab
#19.	(or #8-#18)
#20.	#7 and #19

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B.2 Health Economics literature search strategy

Health economic evidence was identified by conducting a broad search relating to the perioperative care population in NHS Economic Evaluation Database (NHS EED – this ceased to be updated after March 2015) and the Health Technology Assessment database (HTA) with no date restrictions. NHS EED and HTA databases are hosted by the Centre for Research and Dissemination (CRD). Additional health economics searches were run on Medline and Embase.

Table 17: Database date parameters and filters used

Database	Dates searched	Search filter used
Medline	2014 – 30 May 2019	Exclusions Health economics studies
Embase	2014 – 30 May 2019	Exclusions Health economics studies
Centre for Research and Dissemination (CRD)	HTA - Inception – 02 May 2019 NHSEED - Inception to 02 May 2019	None

Medline (Ovid) search terms

1.	exp Preoperative Care/ or exp Perioperative Care/ or exp Perioperative Period/ or exp Perioperative Nursing/
2.	((pre-operative* or preoperative* or preop* or pre-op* or pre-surg* or presurg*) adj3 (care* or caring or treat* or nurs* or monitor* or recover* or medicine)).ti,ab.
3.	((perioperative* or peri-operative* or intraoperative* or intra-operative* or intrasurg* or intra-surg* or peroperat* or per-operat*) adj3 (care* or caring or treat* or nurs* or monitor* or recover* or medicine)).ti,ab.
4.	((postoperative* or postop* or post-op* or post-surg* or postsurg*) adj3 (care* or caring or treat* or nurs* or monitor* or recover* or medicine)).ti,ab.
5.	((care* or caring or treat* or nurs* or recover* or monitor*) adj3 (before or prior or advance or during or after) adj3 (surg* or operat* or anaesthes* or anesthes*)).ti,ab.
6.	1 or 2 or 3 or 4 or 5
7.	(intraoperative* or intra-operative* or intrasurg* or intra-surg* or peroperat* or per-operat* or perioperat* or peri-operat*).ti,ab.
8.	((during or duration) adj3 (surg* or operat* or anaesthes* or anesthes*)).ti,ab.
9.	7 or 8
10.	postoperative care/ or exp Postoperative Period/ or exp Perioperative nursing/
11.	(postop* or post-op* or post-surg* or postsurg* or perioperat* or peri-operat*).ti,ab.
12.	(after adj3 (surg* or operat* or anaesthes* or anesthes*)).ti,ab.
13.	(post adj3 (operat* or anaesthes* or anesthes*)).ti,ab.
14.	10 or 11 or 12 or 13
15.	exp Preoperative Care/ or Preoperative Period/
16.	(pre-operat* or preoperat* or pre-surg* or presurg*).ti,ab.
17.	((before or prior or advance or pre or prepar*) adj3 (surg* or operat* or anaesthes* or anesthes*)).ti,ab.
18.	15 or 16 or 17
19.	6 or 9 or 14 or 18
20.	letter/
21.	editorial/

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22.	news/
23.	exp historical article/
24.	Anecdotes as Topic/
25.	comment/
26.	case report/
27.	(letter or comment*).ti.
28.	or/20-27
29.	randomized controlled trial/ or random*.ti,ab.
30.	28 not 29
31.	animals/ not humans/
32.	exp Animals, Laboratory/
33.	exp Animal Experimentation/
34.	exp Models, Animal/
35.	exp Rodentia/
36.	(rat or rats or mouse or mice).ti.
37.	or/30-36
38.	19 not 37
39.	limit 38 to English language
40.	(exp child/ or exp pediatrics/ or exp infant/) not (exp adolescent/ or exp adult/ or exp middle age/ or exp aged/)
41.	39 not 40
42.	economics/
43.	value of life/
44.	exp "costs and cost analysis"/
45.	exp Economics, Hospital/
46.	exp Economics, medical/
47.	Economics, nursing/
48.	economics, pharmaceutical/
49.	exp "Fees and Charges"/
50.	exp budgets/
51.	budget*.ti,ab.
52.	cost*.ti.
53.	(economic* or pharmaco?economic*).ti.
54.	(price* or pricing*).ti,ab.
55.	(cost* adj2 (effectiv* or utilit* or benefit* or minimi* or unit* or estimat* or variable*)).ab.
56.	(financ* or fee or fees).ti,ab.
57.	(value adj2 (money or monetary)).ti,ab.
58.	or/42-57
59.	41 and 58

Embase (Ovid) search terms

1.	*preoperative period/ or *intraoperative period/ or *postoperative period/ or *perioperative nursing/ or *surgical patient/
2.	((pre-operative* or preoperative* or preop* or pre-op* or pre-surg* or presurg*) adj3 (care* or caring or treat* or nurs* or monitor* or recover* or medicine)).ti,ab.
3.	((perioperative* or peri-operative* or intraoperative* or intra-operative* or intrasurg* or intra-surg* or peroperat* or per-operat*) adj3 (care* or caring or treat* or nurs* or

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	monitor* or recover* or medicine)).ti,ab.
4.	((care* or caring or treat* or nurs* or recover* or monitor*) adj3 (before or prior or advance or during or after) adj3 (surg* or operat* or anaesthes* or anesthes*)).ti,ab.
5.	1 or 2 or 3 or 4
6.	peroperative care/ or exp peroperative care/ or exp perioperative nursing/
7.	(intraoperative* or intra-operative* or intrasurg* or intra-surg* or peroperat* or per-operat* or perioperat* or peri-operat*).ti,ab.
8.	((during or duration) adj3 (surg* or operat* or anaesthes* or anesthes*)).ti,ab.
9.	6 or 7 or 8
10.	postoperative care/ or exp postoperative period/ or perioperative nursing/
11.	(postop* or post-op* or post-surg* or postsurg* or perioperat* or peri-operat*).ti,ab.
12.	(after adj3 (surg* or operat* or anaesthes* or anesthes*)).ti,ab.
13.	(post adj3 (operat* or anaesthes* or anesthes*)).ti,ab.
14.	10 or 11 or 12 or 13
15.	exp preoperative care/ or preoperative period/
16.	(pre-operat* or preoperat* or pre-surg* or presurg*).ti,ab.
17.	((before or prior or advance or pre or prepar*) adj3 (surg* or operat* or anaesthes* or anesthes*)).ti,ab.
18.	15 or 16 or 17
19.	5 or 9 or 14 or 18
20.	letter.pt. or letter/
21.	note.pt.
22.	editorial.pt.
23.	case report/ or case study/
24.	(letter or comment*).ti.
25.	or/20-24
26.	randomized controlled trial/ or random*.ti,ab.
27.	25 not 26
28.	animal/ not human/
29.	nonhuman/
30.	exp Animal Experiment/
31.	exp Experimental Animal/
32.	animal model/
33.	exp Rodent/
34.	(rat or rats or mouse or mice).ti.
35.	or/27-34
36.	19 not 35
37.	limit 36 to English language
38.	(exp child/ or exp pediatrics/) not (exp adult/ or exp adolescent/)
39.	37 not 38
40.	health economics/
41.	exp economic evaluation/

