

AVANOS

CLINICAL COMPENDIUM

OPIOID REDUCTION STUDIES

ON-Q^{*}
PAIN RELIEF SYSTEM



1	Evaluation of novel local anesthetic wound infiltration techniques for postoperative pain following colorectal resection surgery: a meta-analysis	23	Comparison between systemic analgesia, continuous wound catheter analgesia and continuous thoracic paravertebral block: a randomized, controlled trial of postthoracotomy pain management
2	Local delivery of bupivacaine in the wound reduces opioid requirements after intraabdominal surgery in children	24	A randomized trial of bupivacaine pain pumps to eliminate the need for patient controlled analgesia pumps in primary laparoscopic Roux-en-Y gastric bypass
3	Postoperative pain after abdominal hysterectomy: a randomized, double-blind, controlled trial comparing continuous infusion vs. patient-controlled intraperitoneal injection of local anaesthetic	25	Assessment of postoperative pain control with an elastomeric pain pump following cardiothoracic surgery
4	The 2012 Chitranjan Ranawaat Award: Intraarticular analgesia after TKA reduces pain: a randomized double-blinded, placebo-controlled, prospective study	26	Application of continuous incisional infusion of local anesthetic after major pediatric urological surgery
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12	Continuous wound infiltration with ropivacaine reduces pain and analgesic requirement after shoulder surgery	34	Postoperative continuous paravertebral anesthetic infusion for pain control in posterior cervical spine surgery: a case-control study
13	Prospective, randomized double-blind intravenous narcotic patient-controlled anesthesia pump for pain management after free TRAM flap breast reconstruction	35	Reduction or elimination of postoperative pain medication after mastectomy through use of temporarily placed local anesthetic pump vs. control group
14	Use of a continuous local anesthetic infusion for pain management after median sternotomy	36	Improved pain management outcomes with continuous infusion of a local anesthetic after thoracotomy
15	The use of continuous popliteal sciatic nerve block after surgery involving the foot and ankle: does it improve the quality of recovery?	37	Continuous infusion of local anesthetic decreases narcotic use and length of hospitalization after laparoscopic renal surgery
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17	Continuous interscalene infusion and single injection using levobupivacaine for analgesia after surgery of the shoulder	39	Outpatient analgesia via paravertebral peripheral nerve block catheter and ON-Q pump – a case series
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19	Local anesthetic infusion pumps improve postoperative pain after inguinal hernia repair: a randomized trial	41	Successful continuous interscalene analgesia for ambulatory shoulder surgery in a private practice setting
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21	Continuous incisional infusion of local anesthetic in pediatric patients following open heart surgery		
22	Continuous popliteal sciatic nerve block versus single injection nerve block for ankle fracture surgery: a prospective randomized comparative trial		

