Supplementary Materials 7: Tables for cost-effectiveness arm of the review

Table 1. Description of non-prioritised studies identified through cost searches

First author, Date, Country	Intervention name	Broad Intervention Category	Brief description or key features of intervention	Comparator Name and Brief Description	Procedure	Study design	Total Sample Size Intervention/ Comparator	Mean age (SD)	Setting	Treatment stage/s at which intervention occurs					Number of stages
										Pre-Admission	Pre-Treatment	Peri-Operative	Post-Operative	Pre-Discharge	
Cardiac surgery															
Emanminia 2012,[1] USA	Universal bed model	Patient centred care	Care delivery system that maintains patients in the same room from immediately post operation to discharge, while adapting equipment, staff, and other resources according to a patient's level of acuity	Traditional model of admission	Cardiac surgery	CT	225, 963 (Intervention: 610, Comparator: 225, 353)	Intervention: 69.7 (SE 2.82), Comparator: 67.4 (SE 0.14)	Hospital				x		1
Yanatori 2007,[2] Japan	Fast-Track Recovery Program	ERP	12 day admission pathway. Preoperative education after admission, operation 4 days post admission, admission to ICU for 24 hours post op with food and fluid management	Pre Fast-Track Program	Cardio-pulmonary bypass	UBA	Total: 94, Intervention: 54, Comparator: 40	Intervention: 64.8(11.6), Comparator: 66.2(7.4)	General hospital		x		x	x	3

Colorectal surgery														
Ehrlich 2015,[3] Finland	Fast-Track protocol	ERP	Preoperative counselling, oral carbohydrates until 2 h before surgery, I.V. anaesthesia, short acting anaesthetic, standardised pain management, discontinuation of I.V. fluids as soon as possible, early postoperative feeding, removal of urinary catheter on the first postoperative day, and early mobilisation. Set discharge criteria. Those undergoing open surgery technique compared to those undergoing laparoscopic technique	Traditional perioperative care: Open and laparoscopic groups	Colonic resection	UBA	Total: 232 (Intervention1 : FT/Lap 73, Intervention 2: FT/Open 43; Comparator 1: Traditional/Lap 73, Comparator 2: Traditional/Open 43)	Intervention 1: 62.8(12.2), Comparator 1: 64.1(12.1); Intervention 2: 60.8(12.0), Comparator 2: 61.7(12.9)	Hospital	x	x	x	x		4
Garfinkle 2018,[4] Canada	ERP	ERP	Psychological preparations for surgery, preoperative exercises at home, bowel preparation only if diverting ileostomy, routine epidural catheter, structured postoperative mobilisation. Those undergoing open surgery technique compared to those undergoing laparoscopic technique	Conventional care: Open and laparoscopic groups	Rectal surgery	CT	Intervention 1: Lap/ERP: 108, Intervention 2: OP/ERP: 38, Comparator 1: Lap/CC: 34, Comparator 2: OP/CC: 201	Lap/ERP: 62.5(13.2), OP/ERP: 62.8(12.5), Comparator 1: Lap/CC: 60.8(12.0), Comparator 2: OP/CC: 65.8(13.6)	Uni hospital		x	x	x		3

Lee 2015,[5] Canada	Enhanced Recovery Pathway	ERP	Counselling, education, pre-op physical exercises, carbohydrate loading, no pre op sedation, fluid management, early mobilisation, catheter removal, analgesia	Conventional care: medical optimization, no formal education or preoperative exercise instructions, no bowel prep or sedation protocols, no structured mobilisation, thoracic epidural analgesia or PCA. Use of opioids	Colorectal resection	CT	Total: 190 Intervention: 95, Control: 95	Intervention: 63.9(13.1), Comparator: 61.6(13.4)	Uni hospital	x	x	x	x		4
Nelson 2016[6]; Nelson 2016,[7] Canada	Enhanced Recovery After Surgery	ERP	Information, bowel preparation, carbohydrate loading, pre-medication, thrombosis/antibiotic prophylaxis, Surgical protocol, oral and I.V. fluid management, postoperative nutrition and mobilisation, 30 day follow up	Pre-ERAS Pathway	Colorectal surgery	UBA	1331 (Intervention: 981, Comparator: 350)	Intervention: 64, Comparator: 62	6x Hospital	x	x	x	x	x	5
Pedziwlatr 2016,[8] Poland	Enhanced Recovery After Surgery Programme	ERP	ERAS programme includes pre-admission education and exercise, no bowel preparation, clear fluids up to 2h before surgery, laparoscopic surgery, early mobilisation, set criteria for discharge, and telephone calls following discharge	Historical Control Group: Group 1: laparoscopic resection with traditional perioperative care, Group 2: Open resection with traditional care	Laparoscopic colorectal surgery	UBA	Total: 99 (Intervention: 33, Comparator 1: 33, Comparator 2: 33)	Intervention: 66.2(11.7), Comparator 1: 64(11.4) Comparator 2: 65.8(10.9)	Uni hospital	x	x	x	x	x	5

Roulin 2013,[9] Switzerland	Enhanced Recovery Protocol	ERP	Preoperative counselling, reduced preoperative fasting, preoperative carbohydrate loading, avoidance of premedication, optimized fluid balance, standardized postoperative analgesia, use of a no-drain policy, early nutrition and mobilisation	Standard care: no standardised information, fasting from midnight, no carbohydrate loading, premedication, no standardised post op analgesia, use of drains at surgeons discretion, no nutrition or mobilisation protocol	Colorectal surgery	UBA	100(Intervention: 50, Comparator: 50)	Intervention: 65(17.9), Comparator: 65(13.6)	Uni hospital	x	x	x	x		4

Salvans 2013,[10], Spain	Multimodal rehabilitation programme	ERP	Multimodal rehabilitation programme includes preoperative education, liquids and solids up to 6h before surgery, pain management during surgery, diet resumed 6h post-surgery, and early mobilisation encouraged	Conventional perioperative care: oral communication by surgeon only, colon preparation, fasting night before surgery. Fluid therapy at discretion of anaesthesiologist, diet resumed at surgeons discretion	Colorectal surgery	UBA	Total: 365 Intervention: 231, Comparator: 134	Intervention: 68.8(12), 70.4(11)	Uni hospital		x	x	x		3
Lower limb arthroplasty															
Arana 2017,[11] USA	Outcomes manager-led inter-professional team	Staff Mix	Inter-professional team led by outcomes manager who oversees team. Clearly defined professional roles, leadership support and onsite physician champion. Manager identifies gaps in care to enhance operational improvements	Pre-implementation of inter-professional team	Total knee and hip arthroplasty	UBA	Total: 603 Intervention: 330, Comparator: 273)	Intervention: 66.9(8.6), Comparator: 69(9.6)	Hospital		x	x	x		3
Batsis 2008,[12] USA	Specialty Orthopaedic Surgery Units	Specialist Ward	General care nursing unit where patients receive all their postoperative care. Multidisciplinary staff with orthopaedic expertise	Admitted to non-orthopaedic nursing units	Total knee arthroplasty	CT	5534(Intervention: 5082, Comparator: 452)	Intervention: 68.3(10.75), Comparator: 67.9(11.5)	Hospital				x		1

Brunenberg 2005,[13] Netherlands	Joint recovery program	ERP	Pre-assessment screening approximately 6 weeks before operation including anamnesis and blood samples, physical examination and x-rays. Also, home situation and post discharge care needs were analysed. Patient education took place 1 to 2 weeks preoperatively. Group based rehabilitation after operation and supervision by nurses and physiotherapists for duration of admission	Usual Care	Joint replacement	UBA	Total: 160 (Intervention: 78, Comparator: 82)	Intervention: 63.96(10.7), Comparator: 64.83(12.81)	Uni hospital	x	x		x		3
Cullen 2012,[14] New Zealand	Incentive based	Incentive based	Surgery at a new site with a clinically-led care plan, with staff who are incentive based. The participating surgeons and anaesthetists were responsible for increasing surgical throughput. No junior staff.	NR	Hip and knee replacement	CT	Total: 335 (Intervention: 170, Comparator: 165)	Intervention: 64.2(range 25-92), Comparator: 66.18(range 36-85)	Hospital	x	x	x	x	x	5
Duplantier 2016,[15] USA	Hospitalist Comanagement Model	Staff Mix	Postoperative comanagement: students, residents, fellows, nurse practitioners and physician assistants help coordinate care.	Non-hospitalist management model	Total hip or knee arthroplasty	CT	2975(Intervention: 1656, Comparator: 1319)	Intervention: 64.3(11.5), Comparator: 64.4(11.5)	Teach-ing hospital				x		1