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42.	exp health care cost/
43.	exp fee/
44.	budget/
45.	funding/
46.	budget*.ti,ab.
47.	cost*.ti.
48.	(economic* or pharmaco?economic*).ti.
49.	(price* or pricing*).ti,ab.
50.	(cost* adj2 (effectiv* or utilit* or benefit* or minimi* or unit* or estimat* or variable*)).ab.
51.	(financ* or fee or fees).ti,ab.
52.	(value adj2 (money or monetary)).ti,ab.
53.	or/40-52
54.	39 and 53

NHS EED and HTA (CRD) search terms

#1.	MeSH DESCRIPTOR Preoperative Care EXPLODE ALL TREES
#2.	MeSH DESCRIPTOR Perioperative Care EXPLODE ALL TREES
#3.	MeSH DESCRIPTOR Perioperative Period EXPLODE ALL TREES
#4.	MeSH DESCRIPTOR Perioperative Nursing EXPLODE ALL TREES
#5.	(((perioperative* or peri-operative* or intraoperative* or intra-operative* or intrasurg* or intra-surg* or peroperat* or per-operat*) adj3 (care* or caring or treat* or nurs* or monitor* or recover* or medicine)))
#6.	(((care* or caring or treat* or nurs* or recover* or monitor*) adj3 (before or prior or advance or during or after) adj3 (surg* or operat* or anaesthes* or anesthes*)))
#7.	(((pre-operative* or preoperative* or preop* or pre-op* or pre-surg* or presurg*) adj3 (care* or caring or treat* or nurs* or monitor* or recover* or medicine)))
#8.	(((postoperative* or postop* or post-op* or post-surg* or postsurg*) adj3 (care* or caring or treat* or nurs* or monitor* or recover* or medicine)))
#9.	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8
#10.	(* IN HTA)
#11.	(* IN NHSEED)
#12.	#9 AND #10
#13.	#9 AND #11
#14.	MeSH DESCRIPTOR Intraoperative Care EXPLODE ALL TREES
#15.	#1 OR #2 OR #3 OR #4 OR #14
#16.	((intraoperative* or intra-operative* or intrasurg* or intra-surg* or peroperat* or per-operat* or perioperat* or peri-operat*))
#17.	(((during or duration) adj3 (surg* or operat* or anaesthes* or anesthes*)))
#18.	((postop* or post-op* or post-surg* or postsurg* or perioperat* or peri-operat*))
#19.	((after adj3 (surg* or operat* or anaesthes* or anesthes*)))
#20.	((post adj3 (operat* or anaesthes* or anesthes*)))
#21.	((pre-operat* or preoperat* or pre-surg* or presurg*))
#22.	(((before or prior or advance or pre or prepar*) adj3 (surg* or operat* or anaesthes* or anesthes*)))
#23.	#15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22
#24.	#10 AND #23

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#25.	#11 AND #23
#26.	#12 OR #13 OR #24 OR #25

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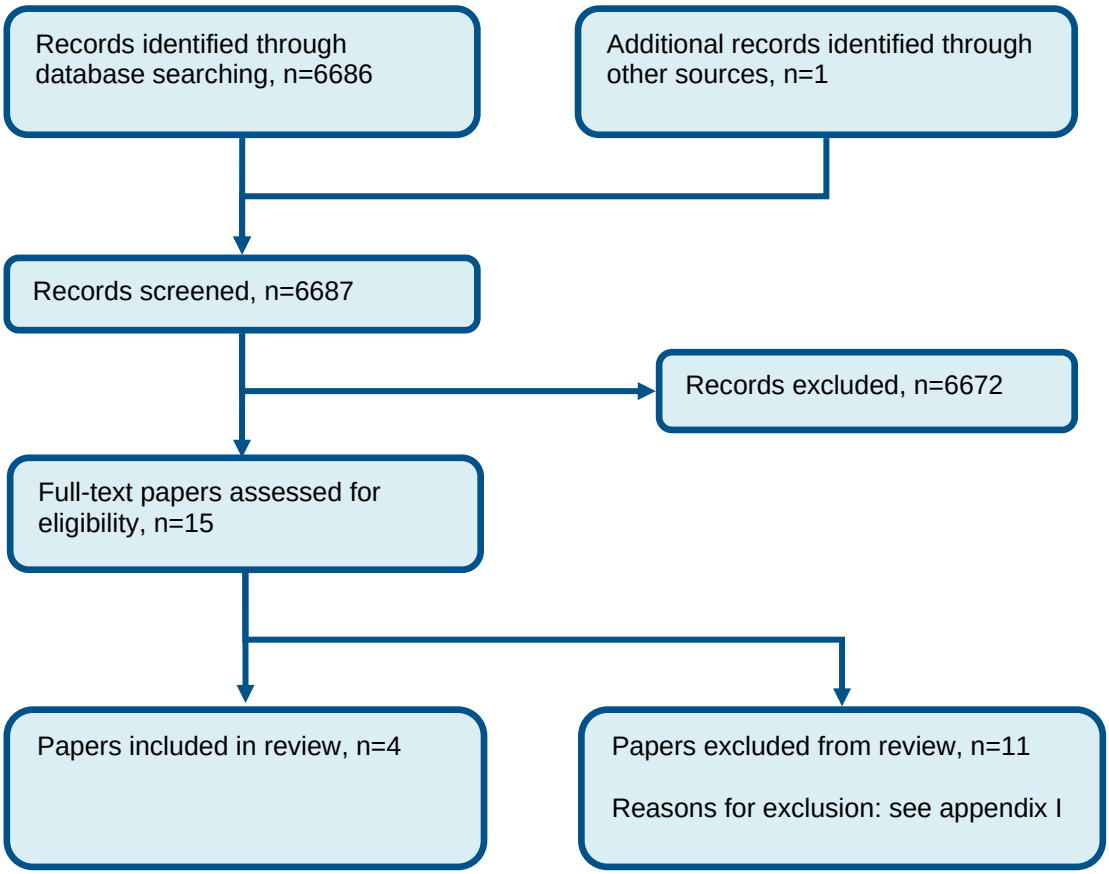
Appendix C: Clinical evidence selection

Figure 1: Flow chart of clinical study selection for the review of postoperative recovery in specialist areas.