ABBREVIATIONS

#	STUDY	LOE	DESIGN	DEVICE/PROCEDURE	CONCLUSION	
					SAFETY	PERFORMANCE
1	<p>Evaluation of novel local anesthetic wound infiltration techniques for postoperative pain following colorectal resection surgery: a meta-analysis</p> <p>Ventham NT, et al. Disease of the Colon and Rectum 2014 Feb; 57(2): 237-50.</p> <p>MD. Department of Colorectal Surgery, Western General Hospital - Edinburgh, UK</p> <p>https://pubmed.ncbi.nlm.nih.gov/24401887</p>	I	<p>Meta-analysis RCTs</p> <p>Included 12 studies 878 patients</p>	<p>Multiple, including ON-Q</p> <p>Colorectal Open or laparoscopic</p>	<ul style="list-style-type: none"> No difference in wound healing or surgical complications between the groups 	<p>Local anesthetic techniques compared to placebo/routine techniques showed:</p> <ul style="list-style-type: none"> Significant reduction in opiate requirement at 48 hrs (P=.002) Lower pain scores on movement at 24 and 48 hrs in studies where catheter was placed subfascial (P=.02, P=.004) Significant reduction in length of stay (P=.02) Significant improvement in return of bowel function
2	<p>Local delivery of bupivacaine in the wound reduces opioid requirements after intraabdominal surgery in children</p> <p>Hermansson O et al. Pediatr Surg Int 2013; 29: 451-4.</p> <p>Pediatric Surgery, University Children's Hospital - Uppsala, Sweden</p> <p>https://pubmed.ncbi.nlm.nih.gov/23483343</p>	I	<p>RCT Double-blind, placebo controlled</p> <p>33 children (6 months-13 y/o)</p> <p>bupivacaine dosing: <9 kg (0.2 mg/kg/h) >9 kg (0.4 mg/kg/h) 100-250 mL at 1-2 mL/hr</p>	<p>ON-Q with soaker catheters</p> <p>Enterostomy closure, open gastrostomy or ureteral reimplantation</p>	<ul style="list-style-type: none"> One catheter was accidentally cut during wound dressing change in the saline group; Pt excluded 	<ul style="list-style-type: none"> PTs in bupivacaine group used significantly less morphine on POD 1 and Cumulative (P<.05) NS on POD 1 and 2 No difference between groups for time to full oral intake or time to discharge
3	<p>Postoperative pain after abdominal hysterectomy: a randomized, double-blind, controlled trial comparing continuous infusion vs. patient-controlled intraperitoneal injection of local anaesthetic</p> <p>Pernola A et al. B J Anaesth 2014; 112: 328-336.</p> <p>Department of Anesthesiology and Intensive Care, University Hospital - Orebro, Sweden</p> <p>https://pubmed.ncbi.nlm.nih.gov/24185607</p>	I	<p>RCT, blinded</p> <p>40 Pts</p> <p>levobupivacaine .125% Normal Saline control</p>	<p>ON-Q and Electronic PCA</p> <p>TAH 2 catheters placed</p>	<ul style="list-style-type: none"> No difference in PONV, sedation of health-related quality of life scores between groups No major complications, including infection No S/S of LA toxicity 	<p>LA PCA group compared with CI PCA group:</p> <ul style="list-style-type: none"> Less use of rescue analgesics during 0-4 hr post-op (P=.015) and 0-24 hr (P=.021) No difference in rescue analgesic 24-48 hrs Used significantly less levobupivacaine after 24 hrs 180 mL vs. 240 mL (P<.01) Quicker return to GI function 1.5 vs. 2.2 days (P<.01)
4	<p>The 2012 Chitranjan Ranawaat Award: Intraarticular analgesia after TKA reduces pain: a randomized double-blinded, placebo-controlled, prospective study</p> <p>Goyal N et al. Clin Orthop Relat Res 2013; 471: 64-75.</p> <p>Surgeon, Anderson Orthopedic Clinic - Alexandria, VA</p> <p>https://pubmed.ncbi.nlm.nih.gov/23011843</p>	I	<p>RCT</p> <p>150 Pts</p>	<p>ON-Q</p> <p>TKA</p>	<ul style="list-style-type: none"> No difference in adverse events between groups 	<p>ON-Q group:</p> <ul style="list-style-type: none"> 33% less narcotic use on POD 2 (P=.021) and 54% reduction on POD 3 (P=.038) Trend toward lower pain scores throughout POD 2 Significant difference in all pain scores on POD 1 (P=.03) Significant difference in highest pain scores on POD 2 (P=.04) No difference in LOS or narcotic side effects Pts reported lower VAS score during hospitalization when asked about their postoperative pain at 4-week f/u visit