Hansen 2012,[16] Denmark	Preoperative screening (as part of fast-track programme)	PACP	Preoperative screening (which took place as part of 'motivational conversation' with a nurse) identified any risk factors, which were addressed by an appropriate intervention ranging from providing information to referral to dietician	Control group: no formal preoperative screening, no intervention during period between decision to operate and surgery	Hip and knee arthroplasty	UBA	Total: 132 (Intervention: 78, Comparator: 54)	Intervention:68 (11.0), Comparator: 69(9.0)	Hospital		x				1
Healy 2002,[17] USA	Clinical pathway and knee standardisation program	ERP	Multidisciplinary team based approach. Pathway begins when decision made to operate, continues throughout acute-care and includes rehabilitation and physical therapy	No clinical pathway or knee-implant standardisation program	Total knee arthroplasty	UBA	Total: 159 (Intervention: 103, Comparator: 56)	Intervention: 69.53 (range 46-91), Comparator: 70.66(range 45-88)	Hospital	x	x	x	x		4
Ho 2007,[18] USA	Critical pathways	ERP	Standardisation of surgical techniques and post-op management	Comparator: no uniform criteria for implant selection, vendor choice, surgical techniques or postoperative management protocols	Total knee replacement	CT	Total: 90, Intervention 1: 30, Intervention 2: 30, Comparator: 30	Intervention 1: 67(NR), Intervention 2: 66(NR), Comparator: 68(NR)	Teaching hospital			x	x		2

Krummenauer 2011,[19] Germany	Interdisciplinary Clinical Pathway	ERP	Patients invited to information session with surgeon 1 month before surgery. Pre-surgery education with physiotherapist about post-operative care. Hospitalisation day of surgery unless patient lives far away in which case hospitalisation day before surgery. Same team used throughout day for all aspects of operation. Post-surgical rehabilitation in patient room	Pre-pathway	Total knee arthroplasty	UBA	Total: 260 (Intervention: 128, Comparator: 132)	Median age: Intervention (without briefing): 69(range 46-85), Intervention (with briefing): 70(range 53-80), Comparator: 68(range 43-88)	Uni hospital	x		x	x		3
Lin 2002,[20] Taiwan	Clinical pathway	ERP	Perioperative clinical pathway including nursing assessment, pain management, nutrition, activity, education and discharge planning	Pre-clinical pathway	Total knee arthroplasty	UBA	Total: 114 (Intervention: 61[a], Comparator: 53)	Intervention: 70(6.6), Comparator 67.7(5.7)	Uni Hospital		x	x	x		3
Lin 2011,[21] Taiwan	Care Mapping	ERP	Continuous patient care including during enrolment, hospitalisation period and follow up service post-discharge. Cared for by primary nurse using a case map. Responsibilities of case managers included: education, coordination, service monitoring and follow up	Control group: cared for using a clinical pathway with no case managers	Total knee replacement	CT	Total: 83 Intervention: 39, Comparator: 44	Overall: 72.73(8.42)	Uni Hospital		x	x	x	x	4

Loftus 2014,[22] USA	Simplified pathway	ERP	Two key drivers: early activity and avoidance of continuous urinary catheters	Pre-pathway	Total knee arthroplasty	UBA	Total: 6154, Intervention: 2925, Comparator 3229	Intervention: 68.01(9.90), Comparator: 68.26 (10.02)	16x Hospital				x		1
Wilches 2017,[23] Spain	Fast track Recovery Technique	ERP	Extended preoperative information, multimodal pain management during and after surgery, early mobilisation	Conventional Recovery: Limited preoperative education, standard pre-anaesthesia visit, peridural anaesthesia with opiate with sedation, pain management, POD1-2: bed rest	Primary total hip and knee replacement	UBA	Total: 200 (Intervention: 100, Comparator: 100)	Intervention: 69.24(9.64), Comparator: 73.07(8.33)	Hospital		x	x	x		3
Pelvic surgery															

Nabhani 2016,[24] USA	ERAS	ERP	Preoperative education, carbohydrate loading, no bowel preparation, no epidural, opioid sparing anaesthesia, no NG tube, nausea management, pain/nutrition protocols, home intravenous hydration	Standard protocol	Radical Cystectomy	UBA	Total: 201(Intervention: 102, Comparator: 99)	Intervention: 68.8(NR), Comparator: 69.2(NR)	Uni hospital		x	x	x	x	4
Thoracic surgery															
Marcantuono 2015,[25] USA	Fast track protocol	ERP	Fast-track trans catheter aortic valve replacement protocols used at two sites	Patients who were ineligible for fast track treatment	Trans femoral trans catheter aortic valve replacement	CT	Total: 99 (Intervention: 39, Comparator: 60)	Intervention: 84.59(5.72), Comparator: 83(4.29)	2x Uni hospitals		x	x	x		3
Maruyama 2006,[26] Japan	Clinical pathway	ERP	Post-op recovery pathway: chest tube, oxygen support, antibiotic, nutrition/ambulation/catheter/ I.V. infusion protocols	Pre-Pathway	Laparoscopic pulmonary resection	UBA	Total: 218, Intervention: 113, Comparator: 105	Intervention: Median age 63(range 17-84), Comparator: Median age 64(range 15-83)	Cancer Centre				x		1
Paci 2017,[27] Canada	ERP	ERP	Enhanced recovery programme includes standardised preoperative education, standardised drain management and nutrition, and early mobilisation	Conventional care based on surgeon preference	Lung resection	UBA	Total: 133 (Intervention: 75, Comparator: 58)	Intervention: 65(13), Comparator: 62(12)	Uni hospital		x	x	x		3

Shargall 2016,[28] Canada	Integrated comprehensive care program: home care initiative	Discharge planning	Discharge plan based on prepared care pathway with a nurse coordinator. Assessment of patient needs after surgery and created a discharge plan with patient and family. Patients discharged to home and contacted by home care team within 24 hours, and visit plan developed as needed	Historical control: not routinely referred to post discharge home program, unless determined by nursing staff before discharge or referrals from primary care post-discharge. Discharge planning not automatically included in care plan. Home care only after referral	Thoracic surgery	UBA	Total: 686 (Intervention: 331, Comparator: 355)	Intervention: 65.57(0.711), Comparator: 63.81(0.783)	Uni hospital				x	x	2
Upper abdominal surgery															
Cunningham 2016,[29] USA	Omitting an intensive care unit stay	ERP	Omitting an intensive care unit (ICU) stay	ICU group	Robotic pancreatico-duodenectomy	UBA	Total: 96(Intervention: 47, Comparator: 49)	Intervention: 66.11(9.75), Comparator: 65.56(12.11)	Uni of Pitts-burgh Medical Centre				x		1

Joliat 2015,[30] SUI	ERAS	ERP	Preoperative counselling and education, clear fluids until 2h before surgery, no premedication, no routine oral bowel preperation, perianaestomic drains used routinely, nasogastric tube not used routinely, free oral drinks 4h after surgery, free fluids on day one, light meals POD 2, normal diet POD 3., mobilisation at least 2h on day of surgery	Pre-ERAS: No preop counselling and education, fasting from 6h before surgery, premedication at discretion of anaesthetist, no routine bowel prep or prophylaxis, Somatostatin, nasogastric tube use and drain removal at discretion of surgeon, No I.V. policy, no routine use of antacids, glycaemic control or laxatives, no mobilisation protocol	Pancreatico - duodenecto my	UBA	Total; 161 (Intervention: 74, Comparator: 87)	Intervention: 67.5(range 57-74), Comparator: 67(range 55-75)	Uni hospital	x	x	x	x		4
Joliat 2016,[31] Switzerland	Enhanced Recovery Program	ERP	Counselling, written information, fluids until 2 hours before surgery, carbohydrate loading, no premedication, PONV prophylaxis, intraoperative I.V. fluid management, postoperative analgesia protocol, no routine abdominal drainage, urinary catheter removal POD3, Nutrition and laxative protocol, early mobilisation	Pre-ERAS: No counselling/educa tion, Fasting, no carbohydrate loading, pre-medication at anaesthesiologist discretion, no routine bowel prep or PONV prophylaxis, no postop care protocol	Liver surgery	UBA	174(Interventio n: 74, Comparator: 100)	Median age Intervention: 60.5(IQR 50-68.25), Comparator: 64(IQR 57.25-69.75)	Uni hospital	x	x	x	x		4