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Appendix D: Clinical evidence tables

Study	Arshad 2014[1]
Study type	Non-randomised comparative study
Number of studies (number of participants)	(n=257)
Countries and setting	USA
Line of therapy	Not applicable
Duration of study	Intervention time: Admission to discharge
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	High risk
Subgroup analysis within study	Not applicable
Inclusion criteria	Patients undergoing free flap surgery for head and neck defects.
Exclusion criteria	Not reported
Recruitment/selection of patients	patients undergoing surgery from June 1, 2006, to June 30, 2010
Age, gender and ethnicity	Age - Mean (SD): 59. Gender (M:F): 161/83
Further population details	1. Age: <60 years
Extra comments	All patients before February 17, 2009 (ICU group) went straight to the ICU after surgery. The patients after that date (non-ICU) went straight to a "specialty specific floor.''
Indirectness of population	No indirectness
Interventions	(n=119) Intervention 1: Postoperative recovery in specialist areas - Level 3 (intensive care unit). ICU protocol patients were taken directly to the ICU after surgery. Patients often remained sedated and on mechanical ventilation until deemed ready for weaning by the ICU and primary teams. The head and neck surgical staff instructed the ICU nurse as to the location and appearance of the flap and the appropriate Doppler signal.. Duration Post-operative period. Concurrent medication/care: Nurses checked the flap appearance and Doppler signal every hour for 48 hours, whereas residents checked it every 4 hours with Doppler and pinprick. After 48 hours, the flap was evaluated every 4 hours by the nurse and every 8 hours by the residents for an additional 2 days. Subsequent to this, the flap was checked once per shift by the nurses and twice daily by residents. All patients received daily aspirin.. Indirectness: No indirectness

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	(n=138) Intervention 2: Postoperative recovery in specialist areas - Level 2 (high dependency unit, post-anesthesia care unit). In the non-ICU protocol, after the patient came out of the operating room (OR), he/she went directly to the post-an-esthesia care unit (PACU) off of mechanical ventilation. Then the floor nurse responsible for the patient's care would come to the PACU and assess the flap appearance and Doppler signal with the surgeons. The patient would then be transferred to the specialty floor after discharge from the PACU.. Duration Post-operative period. Concurrent medication/care: Nurses checked the flap appearance and Doppler signal every hour for 48 hours, whereas residents checked it every 4 hours with Doppler and pinprick. After 48 hours, the flap was evaluated every 4 hours by the nurse and every 8 hours by the residents for an additional 2 days. Subsequent to this, the flap was checked once per shift by the nurses and twice daily by residents. All patients received daily aspirin.. Indirectness: No indirectness Comments: A specialty specific floor was defined as a dedicated ward of the hospital where patients with head and neck cancer typically recover postoperatively.
Funding	Funding not stated

RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: LEVEL 3 (INTENSIVE CARE UNIT) versus LEVEL 2 (HIGH DEPENDENCY UNIT, POST-ANESTHESIA CARE UNIT)

Protocol outcome 1: Mortality
- Actual outcome for High risk: Death at Admission to discharge; Group 1: 0/119, Group 2: 0/125
Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 0; Group 2 Number missing: 13, Reason: admitted to the ICU immediately after surgery because of coincident craniotomy and/or thoracotomy

Protocol outcome 2: Perioperative complications
- Actual outcome for High risk: Post-operative complications at Admission to discharge; p: 0.67, Comments: Median ICU:1 PCU:1);
Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 0; Group 2 Number missing: 13, Reason: admitted to the ICU immediately after surgery because of coincident craniotomy and/or thoracotomy

Protocol outcome 3: Length of hospital stay
- Actual outcome for High risk: Length of hospital stay at Admission to discharge; p: 0.08, Comments: Median ICU: 9 PACU: 8);
Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 0; Group 2 Number missing: 13, Reason: admitted to the ICU immediately after surgery because of coincident craniotomy and/or thoracotomy

Protocol outcome 4: Unplanned intensive unit admission

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- Actual outcome for High risk: ICU admission at Admission to discharge; Eleven patients in the non-ICU protocol were secondarily transferred to the ICU because of flap failure.; Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 0; Group 2 Number missing: 13, Reason: admitted to the ICU immediately after surgery because of coincident craniotomy and/or thoracotomy	
Protocol outcomes not reported by the study	Quality of life ; Hospital readmission ; Postponed/cancelled surgery ; Patient, family and carer experience of care

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Study	Curran 1998[3]
Study type	Non-randomised comparative study
Number of studies (number of participants)	(n=101)
Countries and setting	Conducted in United Kingdom
Line of therapy	Not applicable
Duration of study	Intervention + follow up: Admission to discharge
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	High risk (defined by SORT, P-POSSUM, NSQIP, CPET)
Subgroup analysis within study	Not applicable
Inclusion criteria	All general surgical and vascular patients who had an operation lasting longer than 90 minutes or who were aged ≥70 years having a major surgery during the winter period from December to February, and meeting the criteria for perioperative enhanced delivery.
Exclusion criteria	Define
Age, gender and ethnicity	Age - Other: Mean (SEM): 71 (2.6). Gender (M:F): Not reported
Further population details	1. Age:
Indirectness of population	No indirectness
Interventions	(n=31) Intervention 1: Postoperative recovery in specialist areas - Level 3 (intensive care unit). Post-operative admission to ITU. Duration Post-operative period. Concurrent medication/care: Not reported. Indirectness: No indirectness (n=30) Intervention 2: Postoperative recovery in non-specialist areas (standard care) - Level 0 (postoperative recovery on a surgical ward). No admission to the ITU (no more information). Duration Post-operative period. Concurrent medication/care: Not reported. Indirectness: No indirectness
Funding	Funding not stated

RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: LEVEL 3 (INTENSIVE CARE UNIT) versus LEVEL 0 (POSTOPERATIVE RECOVERY ON A SURGICAL WARD)

Protocol outcome 1: Mortality
- Actual outcome for High risk (defined by SORT, P-POSSUM, NSQIP, CPET): Mortality at 28 days; Group 1: 7/31, Group 2: 2/30
Risk of bias: All domain - High, Selection - Flawed, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Baseline details: Patients not admitted to ITU had the lowest mean number of criteria.