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5	<p>The analgesic effects of a bilateral sternal infusion of ropivacaine after cardiac surgery</p> <p>Eljezi V et al. Reg Anesth Pain Med 2012; 37: 166-174.</p> <p>Surgeon, University Clermont - Clermont-Ferrand, France</p> <p>https://pubmed.ncbi.nlm.nih.gov/22266899</p>	I	RCT 40 Pts	ON-Q Dual site Sternotomy	<ul style="list-style-type: none"> • Serum ropivacaine levels measured with a trend toward increasing concentrations with time (0.2% ropivacaine, 2 mL/hr, dual site) • Serum level >4mg/L in one patient. No symptoms of toxicity reported • No major adverse events due to treatment 	<p>Treatment group:</p> <ul style="list-style-type: none"> • Morphine use less, 20 mg vs. 30 mg (P=.036) • Lower VAS scores at mobilization (P=.0004) and at rest (P=.0006) • Most significant on POD 2 with 41% reporting a reduction in pain on movement • Improved patient satisfaction (P<.0001) • Quality of rehab improved • No difference in respiratory function
6	<p>The analgesic efficacy of continuous wound instillation with ropivacaine after open hepatic surgery</p> <p>Chan SK et al. Anesthesia 2010; 65: 1180-1186.</p> <p>Anesthesiologist, Prince of Wales Hospital/Chinese University - Hong Kong, China</p> <p>https://pubmed.ncbi.nlm.nih.gov/20958277</p>	I	RCT 48 Pts	ON-Q Hepatic Surgery	<ul style="list-style-type: none"> • Ropivacaine serum levels gradually increased (mean of 2.5 mcg/mL) • No clinical evidence of toxicity • Authors concluded that ropivacaine conc should be no greater than 0.25% for patients after hepatic resection 	<p>Treatment group:</p> <ul style="list-style-type: none"> • Morphine consumption less, 58 mg vs. 86 mg (P<.01) • Less pain up to 72 h (P<.01) • Less reduction in lung vital capacity • No difference in LOS, ICU stay or extubation time between groups
7	<p>Continuous Preperitoneal infusion of ropivacaine provides effective analgesia and accelerates recovery after colorectal surgery</p> <p>Beaussier et al. Anesthesiology 2007; 107: 461-468.</p> <p>Anesthesiologist, St. Antoine Hospital - Paris, France</p> <p>https://pubmed.ncbi.nlm.nih.gov/17721249</p>	I	RCT 42 Pts	ON-Q Colon surgery	<ul style="list-style-type: none"> • No adverse events in either group • No systemic local anesthetic toxicity 	<p>Treatment group:</p> <ul style="list-style-type: none"> • Morphine significantly less over all 3 days (P=.0004) • Decrease in pain intensity at rest and coughing (P<.01) • Quality of sleep rated better in x 2 postoperative nights • Recovery of bowel function faster (P=.02) • Decreased LOS (P=.02)
8	<p>Use of the ON-Q pain management system is associated with decreased postoperative analgesic requirement: double blind randomized placebo pilot study</p> <p>Baig et al. J Am Coll Surg 2006; 202: 297-305.</p> <p>Surgeon, Cleveland Clinic Florida - Weston, FL</p> <p>https://pubmed.ncbi.nlm.nih.gov/16427556</p>	I	RCT 70 Pts	ON-Q Colectomy	<ul style="list-style-type: none"> • No difference in PONV • 30-day f/u to assess for complications: wound infection rate of 2.9% in each group compared with 7.26% rate reported by CDC for same surgery 	<p>Treatment group:</p> <ul style="list-style-type: none"> • Significant less narcotic requirements (P<.04) • NS difference in pain scores • Earlier ambulation (P=.033) • Earlier return of bowel function, but NS • No difference in LOS
9	<p>Effectiveness of continuous wound infusion of 0.5% ropivacaine by ON-Q pain relief system for postoperative pain management after open nephrectomy</p> <p>Forastiere E et al. British Journal of Anaesthesia 2008; 101(6): 841-7.</p> <p>Anesthesiologist, National Cancer Institute of Rome - Rome, Italy</p> <p>https://pubmed.ncbi.nlm.nih.gov/19004914</p>	I	RCT 168 Pts	ON-Q Open Nephrectomy	<ul style="list-style-type: none"> • Decreased sedation scores in ON-Q group 	<p>Study group:</p> <ul style="list-style-type: none"> • Lower pain scores (P<.0001-.001) • Mean morphine consumption 47% lower in ON-Q group (P<.001) • PONV lower • Earlier return of bowel activity (P<.001) • Decreased LOS (1 day less, P<.001) • Mean cost of care 34% lower

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10	<p>A randomized trial of postoperative wound irrigation with local anesthetic for pain after cesarean delivery</p> <p>Givens V et al. Am J Obstet Gynecol 2002; 186: 1188-1191.</p> <p>Surgeon, University of Tennessee Health Science Center - Memphis, TN</p> <p>https://pubmed.ncbi.nlm.nih.gov/12066096</p>	I	RCT 36 Pts	ON-Q Cesarean Section	<ul style="list-style-type: none"> • 1 wound cellulitis 	<p>Treatment group:</p> <ul style="list-style-type: none"> • Significant reduction in narcotic usage 43% (P<.01) • No significant difference in pain scores
11	<p>Postoperative analgesia in TKA: ropivacaine continuous intra-articular infusion</p> <p>Gomez-Cardero et al. Clin Orthop Relat Res 2010; Jan 5 [epump ahead of print]</p> <p>Surgeon, La Paz University - Madrid, Spain</p> <p>https://pubmed.ncbi.nlm.nih.gov/20049572</p>	I	RCT 50 Pts	ON-Q TKA	<ul style="list-style-type: none"> • No wound complications or infections due to device • No adverse effects from ropivacaine 	<p>Study group:</p> <ul style="list-style-type: none"> • Lower pain scores x 3 days (P<.001) • Less opioid consumption (P<.004) • 1.5 day reduction in LOS (P<.001) • No difference in joint ROM throughout study period and up to 1 month
12	<p>Continuous wound infiltration with ropivacaine reduces pain and analgesic requirement after shoulder surgery</p> <p>Gottschalk et al. Anesth Analg 2003; 97: 1086-1091.</p> <p>Anesthesiologist, University Hospital Eppendorf - Hamburg, Germany</p> <p>https://pubmed.ncbi.nlm.nih.gov/14500162</p>	I	RCT 45 Pts	ON-Q Shoulder	<ul style="list-style-type: none"> • No clinical symptoms of local anesthetic toxicity • Unbound serum ropivacaine levels below toxic threshold for 48 hrs • No wound healing problems or infections 	<ul style="list-style-type: none"> • Significant reduction in narcotic use (P<.05) • Decrease in VAS at rest (P<.005)
13	<p>Prospective, randomized double-blind intravenous narcotic patient-controlled anesthesia pump for pain management after free TRAM flap breast reconstruction</p> <p>Heller L et al. Plast. Reconstr Surg 2008; 122(4): 1010-18.</p> <p>Surgeon, University of Texas MD Anderson Cancer Center - Houston, TX</p> <p>https://pubmed.ncbi.nlm.nih.gov/18827631</p>	I	RCT 69 Pts	ON-Q TRAM Flap Breast Reconstruction	<ul style="list-style-type: none"> • No infections • No local anesthetic toxicity 	<p>Treatment group:</p> <ul style="list-style-type: none"> • Mean PCA narcotic use 40% less POD 1 and 55% less POD 2 (P=.019) • Mean total narcotic use 27% lower, NS • 3.6 times more likely to rate satisfaction as "very satisfied"
14	<p>Use of a continuous local anesthetic infusion for pain management after median sternotomy</p> <p>White P, et al. Anesthesiology 2003; 99: 918-923.</p> <p>Anesthesiologist, University of TX Southwestern Medical Center - Dallas, TX</p> <p>https://pubmed.ncbi.nlm.nih.gov/14508326</p>	I	RCT Dose response 24 Pts Normal Saline bupivacaine 0.25% bupivacaine 0.5%	ON-Q CABG via Median Sternotomy	<p>Study group:</p> <ul style="list-style-type: none"> • Serum bupivacaine level at <30% toxicity • Urinary catheter removal 1 day earlier (0.5% Group) • No wound infections • No adverse events 	<p>Study group (.05%):</p> <ul style="list-style-type: none"> • 63% reduction in opioid (P<.05) • Ambulation was 12 hrs earlier (P<.05) • 1 day earlier return to normal diet (P<.05)