Kagedan 2017,[32] Canada	ERP	ERP	Multidisciplinary clinical pathway focused on postoperative management. Includes education, pain management, nutrition, activity and discharge planning	Historical control	Pancreatic surgery	UBA	Total: 195 (Intervention: 121, Comparator: 74)	Median age: Intervention: 65(IQR: 56-74), Comparator: 65.5(IQR: 58-74)	Uni hospital				x		1
Kennedy 2007,[33] USA	Critical Pathway	ERP	Preoperative education and heparin, thromboembolic deterrent stockings and sequential compression devices, night of operation spent in ICU, early mobilisation, clear liquid diet on POD 2, regular diet on POD 3, switch all medications to oral route on POD 4, discharge home on POD 6 or 7 and arrange follow-up appointment for 4 weeks after discharge	Pre-pathway	Pancreatico-duodenectomy	UBA	Total: 135 (Intervention: 91, Comparator: 44)	Intervention: 63.9(1.3), Comparator: 61.3(2)	Uni hospital	x	x	x	x	x	5
Kim 2014,[34] Korea	Critical Pathway	ERP	Preoperative bowel preparation, nothing by mouth after lunch, patient controlled analgesia on day of operation, postoperative early mobilisation, standardised postoperative nutrition, set date for discharge and outpatient follow up 2-3 weeks later.	Pre-clinical pathway	Pancreatico-duodenectomy	UBA	Total: 273 (Intervention: 88, Comparator: 185)	Intervention: 60.3(10.5), Comparator: 61.8(11.1)	Uni hospital		x	x	x	x	4

Ovaere 2018,[35] Belgium	Clinical pathway	ERP	Pre-operative patient education. Day of surgery: carbohydrate rich drinks, anaesthesia protocol, nasogastric tube removal before end of surgery, sitting upright in chair in evening. POD 1: Central venous catheter removal, very light diet plus energy drinks, physiotherapy. POD 2: Wound care, regular diet plus energy drinks, consider drain removal and peripheral venous catheter removal. POD 3 - 5: physiotherapy and regular diet. Discharge criteria: regular diet and pain management. Follow up: GP visit 5-7 days post operatively, surgeons office visit 2-3 weeks post operatively	Traditional Management: No preoperative nutrition, timing of surgery not specified, no anaesthesia protocol, nasogastric tube removal, mobilisation POD1, Oral intake as tolerated, drain removal and planning on discharge not specified	Liver surgery	UBA	Total: 229 (Intervention: 74, Comparator: 155)	Median age: Overall 64(IQR 55-74). Intervention 63.5(IQR 55-72), Comparator: 65(IQR 54-74)	Hospital		x	x	x	x	4
Vanounou 2007,[36] USA	Clinical pathway	ERP	Preoperative planning, prophylaxis, perioperative pain management, standardised removal of tubes and drains, psychosocial counselling, geriatric consultation, early rehabilitation	Pre-Pathway	Pancreatico-duodenecto my	UBA	Total: 209 (Intervention: 145, Comparator: 64)	Median age: Intervention: 64(NR), Comparator: 64(NR)	Uni hospital		x	x	x		3

Williamsson 2015,[37] Sweden	Fast Track Protocol	ERP	Information, preoperative nutrition and antithrombotic prophylaxis, fasting from midnight, nutrition/fluid/mobilisation protocol	Pre Fast-Track Protocol: antimicrobial prophylaxis, thoracic epidural/PCA, drains, NG tube, drain removal at surgeons discretion	Pancreatico-duodenectomy	UBA	Total: 100, Intervention: 50, Comparator: 50	Intervention median age: 69(range 15-80), Comparator median age: 67(range 25-81)	Uni hospital	x	x	x	x		4

Lee 2013,[38] Canada	Enhanced recovery pathway	ERP	Preoperative medical education. Smoking cessation counselling and respiratory muscle strengthening. Intraoperative prophylactic antiemetic's for PONV, epidural catheter, extubation in operating room. Minimally invasive approach encouraged and tailored surgical approach according to patient's status. Avoid blood loss. Nil by mouth. Post-surgery early ambulation. Nil by mouth until POD 3 sips of water and POD 4 begin meals. Aim for discharge by POD 7	Traditional care: Medical evaluation, medical and anaesthesia consultation at discretion of surgeon, fluid management at discretion of anaesthetist, tailored surgical approach based upon patient's needs, Thoracic epidural analgesia, tube removal only after solid diet started, discharge at surgeons discretion	Oesophagostomy	UBA	Total: 106, Intervention: 59, Comparator: 47	Intervention: 64(10), Comparator: 65(10)	High-volume Uni-affiliated centre	x	x	x	x		4
Thoracic-abdominal surgery															
Chang 2000,[39] Taiwan	Clinical pathway	ERP	Key documentation, laboratory tests, patient education, I.V. Fluid management, antibiotics, pain management, assigned nurse to monitor pathway adherence, meetings between members of clinical pathway team to resolve deviance from pathway	Group 1: Prior to pathway implementation, Group 2: First year of pathway implementation	Radical nephrectomy	UBA	Total: 5232 (Intervention: 3617, Comparator: 1615)	Intervention 1: 60(range 32-89), Intervention 2: 62(range 32-91), Comparator: 58(range 33-74)	Hospital		x	x	x		3
Vascular surgery															

Aragon 2002,[40] USA	Critical Pathway	ERP	Preoperative assessment and education, immediate postoperative clinical pathway, standardised postoperative recovery including early mobilisation and nutrition, discharge criteria	Pre-Critical Pathway	Carotid endarterectomy	UBA	Total: 717 (Intervention: 588, Comparator: 129)	Overall: 69.84(8.6)	Hospital		x		x		2

[a]Intervention n also reported as 69 within same paper; CT=Controlled Trial; ERAS=Enhanced Recovery After Surgery; ERP=Enhanced Recovery Protocol; GP=General Practitioner; ICU=Intensive Care Unit; I.V.=Intravenous; NG=Nasogastric; NR=Not Reported; POD=Post-Operative Day; PONV=Prevention of Nausea and Vomiting; PCA=Patient-Controlled Analgesia; PACP=Preoperative Assessment and Care Plan; RCT=Randomised Controlled Trial SD=Standard Deviation; UBA=Uncontrolled Before-and-After Trial; Uni =University.

Forty articles (from 39 studies) were non-RCTs conducted outside of the UK, including: fourteen studies from the USA, 7 from Canada, three each from Switzerland and Taiwan and two each from Japan and Spain. Nine studies were CTs and the remaining studies were controlled before-and-after trials.

The most common reasons for admission, according to the broad procedural categories (assigned by LS, MN) were: lower-limb arthroplasty (n=14 studies), upper abdominal (n=10 studies), colorectal surgery (n=7 studies) and thoracic surgery (n=4 studies). The most frequently assigned (LS, MN) category of intervention being evaluated was some form of Enhanced Recovery Pathway (n=32 or 33). Other intervention categories included pre-operative assessment and care plan production (n=1), discharge planning (n=1), specialist units (n=1), incentive-based working (n=1) patient centred care (n=1) and facilitating multi-disciplinary working (n=2). Interventions targeted a mean number of 3 stages (range 1-5) of a patient's treatment journey. Table 1 above summarises the stages of treatment targeted by each intervention, along with a brief description of the intervention and comparator used within each of these non-prioritised studies.