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Patients admitted to ITU also had a higher ASA and POSSUM score. These differences were significant. Protocol outcome 2: Perioperative complications - Actual outcome for High risk (defined by SORT, P-POSSUM, NSQIP, CPET): Post-operative complications at Post-operative period; Group 1: 26/31, Group 2: 13/30 Risk of bias: All domain - High, Selection - Flawed, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Baseline details: Patients not admitted to ITU had the lowest mean number of criteria. Patients admitted to ITU also had a higher ASA and POSSUM score. These differences were significant. Protocol outcome 3: Length of hospital stay - Actual outcome for High risk (defined by SORT, P-POSSUM, NSQIP, CPET): Hospital stay (days) at n/a; Median (range): ICU: 21 (1-121); surgical ward: 17 (2-49); Risk of bias: All domain - High, Selection - Flawed, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Baseline details: Patients not admitted to ITU had the lowest mean number of criteria. Patients admitted to ITU also had a higher ASA and POSSUM score. These differences were significant.	
Protocol outcomes not reported by the study	Quality of life ; Unplanned intensive unit admission ; Hospital readmission ; Postponed/cancelled surgery ; Patient, family and carer experience of care

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Study	Swart 2012[16]
Study type	Non-randomised comparative study
Number of studies (number of participants)	(n=153)
Countries and setting	Conducted in United Kingdom; Setting: UK hospitals; elective surgery.
Line of therapy	Unclear
Duration of study	Intervention time: Admission to discharge
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Elective surgery
Subgroup analysis within study	Not applicable
Inclusion criteria	Patients aged ≥45 years scheduled for elective open colorectal resection.
Exclusion criteria	Patients expected to require postoperative critical care.
Recruitment/selection of patients	Patients scheduled to undergo surgery recruited.
Age, gender and ethnicity	Age - Mean (SD): 72.9 (8.1). Gender (M:F): 44/46
Further population details	1. Age: >60 years (72.9).
Extra comments	Patients underwent cardiopulmonary exercise testing prior to surgery. A subgroup of patients with an anaerobic threshold of <11 ml O2/kg/m were allocated to post-anaesthetic care in either the critical care unit or a surgical ward.
Indirectness of population	No indirectness
Interventions	(n=51) Intervention 1: Postoperative recovery in specialist areas - Level 3 (intensive care unit). Critical care provided more frequent monitoring than ward care, including hourly determination of pulse, blood pressure, pulse oximetry, respiratory rate and urine output. There was an increased nurse and doctor to patient ratio on the CCU. The intended CCU stay was for the first postoperative night. . Duration Post-operative period. Concurrent medication/care: Patients underwent a cardiopulmonary exercise test.. Indirectness: No indirectness (n=39) Intervention 2: Postoperative recovery in non-specialist areas (standard care) - Level 0 (postoperative recovery on a surgical ward). Patients received care in the surgical ward. . Duration Post-operative period. Concurrent medication/care: Patients underwent a cardiopulmonary exercise test.. Indirectness: No indirectness
Funding	Other (cardiopulmonary exercise equipment purchased with a grant by the Torbay Hospital Medical Projects charity.)

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RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: LEVEL 3 (INTENSIVE CARE UNIT) versus LEVEL 0 (POSTOPERATIVE RECOVERY ON A SURGICAL WARD)

Protocol outcome 1: Mortality
- Actual outcome for Elective surgery: Mortality at Post-operative period; Group 1: 2/51, Group 2: 1/39
Risk of bias: All domain - Low, Selection - High, Blinding - Low, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness

Protocol outcome 2: Length of hospital stay
- Actual outcome for Elective surgery: Hospital stay (days) at n/a; Mean; , Comments: Median (range):
ICU: 12 (5-41); surgical ward: 13 (6-61)
Risk of bias: All domain - Low, Selection - High, Blinding - Low, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness

Protocol outcomes not reported by the study	Quality of life ; Perioperative complications ; Unplanned intensive unit admission ; Hospital readmission ; Postponed/cancelled surgery ; Patient, family and carer experience of care

Study	**Swart 2017[17]**
Study type	Non-randomised comparative study
Number of studies (number of participants)	(n=208)
Countries and setting	United Kingdom
Line of therapy	Not applicable
Duration of study	Intervention time: Admission to discharge
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Low risk (1-3% risk of 30 day mortality)
Subgroup analysis within study	Not applicable
Inclusion criteria	Cohort of patients undergoing elective colorectal surgery, whose planned postoperative care was determined by their predicted 30 day mortality. For predicted 30 day mortalities of 1–3% (i.e. intermediate risk), an HDU bed was booked but surgery could proceed if an HDU bed was unavailable on the day of the operation. The following variables were included in the risk calculation: year seen in the clinic; age; sex; history of heart failure, myocardial infarction, stroke, renal failure, peripheral arterial disease, angina, or transient ischaemic

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	attack; peak oxygen consumption; the ventilatory equivalent for carbon dioxide at the anaerobic threshold; and the proposed surgery.
Exclusion criteria	Not reported
Recruitment/selection of patients	patients undergoing surgery from June 1, 2006, to June 30, 2010
Age, gender and ethnicity	Age - Mean (SD): 72 years (7). Gender (m:f)120:88
Further population details	1. Age: >60 years
Extra comments	All sequential patients who were assessed before an elective colorectal resection, reversal of colostomy, or reversal of ileostomy between June 1, 2010 and August 31, 2013
Indirectness of population	No indirectness
Interventions	(n=119) Intervention 1: Postoperative recovery in specialist areas - Level 2 (high dependency unit, post-anaesthesia care unit). Planned HDU postoperative care. Postoperative care was provided on a 10-bed critical care unit (a combined adult general intensive care and HDU). Indirectness: No indirectness. Comments: For predicted 30 day mortalities of 1–3% (i.e. intermediate risk), an HDU bed was booked but surgery could proceed if an HDU bed was unavailable on the day of the operation. (n=138) Intervention 2: Postoperative recovery in non-specialist areas (standard care) - Level 0 (postoperative recovery on a surgical ward). Planned Ward postoperative care. Postoperative care was provided on a 24-bed colorectal surgical ward. Indirectness: No indirectness.
Funding	Funding not stated

RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: LEVEL 3 (INTENSIVE CARE UNIT) versus LEVEL 2 (HIGH DEPENDENCY UNIT, POST-ANESTHESIA CARE UNIT)

Protocol outcome 1: Mortality
- Actual outcome for Low risk: Death at 30 days; Group 1: 1/68, Group 2: 3/139
Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness

Protocol outcome 2: Perioperative complications
- Actual outcome for High risk: Post-operative complications (emergency laparotomy after elective surgery); Group 1: 0/68, Group 2: 14/139, Comments: An emergency laparotomy was defined as a laparotomy that took place after elective colorectal surgery during the same hospital admission as the elective surgery.
Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness

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Protocol outcome 3: Unplanned intensive unit admission - Actual outcome for High risk: ICU admission at Admission to discharge; 22/139 patients in the non-HDU protocol were secondarily transferred to critical care Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness	
Protocol outcomes not reported by the study	Quality of life ; Hospital readmission ; Postponed/cancelled surgery ; Patient, family and carer experience of care