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15	<p>The use of continuous popliteal sciatic nerve block after surgery involving the foot and ankle: does it improve the quality of recovery?</p> <p>White P et al. Anesth Analg 2003; 97: 1303-9.</p> <p>Anesthesiologist, University of TX Southwestern Medical Center - Dallas, TX</p> <p>https://pubmed.ncbi.nlm.nih.gov/14570643</p>	I	RCT 20 Pts	ON-Q CPNB (foot/ankle surgery)	<p>Study group:</p> <ul style="list-style-type: none"> • Pts report increase in tingling of extremity; did not interfere with ambulation 	<p>Study group:</p> <ul style="list-style-type: none"> • Required 70% less PCA morphine than control (P<.05) • Shorter LOS versus control group (0.7 ± 0.7 days versus 1.4 ± 0.5 days; P<.05) • Higher patient satisfaction than control (P<.05) • Higher quality of recovery • Decrease in VAS on POD 1 (P<.05)
16	<p>Continuous peripheral nerve block compared with single-injection peripheral nerve block. A systematic review and meta-analysis of randomized controlled trials</p> <p>Bingham A et al. Regional Anesth and Pain Medicine 2012; 37: 583-594.</p> <p>Anesthesiologist, Columbia University - New York, NY</p> <p>https://pubmed.ncbi.nlm.nih.gov/23080349</p>	I	Meta-analysis RCTs Included 21 studies 712 Pts	Not specified CPNB (orthopedic and breast)	<ul style="list-style-type: none"> • CPNB patients had significantly less PONV • Other complications not reported to enable evaluation 	<p>Compared with single shot nerve blocks, CPNB:</p> <ul style="list-style-type: none"> • Improved pain control on POD 1 (P<.001) • Improved pain control on POD 2 (P<.001) • Decreased overall opioid use (P<.001) • Higher patient satisfaction scores (P<.001) • Unable to compare long-term functional outcomes
17	<p>Continuous interscalene infusion and single injection using levobupivacaine for analgesia after surgery of the shoulder</p> <p>Kean J et al. J Bone Joint Surg [Br] 2006; 88: 1173-1177.</p> <p>Surgeon, Ninewells Hospital and Medical School - Dundee, Scotland</p> <p>https://pubmed.ncbi.nlm.nih.gov/16943467</p>	I	RCT 16 Pts	ON-Q Shoulder	<ul style="list-style-type: none"> • No complications in either group • No neurological complications reported at 6 weeks 	<p>ON-Q group:</p> <ul style="list-style-type: none"> • Lower VAS; only significant at 12 hrs (P=.02) • Less narcotic use, only significant at 24 hrs
18	<p>Interscalene brachial plexus block with a continuous catheter insertion system and a disposable pump</p> <p>Klein S et al. Anesth Analg 2000; 91: 1473-1478.</p> <p>Anesthesiologist, Duke University Medical Center - Raleigh Durham, NC</p> <p>https://pubmed.ncbi.nlm.nih.gov/11094003</p>	I	RCT 40 Pts	ON-Q CPNB (shoulder)	<ul style="list-style-type: none"> • Mean serum ropivacaine levels remained low after 24 hours 	<p>Treatment group:</p> <ul style="list-style-type: none"> • Less morphine consumption than control (P<.004) • Lower pain scores (P=.0007)
19	<p>Local anesthetic infusion pumps improve postoperative pain after inguinal hernia repair: a randomized trial</p> <p>Leblanc K et al. Am Surg 2004; 70: 1002-1006.</p> <p>Surgeon, Surgical Specialty Group - Baton Rouge, LA</p> <p>https://pubmed.ncbi.nlm.nih.gov/15586515</p>	I	RCT 52 Pts	ON-Q Inguinal Hernia Repair	<ul style="list-style-type: none"> • No leakage around the catheter • No wound complications 	<ul style="list-style-type: none"> • 24% of the bupivacaine group required no narcotics vs. 4% of the saline group (P<.05) • Significantly less narcotic use continued for 5 days after pump discontinued at 2 days