Table 2. Economic methods used within prioritised studies

Study, country (currency)	Study design	Sample size	Economic evaluation design	Perspective	Time Horizon	Types of resource us in intervention cost	Other resource use included in analysis	Intervention category
Cardiac surgery								
Furze 2009,[41] UK(£)	RCT	204	CUA	Health provider: UK NHS	8 weeks	Patient education materials (HeartOp Programme)	Patient materials (British Heart Foundation booklets), GP visits, admissions to hospital	Prehab
Goodman 2008,[42] UK(£)	RCT	188	CMA	NR	NR	In-patient, out-patient and community contacts and the homecare contacts	in-patient, out-patient and community contacts and the homecare contacts	PrO support and education
Salhiyyah 2011,[43] UK(UK £, US$)	CT	136	CCA	Hospital	Until discharged from hospital	Time (hours) in TRU (Theatre Recovery Unit)	Time (hours) in each of: Theatre Recovery Unit, Cardiac Intensive Care Unit, Progressive Care Unit and hospital ward	Specialist Ward
Colorectal surgery								
García-Botello 2011,[44] ESP(Euro)	RCT	125	CA	Hospital	Hospital stay only	NR	Total cost of hospitalisation	ERP
King 2006,[45] UK(£)	UBA	146	CCA	Societal[a]	3 months	No intervention costs separately identified - same costs measured before and after introduction of ERP	Inpatient days, recovery, intensive care, ward hotel costs. Theatre time (Includes preoperative and recovery), specific theatre equipment, postoperative costs (includes reoperation), chemotherapy and radiotherapy, follow up at 3 months, indirect costs, patients' employment status, outpatient visits, GP visits, use of community services	ERP

Vlug 2011,[46] NED(Euro)	RCT	93; 427[b]	CCA	Hospital	4-6 weeks - treatment through to 30 days post-op	Costs of Fast-track care not separately identified	Outpatient care, operating time, patient-days, the additional costs of laparoscopy and of FT care, as well as the costs of complications, reoperations and readmissions within 30 days after the index operation	ERP
Lower limb arthroplasty								
Huang 2012,[47] Taiwan((NTD$)	RCT	243	CA	Hospital	Discharge from hospital	Pre-admission medical expenditure NR	Total medical expenditure of hospitalization for TKA: preoperative care, prosthesis, operation, and post-TKA costs	Prehab
Huddleston 2004,[48] USA($)	RCT	505[c]	CCA	Hospital	Hospital stay	Hospital costs, physician cost	Hospital costs, physician cost	Staff mix
Hunt 2009,[49] UK(£)	CT	579; 599[b]	CCA	NHS	6 weeks		Estimation of time spent (mins) by each category of staff in activities. Included: initial consultation, pre-operative examination, patient admission, surgery, recovery, post-operative home visits and patient visits to hospital, admission to rehabilitation facilities, a telephone support line, preoperative tests, prostheses, anaesthesia, drugs dispensed on discharge, overhead costs (function of length of time in surgery)	ERP
Larsen 2009,[50] DEN(DKK)	RCT	90	CUA	Societal	12 months	Medical care (information day, boarding of the patient at the hospital, care in the hospital, rehabilitation in the hospital, patient needs (e.g. non-prescription medication, home changes and transportation) in the follow-up period, primary care in the follow up period, hospital readmission in the follow up period), medication, physiotherapy, effective working hours (staff)	Productivity loss for patients	ERP

McGregor 2004,[51] UK(£)	RCT	39	CMA	NHS	Approx 4 months (2-4 weeks pre-admission to 3 months post-discharge)	Cost of the preadmission class and booklet where appropriate.	Cost of ~~the~~ hospital stay, inpatient physiotherapy, ~~and~~ occupational therapy costs, outpatient costs, visits to the general practitioner, and use of community or outpatient therapy. ~~The costs of~~ Eequipment and medication ~~were~~ not included because these costs were deemed to be similar in the 2 study populations	Prehab and education
Reilly 2005,[52] UK(£)	RCT	41	CA	Hospital	NR	Additional outpatient appointments, cost of specialist registrar time.	Hospital stay cost, surgical staff, anaesthetics, prosthesis, pharmacy	ERP
Sigurdsson 2008,[53] ISL(US$)*	RCT	50	CEA	Societal	6 months	Operation and inpatient costs (=operation cost, implants, material, staff, pharmaceutical - included in weighted daily cost according to length of stay); Plus costs of pre-op education and training (physio or OT delivered), and post-op home-visits from an outpatient team (=physio or OT home visits, registered nurse visits)	Operation and inpatient costs (=operation cost, implants, material, staff, pharmaceutical - included in weighted daily cost according to length of stay); outpatient costs (=GP visits, specialist visits, physio or OT home visits, registered nurse visits, pharmaceuticals, x-rays/tests, convalescence homes [for control group only]); patient costs (=travel, co-payment, lost wages)	ERP
Upper abdominal surgery								
Richardson 2015,[54] UK(£)	UBA	66	CCA	Hospital costs/ budgetary	30 days	Theatre supplies related to the approach	Theatre supplies, theatre time per minute, surgeon time per minute, anaesthetist time per minute, blood transfusion requirement, any re-intervention (radiological and/or surgical) and overall hospital stay. Cost for readmission by 30 days from discharge including any associated re-intervention (radiological and/or surgical), new hospital stay	ERP

Tanaka 2017,[55] JPN(Japanese Yen)	RCT	148	CCA	Hospital	Hospital discharge	NR	Charges for consultation, prescriptions, injections, nursing care, the operating theatre, the laboratory, radiology, the ward and meals, and other services	ERAS

[a]Paper states NHS, but they also consider costs of time off work for patients; [b]Sample size reported across different papers from same study; [c]526 randomised but 21 who took part in the pilot were excluded before starting intervention; CA=Cost Analysis; CCA=Cost-Consequence Analysis; CEA=Cost-Effectiveness Analysis; CMA=Cost-Minimisation Analysis; CUA=Cost-Utility Analysis; CT=Controlled Trial; ERP=Enhanced Recovery Protocol/Programme; ERAS=Enhanced Recovery After Surgery; FT=Fast Track; GP=General Practitioner; NR=Not Reported; OT=Occupational Therapist; PO=Post-Operative; Pre-Operative; RCT=Randomised Controlled Trial; TKA=Total Knee Arthroplasty; UBA=Uncontrolled Before and After trial

Table 3. Data for length of stay, other primary outcomes and costs for all studies included in the cost effectiveness review

Study, intervention	Cost types and key outcomes		Intervention			Comparator			Incremental/Difference			ICER/ PSA/ CEAC
		LOS and primary outcome (units)	n	Est.	Var.	n	Est.	Var.	*d* or OR (95% CI)	Mean change (95% CI)	p	
Cardiac surgery												
Furze 2009,[41] Prehab	**Effects (RCT)**	**LOS (days)**	100	7.61	2.69	104	8.24	4.96	-0.16 (-0.43 to 0.12)	-.63 (-1.74 to .48)	>.05	NA
		Anxiety (State STAI)	100	NR	NR	104	NR	NR				NA
	Costs (GBP £, 2003-2004)	**Mean cost**	100	24.1	6.9	104	22.37	6.7	.25 (-.02 to .53)	1.73 (-.15 to 3.61)	>.05	ICER: 288.33
		QALY	88	0.109	0.003	94	0.103	0.003	-2.0 (-2.36 to -1.64)	.006 (.005 to -.007)	**<.001**	
Goodman 2008,[42] Prehab	**Effects (RCT)**	**LOS (days)**	91	8.5 (median)	6.88 to 10.13 (IQR)	90	9 (median)	7.5 to 10.5 (IQR)	-.28 (-.58 to .01)	-.67 (-1.36 to .02)	>.05	NA
		Anxiety (HADS raw score)	78	NR	NR	75	NR	NR				NA
	Costs (GBP £, NR)	**Mean[a] total estimated cost**	91	10954	3660	90	12771	5801	-.38 (-0.67 to -0.08)	-1817.0 (-3238 to -396)	**<.05**	NR
		Mean[a] inpatient (episodes)	91	9092	3578	90	11047	5118	-.44 (-.74 to -.15)	-1955.0 (-3249 to -661)	**<.01**	NR
Salhiyyah 2011,[43] Specialist Ward	**Effects (CT)**	**Total LOS (days)**	84	8.47	4.69	52	8.22	2.55	.06 (-.28 to .41)	.25 (1.15 to 1.65)	>.05	NA
	Costs (GBP £, NR)	**Unit cost for CICU+TRU**	84	1489	NR	52	NR	NR				NR
		Unit cost for PCU	84	648	NR	52	NR	NR				NR
		Unit cost for ward	84	460	NR	52	NR	NR				NR
		Mean cost per group	84	4182	2284	52	4553	1355	-.19 (-.53 to .16)	-371 (-1062 to 321)	>.05	NR
Colorectal surgery												
Garcia-Botello 2011,[44] ERP	**Effects (RCT)**	**LOS (days)**	61	4.15	2.2	58	9.23	7	-.99 (-1.37 to -.61)	-5.1 (-6.94 to -3.22)	**<.001**	NA
		Readmission rate <30 days (%)	61	3	NA	58	2	NA				NR