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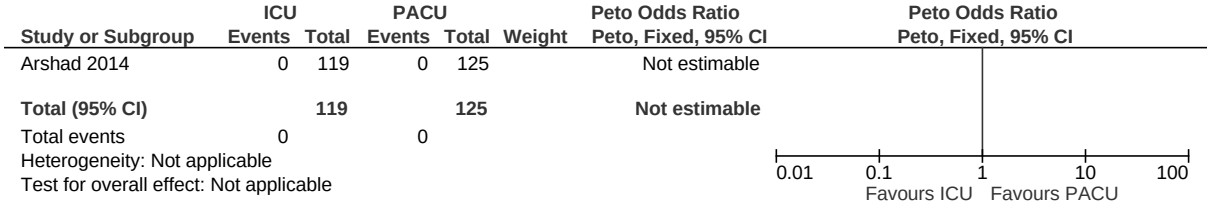
Appendix E: Forest plots

E.1 ICU compared to PACU – high risk; elective surgery

Figure 2: Mortality



E.2 ICU compared to surgical ward – high risk; elective & emergency

Figure 3: Mortality

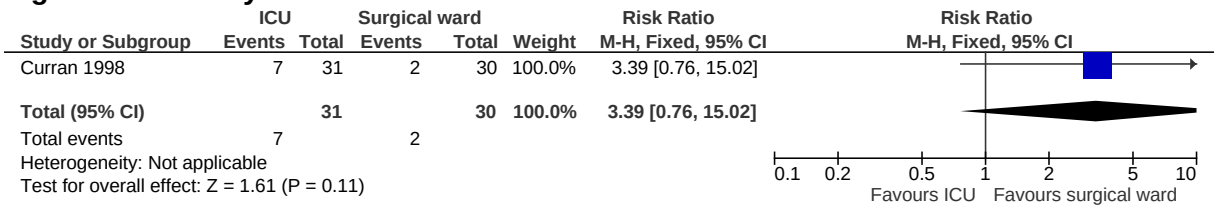
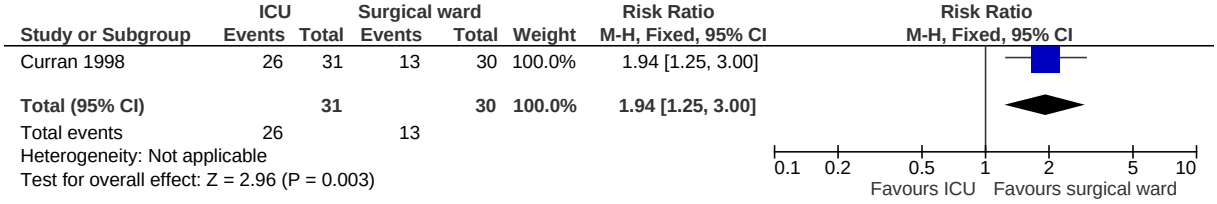


Figure 4: Post-operative complications



E.3 ICU compared to surgical ward – high risk; elective

Figure 5: Mortality

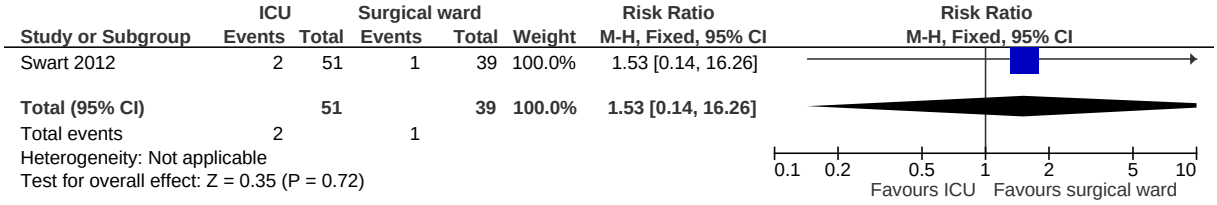


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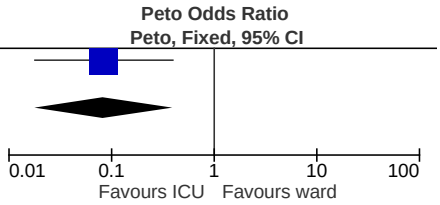
Figure 6: Post-operative complications

Study or Subgroup	ICU Events	ICU Total	Surgical ward Events	Surgical ward Total	Weight	Peto Odds Ratio Peto, Fixed, 95% CI
Swart 2012	0	51	7	39	100.0%	0.08 [0.02, 0.40]
Total (95% CI)		**51**		**39**	**100.0%**	**0.08 [0.02, 0.40]**
Total events	0		7			

Heterogeneity: Not applicable
Test for overall effect: Z = 3.13 (P = 0.002)



E.4 HDU compared to surgical ward – low/intermediate risk; elective

Figure 7: Mortality

Study or Subgroup	HDU Events	HDU Total	Surgical ward Events	Surgical ward Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Swart 2017	1	68	3	139	100.0%	0.68 [0.07, 6.43]
Total (95% CI)		**68**		**139**	**100.0%**	**0.68 [0.07, 6.43]**
Total events	1		3			

Heterogeneity: Not applicable
Test for overall effect: Z = 0.34 (P = 0.74)

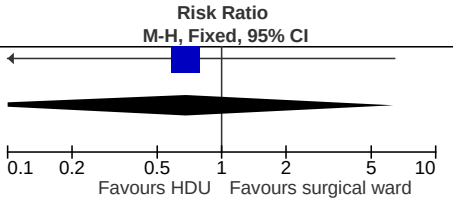
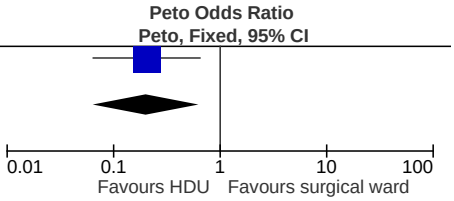


Figure 8: Post-operative complications

Study or Subgroup	HDU Events	HDU Total	Surgical ward Events	Surgical ward Total	Weight	Peto Odds Ratio Peto, Fixed, 95% CI
Swart 2017	0	68	14	139	100.0%	0.20 [0.06, 0.65]
Total (95% CI)		**68**		**139**	**100.0%**	**0.20 [0.06, 0.65]**
Total events	0		14			

Heterogeneity: Not applicable
Test for overall effect: Z = 2.70 (P = 0.007)



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Appendix F: GRADE tables

Table 18: Clinical evidence profile: ICU compared to PACU for adults undergoing surgery – high risk; elective

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	ICU compared to PACU	Control	Relative (95% CI)	Absolute		
Mortality												
1	observational studies[1]	no serious risk of bias[1]	no serious inconsistency	no serious indirectness	no serious imprecision	none	0/119 (0%)	0%	-	-	⊕⊕OO LOW	CRITICAL

[1] Downgraded by 2 increments if the majority of the evidence was from studies with observational/non-randomised study design

Table 19: Clinical evidence profile: ICU compared to surgical ward for adults undergoing surgery – high risk; elective & emergency