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20	<p>Efficacy of continuous wound catheters delivering local anesthetic for postoperative analgesia: a quantitative and qualitative systematic review of randomized controlled trials</p> <p>Liu J et al. J Am Coll Sur 2006; 23 (6): 914-932.</p> <p>Anesthesiologist, Weil College of Medicine, Cornell University - New York, NY</p> <p>https://pubmed.ncbi.nlm.nih.gov/17116561</p>	I	<p>Meta-analysis</p> <p>44 RCT</p> <p>2,141 Pts</p>	<p>Not specified</p> <p>Cardiothoracic, general, orthopedics, gynecology, urology</p>	<ul style="list-style-type: none"> No local anesthetic toxicity Infection rates 0.7% in active group and 1.2% in control group Less PONV in all groups combined (P<.001) 	<ul style="list-style-type: none"> Lower pain scores at rest in all groups combined (P<.001) and all subgroups (P<.001 to P=.02) Fewer Pts required opioid rescue medication in all groups combined (P<.001) Less total opioid required in all groups and all subgroups except orthopedics (P<.001) Better patient satisfaction in all groups combined (P<.007) LOS savings of 1 hospital day overall
21	<p>Continuous incisional infusion of local anesthetic in pediatric patients following open heart surgery</p> <p>Tirotta C et al. Pediatric Anesthesia 2009; 19: 571-576.</p> <p>Anesthesiologist, Miami Children's Hospital - Miami, FL</p> <p>https://pubmed.ncbi.nlm.nih.gov/19645974</p>	I	<p>RCT</p> <p>72 pediatric Pts</p>	<p>ON-Q</p> <p>Open Heart via Median Sternotomy</p>	<p>Study group:</p> <ul style="list-style-type: none"> No wound infections or difference in wound healing No pump malfunctions or disconnections No S/S of local anesthetic toxicity Plasma levels of local anesthetics below toxic threshold Less antiemetic required in Pts weighing > 31 kg (P=.04) 	<p>Treatment group:</p> <ul style="list-style-type: none"> Total morphine requirements 75% less at 24 hrs (P=.007); NS difference POD 2 and 3 Time to first bowel movement 1 day earlier (2.8 days vs. 3.7 days; P=.006) No difference in pain scores between groups No difference in time to first oral intake or urinary catheter removal
22	<p>Continuous popliteal sciatic nerve block versus single injection nerve block for ankle fracture surgery: a prospective randomized comparative trial</p> <p>Ding DY et al. J Orthop Trauma 2015; 29(9): 393-398.</p> <p>MD. Department of Orthopaedic Surgery, New York University School of Medicine - New York, NY</p> <p>https://pubmed.ncbi.nlm.nih.gov/26165259</p>	II	<p>RCT</p> <p>Double blinded until day of surgery</p> <p>44 Pts</p> <ul style="list-style-type: none"> 23 received a sciatic single shot block (SSB) plus continuous block with ropivacaine 0.2% at 8 mL/hr 21 received SSB only 	<p>ON-Q</p> <p>ORIF (unstable ankle fractures)</p>	<ul style="list-style-type: none"> ON-Q group: 5 pts experienced dislodged catheters 1 Pt reported the pump did not flow for the first 12 hrs 1 Pt discontinued his catheter at 24 hrs 1 pump stopped functioning shortly after discharge from PACU No adverse side effects in ON-Q group 	<ul style="list-style-type: none"> Average amount of opioid required in PACU was lower in ON-Q group. (P=.041) ON-Q group took significantly less oral pain meds during first 72 hrs (P=.036) Pts in the ON-Q group reported lower VAS pain scores 2 weeks and 12 weeks after surgery (P=.014 and .004)
23	<p>Comparison between systemic analgesia, continuous wound catheter analgesia and continuous thoracic paravertebral block: a randomized, controlled trial of postthoracotomy pain management</p> <p>Fortier S et al. Eur J Anaesthesiol 2012; 29: 524-30.</p> <p>MD. Department of Anaesthesia. Polyclinique duval de Saone - Macon, France</p> <p>https://pubmed.ncbi.nlm.nih.gov/22914044</p>	II	<p>RCT</p> <p>140 Pts</p> <ul style="list-style-type: none"> 50 received PCA morphine only 44 received thoracic paravertebral block (TPVB) 46 received continuous wound catheter infusion (CWC) 	<p>ON-Q</p> <p>Dual catheters for CWC group</p> <p>Thoracotomy</p>	<ul style="list-style-type: none"> No signs of toxicity or local complications observed 	<ul style="list-style-type: none"> VAS scores at rest were significantly better in the TPVB group compared to PCA at 0, 1, 3, and 6 hrs. (P<.0026) VAS scores at rest were significantly better in the TPVB group compared to PCA after coughing at 0, 1, 3, 6 and 12 hrs. (P<.003) Morphine use was significantly less in recovery room in the TPVB group, and at 24 hrs. (P=.00001; PP=.0036) There was no difference between CWC and PCA groups in VAS scores or morphine consumption