Study, intervention	Cost types and key outcomes		Intervention			Comparator			Incremental/Difference			ICER/ PSA/ CEAC
		LOS and primary outcome (units)	n	Est.	Var.	n	Est.	Var.	*d* or OR (95% CI)	Mean change (95% CI)	p	
	Costs (Euros, NR)	**Mean hospital cost**	61	1.418.1	745	58	3.153.9	2.381.7	-.99 (-1.38 to -.61)	-1736 (-2370 to -1102)	**<.001**	NR
King 2006,[45] ERP	**Effects (UBA)**	**Postoperative LOS (days)**	60	5.8	NR	86	10.7	NR				NA
		Readmissions within 30 days (n)	60	7	NR	86	8	NR	OR: 1.29 (0.44 to 3.76)		>.05	NA
		30 day hospital deaths (n)	60	2		86	6		OR: 0.46 (0.09 to 2.36)		>.05	NA
		Major complications (n)	60	11		86	24		OR: 0.58 (0.26 to 1.3)		>.05	NA
	Costs (GBP £, 2001)	**Mean theatre costs (includes pre-operative and recovery)**	60	2689.32	NR	86	2626.24	NR				NR
		Mean hospital costs (includes intensive care)	60	2715.27	NR	86	3039.19	NR				NR
		Mean postoperative costs (includes re-operation)	60	610.81	NR	86	639.9	NR				NR
		Mean chemotherapy and radiotherapy costs	60	203.5	NR	86	168.21	NR				NR
		Mean follow up at 3 months costs	60	450.55	NR	86	339.5	NR				NR
		Mean indirect costs	60	658.02	NR	86	1185.14	NR				NR
		Mean total costs	60	7327.47	NR	86	7998.18	NR				NR
Vlug 2011,[46] ERP	**Effects (RCT)**	**Total hospital LOS (days): Lap+FT**	100	5 (median)	IQR: 4 to 8	109	6 (median)	IQR: 4.5 to 9.5	-.39 (-.66 to -.12)	-1.33 (2.27 to -.40)	**<.01**	NA
		Total hospital LOS (days): Open+FT	93	7	IQR: 5 to 11	98	7	IQR: 6 to 13	-.2 (-.49 to .08)	-1.0 (-2.40 to .40)	>.05	NA
	Costs (Euros, NR)	**LAP+FT (In hospital costs for University hospitals)**	NR	Median: 10594	IQR: 5461-16763	NR	Median: 11967	IQR: 6222-17039				NR
		Open+FT (In hospital costs for University hospitals)	NR	Median: 12805	IQR: 6847-20658	NR	Median: 10479	IQR: 6608-16875				NR

Study, intervention	Cost types and key outcomes		Intervention			Comparator			Incremental/Difference			ICER/ PSA/ CEAC
		LOS and primary outcome (units)	n	Est.	Var.	n	Est.	Var.	*d* or OR (95% CI)	Mean change (95% CI)	p	
		LAP+FT(In hospital costs for teaching hospitals)	NR	Median: 5768	IQR: 4873-8917	NR	Median: 6228	IQR: 5280-6604				NR
		Open+FT(In hospital costs for teaching hospitals)	NR	Median: 5497	IQR: 4506-6513	NR	Median: 5650	IQR: 4836-8003				NR
Lower limb arthroplasty												
Huang 2012,[47] Prehab	**Effects (RCT)**	**LOS (days)**	126	7	2	117	8	1	-.63 (-.88 to -.37)	-1.0 (-1.40 to -.60)	**<.001**	NA
		Knee pain (VAS 1-10)	126	4.5	1.3	117	4.4	1.2	.08 (-.17 to .33)	.1 (-.22 to .42)	>.05	NA
		Knee ROM (degrees)	126	30	11	117	30	12	.0 (-.25 to .25)	.0 (-2.91 to 2.91)	>.05	NA
	Costs (NTD$, NR)	**Mean hospital cost**	126	123726.0	5204	117	125838.0	4428	-.44 (-.69 to -.18)	-2112 (-3337 to -886)	**<.001**	NR
Huddleston 2004,[48] Staff Mix	**Effects (RCT)**	**LOS (days): adjusted**	232	5.1	NR	236	5.6	NR				NA
		Patients experiencing complications (%)	232	38.4	NR	237	50.2	NR				NA
	Costs (US$, 2000)	**Mean direct medical costs (hospital)**	232	12684	NR	237	12916	NR				NR
		Mean direct medical costs (physician)	232	2689	NR	237	2367	NR				NR
		Mean direct medical costs (total)	232	15373	NR	237	15283	NR				NR
Hunt 2009,[49] ERP	**Effects (CT)**	**Postoperative LOS (days)**	316	3 (median)	1 to 49	87; 119	6; 5 (median)	Range: 3 to 19; 1 to 13				NA
		Oxford Hip Score (raw score)	316	26.5	7.2	87; 119	31.6; 29.8	9.1; 8.8	-.66 (-.91 to -.42); -.43 (-.64 to -.22)	-3.3 (-4.93 to -1.67) -5.1 (-6.93 to -3.27)	**<.001; <.001**	NA
		QOL Index (EuroQoL)	316	0.7	0.2	87	0.7; 0.7	0.2; 0.2	.11	.02 (-.02 to .06)	>.05	NA

Study, intervention	Cost types and key outcomes		Intervention			Comparator			Incremental/Difference			ICER/ PSA/ CEAC
		LOS and primary outcome (units)	n	Est.	Var.	n	Est.	Var.	*d* or OR (95% CI)	Mean change (95% CI)	p	
									(-.13 to .35) (both comparisons))	(both comparisons)		
	Costs (GBP £, 2006)	**Unit cost: Hospital staff input**	316	1119	NR	87/ 119	1748/ 1471	NR				NR
		Unit cost: Other resource use (Tests, investigations, blood, drugs)(£)	316	119	NR	87/ 119	127/ 141	NR				NR
		Unit cost: Bed days(£)	316	1796	NR	87/ 119	1572/ 1769	NR				NR
		Unit cost: Anaesthetic(£)	316	27	NR	87/ 119	24/27	NR				NR
		Unit cost: Prosthetic and cement(£)	316	1429	NR	87/ 119	908/ 1804	NR				NR
		Unit cost: Staff visits to patient's homes (post op)(GP, Community nurse, physiotherapist, O.T. home help)(£)	316	45	NR	87/ 119	118/115	NR				NR
		Unit cost: Patient visits to hospital (post op)(GP, Practise nurse, physiotherapist, outpatients, telephone contacts)(£)	316	137	NR	87/ 119	184/202	NR				NR
		A&E visits (post op)(£)	316	3	NR	87/ 119	9/4	NR				NR
		Unit cost: Discharge to rehab facilities (post op)(£)	316	112	NR	87/ 119	117/255	NR				NR
		Unit cost: Theatre overheads(£)	316	121	NR	87/ 119	263/182	NR				NR
		Total cost/patient(£)	316	4909	NR	87/ 119	5070/ 5970	NR				NR
Larsen 2009,[50] ERP	**Effects (RCT)**	**LOS (days)**	45	4.9	2.4	42	7.8	2.1	-1.28 (-1.75 to -.82)	-2.9 (-3.89 to -1.94)	**<.001**	NA