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	ICU compared to surgical ward	Control	Relative (95% CI)	Absolute		
Mortality												
1	observational studies[1]	no serious risk of bias[1]	no serious inconsistency	no serious indirectness	very serious[2]	none	7/31 (22.6%)	22.6%	RR 3.39 (0.76 to 15.02)	540 more per 1000 (from 54 fewer to 1000 more)	⊕OOO VERY LOW	CRITICAL
Post-operative complications												
1	observational studies[1]	no serious risk of bias[1]	no serious inconsistency	no serious indirectness	no serious imprecision	none	26/31 (83.9%)	13/30 (43.3%)	RR 1.94 (1.25 to 3)	407 more per 1000 (from 108 more to 867 more)	⊕⊕OO LOW	CRITICAL

[1] Downgraded by 2 increments if the majority of the evidence was from studies with observational/non-randomised study design
[2] Downgraded by 1 increment if the confidence interval crossed one MID or by 2 increments if the confidence interval crossed both MIDs

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Table 20: Clinical evidence profile: ICU compared to surgical ward for adults undergoing surgery – high risk; elective

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	ICU compared to surgical ward	Control	Relative (95% CI)	Absolute		
Mortality												
1	observational studies[1]	no serious risk of bias[1]	no serious inconsistency	no serious indirectness	very serious[2]	none	2/51 (3.9%)	2.6%	RR 1.53 (0.14 to 16.26)	14 more per 1000 (from 22 fewer to 397 more)	⊕OOO VERY LOW	CRITICAL
1	observational studies[1]	no serious risk of bias[1]	no serious inconsistency	no serious indirectness	no serious imprecision	none	0/51 (0%)	17.9%	Peto OR 0.08 (0.02 to 0.4)	165 fewer per 1000 (from 108 to 176 fewer)	⊕⊕OO LOW	CRITICAL

[1] Downgraded by 2 increments if the majority of the evidence was from studies with observational/non-randomised study design
[2] Downgraded by 1 increment if the confidence interval crossed one MID or by 2 increments if the confidence interval crossed both MIDs

Table 21: Clinical evidence profile: HDU compared to surgical ward for adults undergoing surgery – low/intermediate risk; elective

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Low risk - HDU	Surgical ward	Relative (95% CI)	Absolute		
Mortality (follow-up 30 days)												
1	observational studies	no serious risk of bias[1]	no serious inconsistency	no serious indirectness	very serious[2]	none	1/68 (1.5%)	2.2%	RR 0.68 (0.07 to 6.43)	7 fewer per 1000 (from 20 fewer to 119 more)	⊕OOO VERY LOW	CRITICAL
Post-operative complication: emergency laparotomy (follow-up postoperatively)												
1	observational studies	no serious risk of bias[1]	no serious inconsistency	no serious indirectness	no serious imprecision	strong association[3]	0/68 (0%)	10.1%	OR 0.2 (0.06 to 0.65)	79 fewer per 1000 (from 33 fewer to 94 fewer)	⊕⊕⊕O MODERATE	CRITICAL

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[1] Downgraded by 2 increments if the majority of the evidence was from studies with observational/non-randomised study design
[2] Downgraded by 1 increment if the confidence interval crossed one MID or by 2 increments if the confidence interval crossed both MIDs
[3] Upgraded by 1 increment if the magnitude of effect is large (OR = 2-5 or OR = 0.5-0.2) or by 2 increments if the magnitude of effect is very large (OR > 5 or OR < 0.2)

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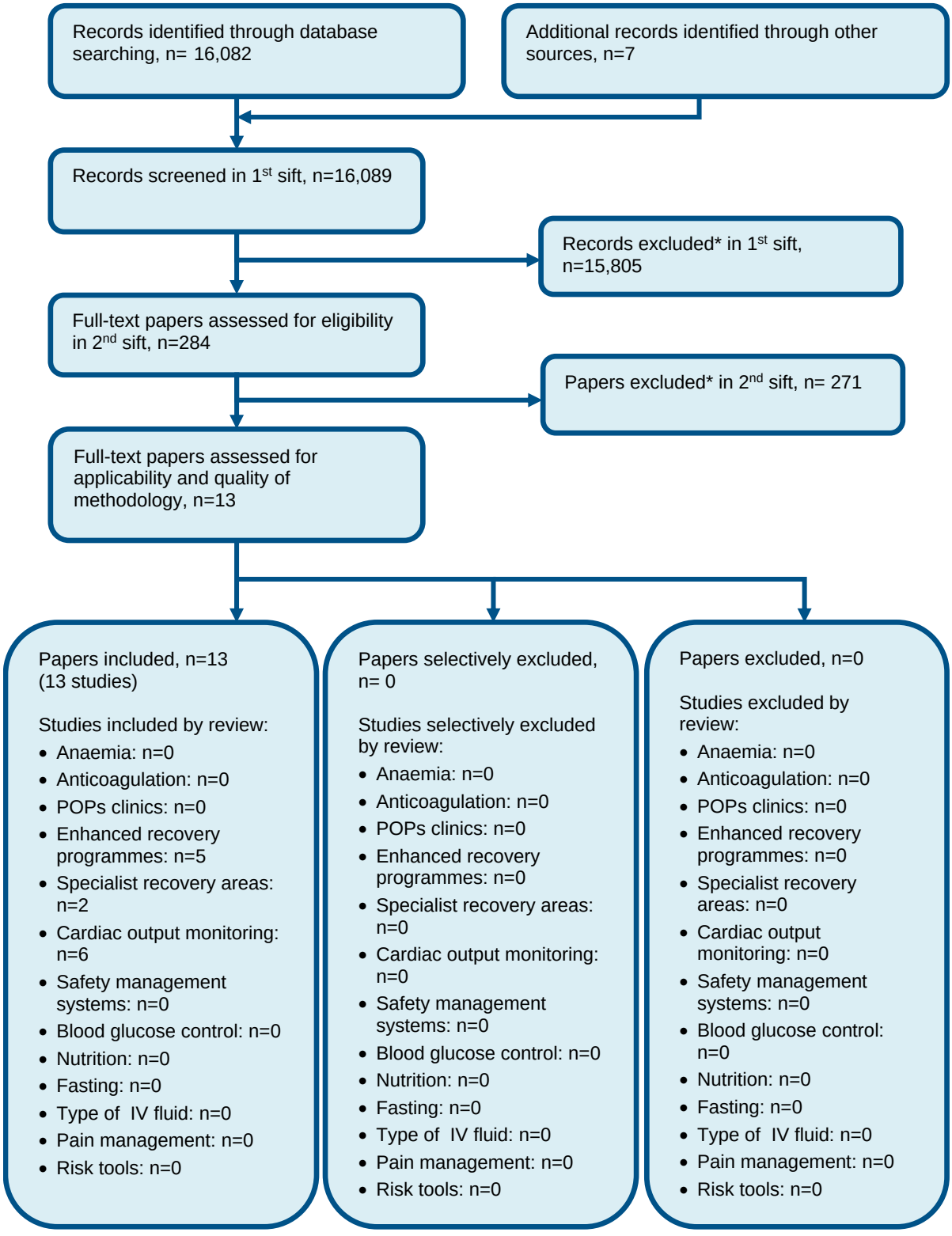
Appendix G: Health economic evidence selection