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24	<p>A randomized trial of bupivacaine pain pumps to eliminate the need for patient controlled analgesia pumps in primary laparoscopic Roux-en-Y gastric bypass</p> <p>Cottam D et al. Obesity Surgery 2007; 17: 595-600.</p> <p>Surgeon, Surgical Weight Control Center - Las Vegas, NV</p> <p>https://pubmed.ncbi.nlm.nih.gov/17658017</p>	II	<p>RCT</p> <p>40 Pts</p>	<p>ON-Q</p> <p>Laparoscopic Roux-en-Y</p>	<ul style="list-style-type: none"> • Not assessed 	<ul style="list-style-type: none"> • Significant decrease in narcotic use from PACU to 0:600 in ON-Q group (129 mg ON-Q vs 217 mg PCA, P=.008) • No difference in PONV or pain scores between groups • Study ended after 18 hrs
25	<p>Assessment of postoperative pain control with an elastomeric pain pump following cardiothoracic surgery</p> <p>Chopra A, et al. Pain Medicine 2017; 0: 1-5.</p> <p>PharmD. Departments of Pharmacy and Medical Education. St. John Hospital and Medical Center - Detroit, MI</p> <p>https://pubmed.ncbi.nlm.nih.gov/28074028</p>	III	<p>Retrospective Comparison</p> <p>200 Pts</p> <ul style="list-style-type: none"> • 100 received continuous bupivacaine infusion for 96 hours • 100 received traditional pain management 	<p>ON-Q</p> <p>Dual pump with bilateral subpectoral catheters</p> <p>Cardiothoracic via Median Sternotomy</p>	<ul style="list-style-type: none"> • Respiratory depression was more common in patients with ON-Q (4% vs.0%) • Re-intubation rate was the same between groups 	<ul style="list-style-type: none"> • After first 24 hrs, ON-Q group used less opioids each 24-hr period for 96 hrs, NS (P=.14-0.31) • Pain scores were similar between groups • No difference between use of ketorolac or acetaminophen
26	<p>Application of continuous incisional infusion of local anesthetic after major pediatric urological surgery</p> <p>Hidas G et al. J of Ped Urology 2013; 9; 927-31.</p> <p>Urology, Children's Hospital - Orange County, CA</p> <p>https://pubmed.ncbi.nlm.nih.gov/25746712</p>	III	<p>Case Control</p> <p>40 Pts</p> <ul style="list-style-type: none"> • 20 received ON-Q 0.25% bupivacaine @ 1-4 ml/hr • 20 received IV analgesia 	<p>ON-Q</p> <p>Major Urological procedures</p>	<ul style="list-style-type: none"> • No differences in frequency of fever between groups • No S/S of local anesthetic toxicity • No sign of infection, seromas or delayed wound healing • No reported instances of the patients stepping or pulling on the pump 	<ul style="list-style-type: none"> • ON-Q group had significantly lower maximum pain compared to control on POD 1 (3 vs.5.2, P=.03) • Trend toward lower pain scores with ON-Q on POD 2 • IV and oral analgesia was significantly lower in ON-Q group on day of surgery and POD 1
27	<p>Improving postoperative pain management in subpectoral tissue expander implant reconstruction of the breast using an elastomeric pump</p> <p>Chaudry A et al. Ann R Coll Surg Engl. 2015; 97: 364-68.</p> <p>MD. Great Western Hospital NHS Foundation Trust - UK</p> <p>https://pubmed.ncbi.nlm.nih.gov/26264088</p>	III	<p>Retrospective Comparison</p> <p>50 Pts</p> <ul style="list-style-type: none"> • 25 received elastomeric infusion of local anesthetic @ 5mL/hr • 25 control 	<p>B. Braun EasyPump (ON-Q)</p> <p>Mastectomy and insertion of subpectoral tissue expander implant</p>	<ul style="list-style-type: none"> • No catheter dislodgements • No mechanical pump failures or difficulty removing catheters 	<ul style="list-style-type: none"> • Pain scores significantly lower at 24 hrs in pump group (P≤.0001) • Length of stay was lower in pump group, though not statistically significant. (P=.15) • 22 Pts required no opioids in pump group compared to 0 in control group