Study, intervention	Cost types and key outcomes		Intervention			Comparator			Incremental/Difference			ICER/ PSA/ CEAC
		LOS and primary outcome (units)	n	Est.	Var.	n	Est.	Var.	*d* or OR (95% CI)	Mean change (95% CI)	p	
		Health Related QoL (EQ-5D)	45	0.87	0.15	42	0.79	0.2	.50 (.07 to .93)	.08 (.004 to .16)	**<.05**	0.87
		Readmissions (n)	45	2		41	1		OR: 1.86 (0.16 to 21.32)		>.05	NA
	Costs (DEN DKK, 2006)	**Average total cost: THA**	28	71768	41544	28	87657	39915	-.39 (-.92 to .14)	-15889 (-37717 to 5939)	>.05	
		Average total cost: TKA/ Uni-compartmental Knee arthroplasty	17	70644	38437	14	95367	61293	-.49 (-1.21 to .22)	-24723 (-61624 to 12178)	>.05	NR
		Hospital readmission cost: TKA	0			1	7893					NR
		Average number of QALYs: All	45	0.83	0.1	42	0.78	0.15	.39 (-.03 to .82)	.05 (-.004 to .10)	>.05	NR
		Average number of QALYs: THA	28	0.84	0.11	28	0.75	0.18	.60 (.07 to 1.14)	.09 (.01 to .17)	**<.05**	NR
		Average number of QALYs: TKA	15	0.81	0.09	12	0.85	0.05	-.53 (-1.31 to .24)	-.04 (-.10 to .02)	>.05	NR
McGregor 2004,[51] Prehab + education	**Effects (RCT)**	**LOS (days)**	19	15	NR	20	18	NR				NA
		WOMAC Pain (raw score)	19	10.2	2.7	20	10.3	4.1	-.03 (-.66 to .60)	-.1 (-2.37 to 2.17)	>.05	NA
		WOMAC Stiffness (raw score)	19	4.3	1.3	20	4.1	1.7	.13 (-.50 to .76)	.2 (-.79 to 1.19)	>.05	NA
		WOMAC Function (raw score)	19	35.8	12	20	41	10	-.47 (-1.11 to .17)	-5.2 (-12.4 to 1.95)	>.05	NA
		Harris Hip Score (raw score)	19	45.4	11.5	20	43.2	16.2	.16 (-.47 to .78)	2.2 (-6.96 to 11.4)	>.05	NA
	Costs (GBP £, NR)	**Average cost of care**	19	2842	NR	20	3429	NR				NR
Reilly 2005,[52] ERP	**Effects (RCT)**	**LOS (days)**	21	1.5	Range: 1 to 5	20	4.3	Range: 1 to 6				NA
		Oxford Knee Score at 6 months (raw score)	21	43.7	3.7	20	42.2	7.1	.27 (-0.35 to .88)	1.5 (-2.05 to 5.05)	>.05	NA

Study, intervention	Cost types and key outcomes		Intervention			Comparator			Incremental/Difference			ICER/ PSA/ CEAC
		LOS and primary outcome (units)	n	Est.	Var.	n	Est.	Var.	*d* or OR (95% CI)	Mean change (95% CI)	p	
		AKSS Objective at 6 months (raw score)	21	100	10.4	20	89.4	17.5	-.07 (-.68 to .54)	-1.0 (-10.0 to 8.04)	>.05	NA
		AKSS Functional at 6 months (raw score)	21	90.9	11.7	20	90	13.3	.07 (-.54 to .68)	.9 (-7.00 to 8.80)	>.05	NA
	Costs (GBP £, NR)	**Total cost per patient**	21	3391	NR	20	4634	NR				NR
		Fixed costs (surgical staff, anaesthetics, prosthesis, pharmacy)	21	2540	NR	20	2540	NR				NR
		Hospital stay cost	21	730	NR	20	2094	NR				NR
		Additional outpatient appointment	21	36	NR	20	0	NR				NR
		Cost of Specialist Registrar time	21	85	NR	20	0	NR				NR
Sigurdsson 2008,[53] ERP	**Effects (RCT)**	**LOS (days)**	27	6.4	2.4	23	10	3.5	-1.22 (-1.83 to -.61)	-3.6 (-5.29 to -1.91)	**<.001**	NA
		Oxford Hips Score (Pain and Function) (raw score)	27	19	6.3	21	24	9	-.66 (-1.24 to -.07)	-5.0 (-9.45 to -.55)	**<.05**	NA
		Harris Hip Score (raw score)	27	76 (median)	56 to 93 (range)	27	71 (median)	31 to 83 (range)				NA
	Costs (USD$, 1999)	**Total cost in hospital**	27	5225	989	23	6515	1018	-1.29 (-1.9 to -.67)	-1290 (-1861 to -718.1)	**<.001**	NR
		Total post-op government cost	27	496	244	23	1748	1733	-1.05 (-1.65 to -.46)	-1252 (-1929 to -574.8)	**<.001**	NR
		Total healthcare cost	27	5720	1047	23	8263	2215	-1.51 (-2.14 to -.88)	-2543 (-3505 to -1581)	**<.001**	NR
		Total patient cost	27	2830	2191	23	3689	2292	-.38 (-.95 to .18)	-859 (-2136 to 418)	>.05	NR
		Grand total cost	27	8550	2409	23	11952	3202	-1.21 (-1.82 to -.61)	-3402 (-5000 to -1804)	**<.001**	NR
Upper abdominal surgery												

Study, intervention	Cost types and key outcomes		Intervention			Comparator			Incremental/Difference			ICER/ PSA/ CEAC
		LOS and primary outcome (units)	n	Est.	Var.	n	Est.	Var.	*d* or OR (95% CI)	Mean change (95% CI)	p	
Richardson 2015,[54] ERP	**Effects (UBA)**	**Postoperative LOS (days)**	22	3 (median)	IQR: 3 to 4	44	6 (median)	IQR: 5 to 10	-1.47 (-2.04 to -.9)	-4.67 (-6.32 to -3.01)	**<.001**	NA
		Overall complications (n)	22	6	NR	44	17	NR	OR: 0.6 (0.19 to 1.82)		.36	NA
		90 day mortality (n)	22	0	NR	44	0	NR				NR
		Readmission within 30 days (n)	22	2	NR	44	8	NR				NR
	Costs (GBP £, NR)	**Intraoperative cost (GBP)**	22	NR	NR	44	NR	NR				NR
		Postoperative cost (GBP)	22	1870	NR	44	4680	NR				NR
		Total cost without readmission (GBP)	22	6650	NR	44	9850	NR				NR
		Total cost with readmission (GBP)	22	6800	NR	44	10045	NR				NR
Tanaka 2017,[55] ERAS	**Effects (RCT)**	**Postoperative LOS (days)**	73	9 (median)	IQR: 8 to 10	69	10 (median)	IQR: 9 to 11.5	-.88 (-1.22 to -.53)	-1.5 (-2.07 to -.93)	<.001	NA
	Costs (JPY, NR)	**Admission cost**	73	Median: 1,462,766	IQR: 1,421,364 to 1,586,539	69	Median: 1,493,930	IQR: 1,449,172 to 1,621,128	-.33 (-.66 to .01)	-41575 (-83902 to 752.8)	>.05	NR

[a]Assumed; Blue text=Second Comparator; CEAC= Cost-Effectiveness Acceptability Curve CT=Controlled Trial; ERP=Enhanced Recovery Protocol/Program; FT=Fast-track; ICER=Incremental Cost-Effectiveness Ration; IQR=Inter-quartile range; LOS=Length of Stay; NA=Not Applicable; NR=Not Reported; PrO=Pre-Operative; PSA=Probability Sensitivity Analysis; RCT=Randomised Controlled Trial; UBA=Uncontrolled Before and After Trial; VAS=Visual Analogue Scale; WOMAC=Western Ontario and McMaster Universities Osteoarthritis Index;

References

1. Emaminia A, Corcoran PC, Siegenthaler MP, Means M, Rasmussen S, Krause L, *et al.* The universal bed model for patient care improves outcome and lowers cost in cardiac surgery. *J Thorac Cardiovasc Surg* 2012;**143**:475-81. https://doi.org/10.1016/j.jtcvs.2011.10.001

2. Yanatori M, Tomita S, Miura Y, Ueno Y. Feasibility of the fast-track recovery program after cardiac surgery in Japan. *Gen Thorac Cardiovasc Surg* 2007;**55**:445-9. https://doi.org/10.1007/s11748-007-0162-2

3. Ehrlich A, Kellokumpu S, Wagner B, Kautiainen H, Kellokumpu I. Comparison of laparoscopic and open colonic resection within fast-track and traditional perioperative care pathways: Clinical outcomes and in-hospital costs. *Scand J Surg* 2015;**104**:211-8. https://doi.org/10.1177/1457496914557016