Figure 9: Flow chart of HE study selection for the review of specialist recovery areas



* Non-relevant population, intervention, comparison, design or setting; non-English language

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Appendix H: Health economic evidence tables

Study	Lindemark 2017[7]			
Study details	**Population & interventions**	**Costs**	**Health outcomes**	**Cost effectiveness**
Economic analysis: CUA (health outcome: QALYs) **Study design:** Probabilistic decision analytic model **Approach to analysis:** A micro-simulation model was conducted which involved a Markov process based on 3 health states (treatment, alive and dead). The Markov process was run separately for 30,712 individuals, based on individuals from the Norwegian Intensive Care Registry. **Perspective:** Norwegian healthcare perspective **Time horizon:** Lifetime **Treatment effect duration:**[(a)] until hospital discharge **Discounting:** Costs: 4%; Outcomes: 4%	**Population:** General adult ICU population (acute surgery and planned surgery reported). **Cohort settings:** *Acute surgery:* N = 9,722 Mean age = 61.4 (SD: 19.3) *Planned surgery:* N = 3,868 Mean age = 65.2 (SD: 15.4) **Intervention 1:** General ward (hypothetical rejection from ICU) **Intervention 2:** Intensive care unit	**Total costs (mean per patient):** *Acute surgery:* Intervention 1: £10,552 Intervention 2: £24,036 Incremental (2−1): £13,484 (95% CI: NR; p=NR) *Planned surgery:* Intervention 1: £12,507 Intervention 2: £23,059 Incremental (2−1): £10,552 (95% CI: NR; p=NR) **Currency & cost year:** 2016 euros (presented here as 2016 UK pounds[(b)]) **Cost components incorporated:** Cost of day on ICU or general ward, including nurse and physician salary, overheads, medication and disposables. Costs 5 years post discharge.	**QALYs (mean per patient):** *Acute surgery:* Intervention 1: 6.5 Intervention 2: 8.2 Incremental (2−1): 1.7 (95% CI: NR; p=NR) *Planned surgery:* Intervention 1: 6.5 Intervention 2: 7.7 Incremental (2−1): 1.2 (95% CI: NR; p=NR)	**ICER (Intervention 2 versus Intervention 1):** *Acute surgery:* £7,932 per QALY gained 95% CI: NR Probability Intervention 2 cost effective at a €22,000 threshold: 93% *Planned surgery:* £8,794 per QALY gained 95% CI: NR Probability Intervention 2 cost effective at a €22,000 threshold: 84% **Analysis of uncertainty:** Probabilistic sensitivity analysis was conducted by performing 1000 iterations. Scenario analyses involved applying a constant ICU or general ward daily cost and another scenario involved accounting for lifetime health care costs beyond 5 years. Scenario analyses showed similar results to the base case analysis.
Data sources				

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Health outcomes: The Norwegian intensive care registry was used which contains detailed patient level data on ICU admissions. 30,172 patients were used from this registry. The population was split into medical, acute surgery, planned surgery, and all. Only the two surgical subgroups results are reported here as matching the population for this clinical protocol. The registry data was used for patient characteristics feeding into the microsimulation, and also for the baseline data of length of stay in ICU. The treatment effect of the benefits of ICU versus ward stay was based on the short term survival benefit based on the relationship between the SAPS II score and death. Different shapes of this relationship were tested. Subsequent survival after hospital discharge was estimated using the same life tables for both treatment options, corrected for excess mortality in ICU survivors. **Quality-of-life weights:** Age-specific HRQoL weights from the Swedish general population were used and the same were applied to survivors of both treatments. The HRQoL was down-weighted by 20% over the first 5 years after the hospital stay because it was assumed that the HRQoL of ICU survivors persist at a lower level than the general population. **Cost sources:** The estimated cost of an ICU admission took into account both the cost of the initial hospital stay and the resource use among survivors up to 5 years after discharge. Similar estimates were obtained for ward patients. Cost per day in ICU was higher in the first 24 hours and then reduced. Average ICU and ward bed day costs were from hospitals piloting a cost-per-patient specification issued by The Norwegian Directorate of Health. The length of stay for ward patients was based on what their LoS would have been if they were on ICU, and reduced or increased by a percentage depending on if they died or survived in the ICU and then derived a weighted average depending on if they died or survived. Costs following discharge were based on a Scottish study[8]. Both arms assumed the same long terms costs for survivors.

Comments

Source of funding: Norway's Western Regional Health Authority, Stavanger, Norway. **Limitations:** Norwegian healthcare perspective and 2016 Norwegian Kroners may not be relevant to current UK practice. Health related quality of life was not obtained from patients and unclear what valuation method was used. Discount rate used is not in line with NICE reference case methods and cost of day in ICU and general ward was much higher compared to NHS. Baseline and treatment effects were not obtained from relevant RCT data but from registry data and SAPS 2 model. Unclear if complications were included in the model. Resource use and costs associated with general ward length of stay was based on assumptions. **Other:** ICERs were reported separately for what was called a distribution weighted economic evaluation, where those who had low QALYs in the general ward intervention were attributed higher gains in order to give a higher weighting to those considered to be more severe. This goes against the principles of the QALY that is considered equal in all individuals therefore those results have not been reported.

Overall applicability:[(c)] Partially applicable **Overall quality:**[(d)] Potentially serious limitations

Abbreviations: 95% CI = 95% confidence interval; CUA = cost–utility analysis; ICER = incremental cost-effectiveness ratio; ICU = intensive care unit; NR = not reported; LOS = length of stay; QALYs = quality-adjusted life years

(a) For studies where the time horizon is longer than the treatment duration, an assumption needs to be made about the continuation of the study effect. For example, does a difference in utility between groups during treatment continue beyond the end of treatment and if so for how long.