#	STUDY	LOE	DESIGN	DEVICE/PROCEDURE	CONCLUSION	
					SAFETY	PERFORMANCE
28	<p>Paraincisional subcutaneous infusion of ropivacaine after open abdominal vascular surgery shows significant advantages</p> <p>Chaykovska et al. Annals of Vascular Surgery May 2014; 28:4; 837-844.</p> <p>Cardiovascular Surgery, University Hospital - Zurich, Switzerland</p> <p>https://pubmed.ncbi.nlm.nih.gov/24456863</p>	III	<p>Retrospective Single-Center Study</p> <p>58 Pts</p>	<p>ON-Q with soaker catheters</p> <p>Equivalent: Perfusor Pump-Syringe (B.Braun)</p> <p>Open Abdominal surgery for aortic aneurysm/Midline Laparotomy</p>	<ul style="list-style-type: none"> No surgical complication caused by installation of the para-incisional sub-q catheter (PSC) No wound infection or wound-healing disorders 2 Pts with ESRD developed neuro symptoms (light-headedness, tinnitus, numbness of tongue) and had increase concentration of ropivacaine in blood and diagnosed with ropivacaine intoxication (dose decreased) Caution should be used when administering local anesthetic in patients with renal impairment 	<p>Treatment group:</p> <ul style="list-style-type: none"> Post-op pain was the same as control group POD 1 and 2, but significantly less on POD 3 Received significantly less morphine every day during the 5-day postoperative period Achieved complete pain relief quicker Using continuous injection reduces amount of manipulations on the catheter port and therefore reduces risk of catheter contamination and/or wound infection
29	<p>Efficacy and safety of continuous local infusion of ropivacaine after retroperineoscopic live donor nephrectomy</p> <p>Biglarnia AR et al. American Journal of Transplantation 2011; 11: 93-100.</p> <p>Surgeon, Uppsala University Hospital - Uppsala, Sweden</p> <p>https://pubmed.ncbi.nlm.nih.gov/21199350</p>	III	<p>Case Control</p> <p>40 donors 40 cohorts</p>	<p>ON-Q with silver soaker</p> <p>Live Donor Nephrectomy</p>	<p>ON-Q group:</p> <ul style="list-style-type: none"> Leakage of fluid from incision in ON-Q group, which required an increased number of dressing changes Sharp peel-away needles replaced with blunt trocars for introducing the catheter; potential cause of hematoma in one patient Asymptomatic serous fluid evacuated from incision from one patient 	<p>ON-Q group:</p> <ul style="list-style-type: none"> Lower morphine equivalent consumption, 7 mg vs. 42 mg (P<.0000001) Less nausea (45% vs. 87%, P<.001) Shorter time in PACU (160 vs. 242.5 min, P<.001)
30	<p>Continuous infusion of bupivacaine reduces postoperative morphine use in adolescent idiopathic scoliosis after posterior spine fusion</p> <p>Ross P et al. Spine 2011 Aug 15; 38(18): 1478-83.</p> <p>Surgeon, Children's Hospital of Los Angeles - Los Angeles, CA</p> <p>https://pubmed.ncbi.nlm.nih.gov/20881514</p>	III	<p>Retrospective Analysis</p> <p>244 Pts</p>	<p>ON-Q</p> <p>Spine</p>	<ul style="list-style-type: none"> Significantly less antiemetic meds administered to ON-Q group (70.5% vs. 82.2%, P=.0001) 	<p>ON-Q group:</p> <ul style="list-style-type: none"> Less morphine required (32.6% vs. 85.2%, P<.001) Overall reduction in morphine (18.9 mg vs. 26.4 mg, P<.001) ON-Q group had higher pain scores at 18 hours (1.7 vs. 2.7, P=.002) No significant difference in postoperative morphine use based on depth of catheter placement
31	<p>Decreased narcotic use with an implantable local anesthetic catheter after deep inferior epigastric perforator breast flap construction</p> <p>Boehmler J et al. Ann Plastic Surg 2009; 62: 618-620.</p> <p>Surgeon, Georgetown University Hospital - Washington, DC</p> <p>https://pubmed.ncbi.nlm.nih.gov/19461271</p>	III	<p>Prospective Historical control</p> <p>40 Pts</p>	<p>ON-Q</p> <p>Breast Reconstruction</p>	<ul style="list-style-type: none"> No complications associated with ON-Q 	<ul style="list-style-type: none"> Significantly less total narcotic use in ON-Q Group (P=.02)