4. Garfinkle R, Boutros M, Ghitulescu G, Vasilevsky CA, Charlebois P, Liberman S, *et al.* Clinical and Economic Impact of an Enhanced Recovery Pathway for Open and Laparoscopic Rectal Surgery. *J Laparoendosc Adv Surg Tech A* 2018;**28**:811-8. https://doi.org/10.1089/lap.2017.0677

5. Lee L, Mata J, Ghitulescu GA, Boutros M, Charlebois P, Stein B, *et al.* Cost-effectiveness of Enhanced Recovery Versus Conventional Perioperative Management for Colorectal Surgery. *Ann Surg* 2015;**262**:1026-33. https://doi.org/10.1097/SLA.0000000000001019

6. Nelson G, Kiyang LN, Crumley ET, Chuck A, Nguyen T, Faris P, *et al.* Implementation of Enhanced Recovery After Surgery (ERAS) Across a Provincial Healthcare System: The ERAS Alberta Colorectal Surgery Experience. *World J Surg* 2016;**40**:1092-103. https://doi.org/10.1007/s00268-016-3472-7

7. Nelson G, Kiyang LN, Chuck A, Thanh NX, Gramlich LM. Cost impact analysis of Enhanced Recovery After Surgery program implementation in Alberta colon cancer patients. *Curr Oncol* 2016;**23**:e221-7. https://doi.org/10.3747/co.23.2980

8. Pedziwiatr M, Wierdak M, Nowakowski M, Pisarska M, Stanek M, Kisielewski M, *et al.* Cost minimization analysis of laparoscopic surgery for colorectal cancer within the enhanced recovery after surgery (ERAS) protocol: a single-centre, case-matched study. *Wideochir Inne Tech Maloinwazyjne* 2016;**11**:14-21. https://doi.org/10.5114/wiitm.2016.58617

9. Roulin D, Donadini A, Gander S, Griesser AC, Blanc C, Hubner M, *et al.* Cost-effectiveness of the implementation of an enhanced recovery protocol for colorectal surgery. *Br J Surg* 2013;**100**:1108-14. https://doi.org/10.1002/bjs.9184

10. Salvans S, Gil-Egea MJ, Pera M, Lorente L, Cots F, Pascual M, *et al.* Multimodal rehabilitation program in elective colorectal surgery: Impact on hospital costs. *Cir Esp* 2013;**91**:638-44. https://doi.org/10.1016/j.ciresp.2013.01.010

11. Arana M, Harper L, Qin H, Mabrey J. Reducing Length of Stay, Direct Cost, and Readmissions in Total Joint Arthroplasty Patients With an Outcomes Manager-Led Interprofessional Team. *Orthop Nurs* 2017;**36**:279-84. https://doi.org/10.1097/NOR.0000000000000366

12. Batsis JA, Naessens JM, Keegan MT, Huddleston PM, Wagie AE, Huddleston JM. Resource utilization of total knee arthroplasty patients cared for on specialty orthopedic surgery units. *J Hosp Med* 2008;**3**:218-27. https://doi.org/10.1002/jhm.299

13. Brunenberg DE, van Steyn MJ, Sluimer JC, Bekebrede LL, Bulstra SK, Joore MA. Joint recovery programme versus usual care: an economic evaluation of a clinical pathway for joint replacement surgery. *Med Care* 2005;**43**:1018-26.

14. Cullen J, Bramley D, Armstrong D, Butler L, Rouse P, Ashton T. Increasing productivity, reducing cost and improving quality in elective surgery in New Zealand: the Waitemata District Health Board joint arthroplasty pilot. *Intern Med J* 2012;**42**:620-6. https://doi.org/10.1111/j.1445-5994.2012.02815.x

15. Duplantier NL, Briski DC, Luce LT, Meyer MS, Ochsner JL, Chimento GF. The Effects of a Hospitalist Comanagement Model for Joint Arthroplasty Patients in a Teaching Facility. *J Arthroplasty* 2016;**31**:567-72. https://doi.org/10.1016/j.arth.2015.10.010

16. Hansen TB, Bredtoft HK, Larsen K. Preoperative physical optimization in fast-track hip and knee arthroplasty. *Dan Med J* 2012;**59**:A4381.

17. Healy WL, Iorio R, Ko J, Appleby D, Lemos DW. Impact of cost reduction programs on short-term patient outcome and hospital cost of total knee arthroplasty. *J Bone Joint Surg Am* 2002;**84-A**:348-53.

18. Ho DM, Huo MH. Are critical pathways and implant standardization programs effective in reducing costs in total knee replacement operations? *J Am Coll Surg* 2007;**205**:97-100. https://doi.org/10.1016/j.jamcollsurg.2007.03.009

19. Krummenauer F, Guenther KP, Kirschner S. Cost effectiveness of total knee arthroplasty from a health care providers' perspective before and after introduction of an interdisciplinary clinical pathway--is investment always improvement? *BMC Health Serv Res* 2011;**11**:338. https://doi.org/10.1186/1472-6963-11-338

20. Lin YK, Su JY, Lin GT, Tien YC, Chien SS, Lin CJ, *et al.* Impact of a clinical pathway for total knee arthroplasty. *Kaohsiung J Med Sci* 2002;**18**:134-40.

21. Lin PC, Hung SH, Wu HF, Hsu HC, Chu CY, Su SJ. The effects of a care map for total knee replacement patients. *J Clin Nurs* 2011;**20**:3119-27. https://doi.org/10.1111/j.1365-2702.2011.03804.x

22. Loftus T, Agee C, Jaffe R, Tao J, Jacofsky DJ. A simplified pathway for total knee arthroplasty improves outcomes. *J Knee Surg* 2014;**27**:221-8. https://doi.org/10.1055/s-0033-1360657

23. Wilches C, Sulbaran JD, Fernandez JE, Gisbert JM, Bausili JM, Pelfort X. Fast-track recovery technique applied to primary total hip and knee replacement surgery. Analysis of costs and complications. *Rev Esp Cir Ortop Traumatol* 2017;**61**:111-6. https://doi.org/10.1016/j.recot.2016.10.002

24. Nabhani J, Ahmadi H, Schuckman AK, Cai J, Miranda G, Djaladat H, *et al.* Cost Analysis of the Enhanced Recovery After Surgery Protocol in Patients Undergoing Radical Cystectomy for Bladder Cancer. *Eur Urol Focus* 2016;**2**:92-6. https://doi.org/10.1016/j.euf.2015.06.009

25. Marcantuono R, Gutsche J, Burke-Julien M, Anwaruddin S, Augoustides JG, Jones D, *et al.* Rationale, development, implementation, and initial results of a fast track protocol for

transfemoral transcatheter aortic valve replacement (TAVR). *Catheter Cardiovasc Interv* 2015;**85**:648-54. https://doi.org/10.1002/ccd.25749

26. Maruyama R, Miyake T, Kojo M, Aoki Y, Suemitsu R, Okamoto T, *et al.* Establishment of a clinical pathway as an effective tool to reduce hospitalization and charges after video-assisted thoracoscopic pulmonary resection. *Jpn J Thorac Cardiovasc Surg* 2006;**54**:387-90. https://doi.org/10.1007/s11748-006-0014-5

27. Paci P, Madani A, Lee L, Mata J, Mulder DS, Spicer J, *et al.* Economic Impact of an Enhanced Recovery Pathway for Lung Resection. *Ann Thorac Surg* 2017;**104**:950-7. https://doi.org/10.1016/j.athoracsur.2017.05.085

28. Shargall Y, Hanna WC, Schneider L, Schieman C, Finley CJ, Tran A, *et al.* The Integrated Comprehensive Care Program: A Novel Home Care Initiative After Major Thoracic Surgery. *Semin Thorac Cardiovasc Surg* 2016;**28**:574-82. https://doi.org/10.1053/j.semtcvs.2015.12.003

29. Cunningham KE, Zenati MS, Petrie JR, Steve JL, Hogg ME, Zeh HJ, 3rd, *et al.* A policy of omitting an intensive care unit stay after robotic pancreaticoduodenectomy is safe and cost-effective. *J Surg Res* 2016;**204**:8-14. https://doi.org/10.1016/j.jss.2016.04.023