(b) Converted using 2016 purchasing power parities[13]

(c) Directly applicable / Partially applicable / Not applicable

(d) Minor limitations / Potentially serious limitations / Very serious limitations

Study	**Swart 2017[17]**			
Study details	**Population & interventions**	**Costs**	**Health outcomes**	**Cost effectiveness**
Economic analysis:	**Population:**	**Total costs (mean per**	**Mortality:**	Intervention 2 was cost-saving, and led

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CCA (health outcome: various health outcomes) **Study design:** Within-trial analysis (non-randomised study) **Approach to analysis:** Analysis of individual level data for mortality and resource use with unit costs applied. **Perspective:** UK NHS **Follow-up:** 30 days **Discounting:** Costs: n/a; Outcomes: n/a	People undergoing elective colorectal surgery with a 1-3% risk of 30 day mortality **Patient characteristics:** N = 207 Mean age: 72 (SD:7) Male: 58% **Intervention 1:** Planned general ward postoperative care **Intervention 2:** Planned HDU postoperative care	**patient):** Intervention 1: £3,613 Intervention 2: £3,236 Incremental (2−1): -£350 (95% CI: NR; p=NR) **Currency & cost year:** 2013 UK pounds **Cost components incorporated:** Cost of ward bed day, HDU bed day and ICU bed day	RR 0.68 (CI: 0.07, 6.43); ARD -7 per 1000 **Postoperative complication - emergency laparotomy:** Peto OR 0.2 (CI: 0.06, 0.65); ARD -79 per 1000	to lower mortality and complications. **Analysis of uncertainty:** None.
Data sources				
Health outcomes: Baseline risks and relative treatment effects were based on patient level analysis of the trial consisting of 207 participants undergoing elective colorectal surgery at a hospital in the UK. Outcomes recorded in the trial were reported and emergency laparotomy. **Cost sources:** The estimated cost of postoperative care was conducted by calculating the average ward, HDU, and ICU bed days per patient for each group and then multiplying by the UK 2013 payment by results tariff.				
Comments				
Source of funding: NR. **Limitations:** UK NHS perspective and costs from 2013 may not reflect current practice. Measure of effect is not in line with NICE reference case methods as the analysis does not report QALYs. Baseline and treatment effects were based on a single cohort study conducted at one hospital England; analysis may not fully capture all outcomes as overall complications were not reported. Source of unit costs based on the payment by results tariff which may understate actual costs incurred by the NHS.				
Overall applicability:[(a)] Partially applicable **Overall quality:**[(b)] Potentially serious limitations				

Abbreviations: CCA = cost–consequences analysis; 95% CI = 95% confidence interval; HDU = high-dependency unit; ICU = intensive care unit; NR = not reported; OR = odds ratio; QALYs = quality-adjusted life years; RR = risk ratio

(a) Directly applicable / Partially applicable / Not applicable

(b) Minor limitations / Potentially serious limitations / Very serious limitations

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Appendix I: Excluded studies

I.1 Excluded clinical studies

Table 22: Studies excluded from the clinical review

Reference	Reason for exclusion
Carter 2012[2]	Incorrect interventions
Dalziel 2001[4]	Not available
De Almeida 2018[5]	Treatment for neurosurgery
NCT 2015[10]	Citation only
NCT 2017[11]	Citation only
Pedoto 2009[14]	Inappropriate study design
Shan 2013[15]	Not review population
Turner 2002[18]	Not available
Turner 2003[19]	Systematic review: no evidence identified
Vester-Andersen 2015[20]	Inappropriate comparison
White 2003[21]	Incorrect interventions

I.2 Excluded health economic studies

Published health economic studies that met the inclusion criteria (relevant population, comparators, economic study design, published 2003 or later and not from non-OECD country or USA) but that were excluded following appraisal of applicability and methodological quality are listed below. See the health economic protocol for more details.

Table 23: Studies excluded from the health economic review

Reference	Reason for exclusion
None.	

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Appendix J: Research recommendations

J.1 Specialist recovery areas

Research question: Which patients, other than those known to have a high risk of complications or mortality, would benefit from postoperative care in a specialist recovery area (a high-dependency unit, a post-anaesthesia unit or an intensive care unit)?

Why this is important:

The increasing medical complexity of patients presenting for surgery and the vast array of surgical procedures possible are changing the landscape of perioperative care. The needs of such patients in the post-operative phase (during which most complications and factors relating to poor outcomes occur) can be highly diverse depending on these patient factors and the nature of their surgery. Rationalising the limited resources of specialist areas is additionally a key imperative. Predicting pre operatively which patients will require specialist recovery areas is an inexact science and supported by limited evidence. A better understanding of this would allow more rational, bespoke and cost effective solutions for resource allocation while ensuring appropriate care levels are correctly provided.

Criteria for selecting high-priority research recommendations:

PICO question	Population: Adults 18 years and over having major surgery. Stratified by: • Type/ nature/ complexity of surgical procedure • Complexity of comorbid medical illness • Outcome of preoperative risk assessment Intervention(s): • Level 2 (High Dependency Unit, Post-Anaesthesia Care Unit) • Level 3 (Intensive Care Unit) Comparison: • Level 0 (postoperative recovery on a surgical ward) • Level 1 (postoperative recovery on a surgical ward with access to a Critical Care Outreach Team) • Compared to each other Outcome(s): Health-related quality of life, mortality, adverse events and complications (Clavien-Dindo, postoperative morbidity score (POMS)), unplanned intensive care unit admission/readmission, length of hospital stay, hospital readmission, postponed/cancelled surgery and patient/family/carer experience of care.
Importance to patients or the population	While it is often clear at the varying ends of the spectrum whether patients specifically do or do not require level 2 or 3 care, there is a large population of surgical patients where these decisions are unclear. It is important that the decisions for post-operative destination are appropriately rationalised given the resources are limited and potentially costly. There exists limited evidence and guidance for such decisions and when they are made on seemingly arbitrary criteria like age or ASA grade there is a propensity to over or under triage for this resource. Furthermore the value-add of specialist areas for postoperative care in some contexts is unclear and difficult to measure particularly if the surgery has been routine or unproblematic. Conversely some patients are not selected for recovery in specialist areas when their combination of factors surrounding

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	their surgery may indicate higher risk for post-operative complications.
Relevance to NICE guidance	There is currently no evidence or guidance on how best to approach selecting patients for specialist recovery areas and rationalisation of this limited resource.
Relevance to the NHS	Research in this area will inform NICE recommendations for service delivery and provide information about clinical and cost-effectiveness.
National priorities	Rationalisation of Specialist Recovery Areas as a resource will have financial implications on the NHS and nationally.
Current evidence base	Three small non-randomised studies comparing ICU with a post-anaesthesia care unit/specialist area or surgical ward were identified. There was insufficient evidence to make a recommendation. There exists a gap in well-defined research criteria and this is an area for benchmarking relevant criteria against which this can be studied.
Equality	Not applicable
Study design	A randomised study would be difficult to perform for this area. Well conducted prospective cohort studies which benchmark usable criteria for patient selection would be valuable.
Feasibility	Doing good research in this field is particularly difficult because of the heterogeneity of the population and the heterogeneity of types of surgery.
Other comments	The committee is aware this is a complex area for a research study that will provide something useful and representative.
Importance	• Medium: the research is relevant to the recommendations in the guideline and would be useful to future updates.

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