30. Joliat GR, Labgaa I, Petermann D, Hubner M, Griesser AC, Demartines N, *et al.* Cost-benefit analysis of an enhanced recovery protocol for pancreaticoduodenectomy. *Br J Surg* 2015;**102**:1676-83. https://doi.org/10.1002/bjs.9957

31. Joliat GR, Labgaa I, Hubner M, Blanc C, Griesser AC, Schafer M, *et al.* Cost-Benefit Analysis of the Implementation of an Enhanced Recovery Program in Liver Surgery. *World J Surg* 2016;**40**:2441-50. https://doi.org/10.1007/s00268-016-3582-2

32. Kagedan DJ, Devitt KS, Tremblay St-Germain A, Ramjaun A, Cleary SP, Wei AC. The economics of recovery after pancreatic surgery: detailed cost minimization analysis of an enhanced recovery program. *HPB (Oxford)* 2017;**19**:1026-33. https://doi.org/10.1016/j.hpb.2017.07.013

33. Kennedy EP, Rosato EL, Sauter PK, Rosenberg LM, Doria C, Marino IR, *et al.* Initiation of a critical pathway for pancreaticoduodenectomy at an academic institution--the first step in multidisciplinary team building. *J Am Coll Surg* 2007;**204**:917-23; discussion 23-4. https://doi.org/10.1016/j.jamcollsurg.2007.01.057

34. Kim HE, Kim YH, Song KB, Chung YS, Hwang S, Lee YJ, *et al.* Impact of critical pathway implementation on hospital stay and costs in patients undergoing pancreaticoduodenectomy. *Korean J Hepatobiliary Pancreat Surg* 2014;**18**:14-20. https://doi.org/10.14701/kjhbps.2014.18.1.14

35. Ovaere S, Boscart I, Parmentier I, Steelant PJ, Gabriel T, Allewaert J, *et al.* The Effectiveness of a Clinical Pathway in Liver Surgery: a Case-Control Study. *J Gastrointest Surg* 2018;**22**:684-94. https://doi.org/10.1007/s11605-017-3653-1

36. Vanounou T, Pratt W, Fischer JE, Vollmer CM, Jr., Callery MP. Deviation-based cost modeling: a novel model to evaluate the clinical and economic impact of clinical pathways. *J Am Coll Surg* 2007;**204**:570-9. https://doi.org/10.1016/j.jamcollsurg.2007.01.025

37. Williamsson C, Karlsson N, Sturesson C, Lindell G, Andersson R, Tingstedt B. Impact of a fast-track surgery programme for pancreaticoduodenectomy. *Br J Surg* 2015;**102**:1133-41. https://doi.org/10.1002/bjs.9856

38. Lee L, Li C, Robert N, Latimer E, Carli F, Mulder DS, *et al.* Economic impact of an enhanced recovery pathway foroesophagectomy. *Br J Surg* 2013;**100**:1326-34. https://doi.org/10.1002/bjs.9224

39. Chang PL, Wang TM, Huang ST, Hsieh ML, Chuang YC, Chang CH. Improvement of health outcomes after continued implementation of a clinical pathway for radical nephrectomy. *World J Urol* 2000;**18**:417-21.

40. Aragon D, Burton V, Byers JF, Cohen M. The effect of a critical pathway on patients' outcomes after carotid endarterectomy. *Am J Crit Care* 2002;**11**:250-8; quiz 9-60.

41. Furze G, Dumville JC, Miles JN, Irvine K, Thompson DR, Lewin RJ. "Prehabilitation" prior to CABG surgery improves physical functioning and depression. *Int J Cardiol* 2009;**132**:51-8. https://doi.org/10.1016/j.ijcard.2008.06.001

42. Goodman H, Parsons A, Davison J, Preedy M, Peters E, Shuldham C, *et al.* A randomised controlled trial to evaluate a nurse-led programme of support and lifestyle management for patients awaiting cardiac surgery 'Fit for surgery: Fit for life' study. *Eur J Cardiovasc Nurs* 2008;**7**:189-95. https://doi.org/10.1016/j.ejcnurse.2007.11.001

43. Salhiyyah K, Elsobky S, Raja S, Attia R, Brazier J, Cooper GJ. A clinical and economic evaluation of fast-track recovery after cardiac surgery. *Heart Surg Forum* 2011;**14**:E330-4. https://doi.org/10.1532/HSF98.20111029

44. Garcia-Botello S, Canovas de Lucas R, Tornero C, Escamilla B, Espi-Macias A, Esclapez-Valero P, *et al.* [Implementation of a perioperative multimodal rehabilitation protocol in elective colorectal surgery. A prospective randomised controlled study]. *Cir Esp* 2011;**89**:159-66. https://doi.org/10.1016/j.ciresp.2010.12.004

45. King PM, Blazeby JM, Ewings P, Longman RJ, Kipling RM, Franks PJ, *et al.* The influence of an enhanced recovery programme on clinical outcomes, costs and quality of life after surgery for colorectal cancer. *Colorectal Dis* 2006;**8**:506-13. https://doi.org/10.1111/j.1463-1318.2006.00963.x

46. Vlug MS, Wind J, Hollmann MW, Ubbink DT, Cense HA, Engel AF, *et al.* Laparoscopy in combination with fast track multimodal management is the best perioperative strategy in patients undergoing colonic surgery: a randomized clinical trial (LAFA-study). *Ann Surg* 2011;**254**:868-75. https://doi.org/10.1097/SLA.0b013e31821fd1ce

47. Huang SW, Chen PH, Chou YH. Effects of a preoperative simplified home rehabilitation education program on length of stay of total knee arthroplasty patients. *Orthop Traumatol Surg Res* 2012;**98**:259-64. https://doi.org/10.1016/j.otsr.2011.12.004

48. Huddleston JM, Long KH, Naessens JM, Vanness D, Larson D, Trousdale R, *et al.* Medical and surgical comanagement after elective hip and knee arthroplasty: a randomized, controlled trial. *Ann Intern Med* 2004;**141**:28-38.

49. Hunt GR, Crealey G, Murthy BV, Hall GM, Constantine P, O'Brien S, *et al.* The consequences of early discharge after hip arthroplasty for patient outcomes and health care costs: comparison of three centres with differing durations of stay. *Clin Rehabil* 2009;**23**:1067-77. https://doi.org/10.1177/0269215509339000

50. Larsen K, Hansen TB, Thomsen PB, Christiansen T, Soballe K. Cost-effectiveness of accelerated perioperative care and rehabilitation after total hip and knee arthroplasty. *J Bone Joint Surg Am* 2009;**91**:761-72. https://doi.org/10.2106/JBJS.G.01472

51. McGregor AH, Rylands H, Owen A, Dore CJ, Hughes SP. Does preoperative hip rehabilitation advice improve recovery and patient satisfaction? *J Arthroplasty* 2004;**19**:464-8.

52. Reilly KA, Beard DJ, Barker KL, Dodd CA, Price AJ, Murray DW. Efficacy of an accelerated recovery protocol for Oxford unicompartmental knee arthroplasty--a randomised controlled trial. *Knee* 2005;**12**:351-7. https://doi.org/10.1016/j.knee.2005.01.002

53. Sigurdsson E, Siggeirsdottir K, Jonsson H, Jr., Gudnason V, Matthiasson T, Jonsson BY. Early discharge and home intervention reduces unit costs after total hip replacement: results of a cost analysis in a randomized study. *Int J Health Care Finance Econ* 2008;**8**:181-92. https://doi.org/10.1007/s10754-008-9036-0

54. Richardson J, Di Fabio F, Clarke H, Bajalan M, Davids J, Abu Hilal M. Implementation of enhanced recovery programme for laparoscopic distal pancreatectomy: feasibility, safety and cost analysis. *Pancreatology* 2015;**15**:185-90. https://doi.org/10.1016/j.pan.2015.01.002

55. Tanaka R, Lee SW, Kawai M, Tashiro K, Kawashima S, Kagota S, *et al*. Protocol for enhanced recovery after surgery improves short-term outcomes for patients with gastric cancer: a randomized clinical trial. *Gastric Cancer* 2017;**20**:861-71. https://doi.org/10.1007/s10120-016-0686-1