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32	<p>Use of the ON-Q pain pump management system in the head and neck: preliminary report</p> <p>Charous S. Otolaryngology – Head and Neck Surgery 2008; 138:110-112.</p> <p>Surgeon, Rush University Medical Center – Chicago, IL</p> <p>https://pubmed.ncbi.nlm.nih.gov/18165004</p>	III	Retrospective Comparison 28 Pts	ON-Q Thyroid Parathyroid Neck Dissection	<ul style="list-style-type: none"> No wound infections, nerve paresthesia or catheter related complications 	<p>ON-Q group:</p> <ul style="list-style-type: none"> Decreased pain scores on POD 1 (P=.0001) Decrease in opioid usage (P=.025) Significantly less nausea and vomiting
33	<p>Postoperative continuous paravertebral anesthetic infusion for pain control in lumbar spinal fusion surgery</p> <p>Elder J et al. Spine 2008; 33: 210-218.</p> <p>USC California Keck School of Medicine – Los Angeles, CA</p> <p>https://pubmed.ncbi.nlm.nih.gov/18197109</p>	III	Case Control 50 Pts	ON-Q Lumbar Spinal Fusion	<ul style="list-style-type: none"> 4 catheters were accidentally dislodged 1 patient from each group developed a wound infection 	<p>ON-Q group:</p> <ul style="list-style-type: none"> Earlier return to bowel function (P=.048) Used 45.7% less narcotics (P=.044) Reported 45% less pain on POD 1-6 (P=.006-.046)
34	<p>Postoperative continuous paravertebral anesthetic infusion for pain control in posterior cervical spine surgery: a case-control study</p> <p>Elder J et al. Neurosurgery 2010; 66: 99-107.</p> <p>Surgeon, University of Southern California Keck School of Medicine – Los Angeles, CA</p> <p>https://pubmed.ncbi.nlm.nih.gov/20173578</p>	III	Case Control 25 Pts	ON-Q Cervical Spinal Fusion	<ul style="list-style-type: none"> 3 catheters accidentally removed before 72 hours No immediate complications attributed to the device 	<p>ON-Q group compared to control:</p> <ul style="list-style-type: none"> 34.4% less morphine use (P=.02) Pain Scores lower on POD 1, 3, 4 (P<.05) Time to first BM, discharge home, d/c of PCA also significantly less than control (P<.05)
35	<p>Reduction or elimination of postoperative pain medication after mastectomy through use of temporarily placed local anesthetic pump vs. control group</p> <p>Morrison JE. Zentralblatt für Gynäkologie. 2003; 125: 17-22.</p> <p>Surgeon, Fayette Medical Center – Fayette, AL</p> <p>https://pubmed.ncbi.nlm.nih.gov/12877104</p>	III	Prospective Historical control 49 Pts	ON-Q Mastectomy	<ul style="list-style-type: none"> No complications reported 	<p>ON-Q group compared to control:</p> <ul style="list-style-type: none"> Did not request any post-operative opioids (18.2% vs. 3.7%, P=.1) Total opioids usage in dose equivalents was 62.8% lower (1.25 vs. 3.36, P=.016) LOS reduced by 0.5 days Reduced ICU stay

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36	<p>Improved pain management outcomes with continuous infusion of a local anesthetic after thoracotomy</p> <p>Wheatley G et al. Journal of Thoracic and Cardiovascular Surgery 2005; 130: 464-468.</p> <p>Surgeon, University of Texas Southwestern Medical Center - Dallas, TX</p> <p>https://pubmed.ncbi.nlm.nih.gov/16077414</p>	III	<p>Retrospective Comparison</p> <p>110 Pts</p>	<p>ON-Q</p> <p>Thoracotomy</p>	<ul style="list-style-type: none"> No infections or wound healing complications 	<p>ON-Q groups compared to control:</p> <ul style="list-style-type: none"> Less narcotic use by both ON-Q groups compared to epidural (P<.001) Lower pain scores by both ON-Q groups compared to epidural group (P<.001) No difference in time to first bowel movement or progression to normal diet
37	<p>Continuous infusion of local anesthetic decreases narcotic use and length of hospitalization after laparoscopic renal surgery</p> <p>Yoost T et al. Journal of Endourology 2009; 23: 623-626.</p> <p>Surgeon, Medical University of SC - Charleston, SC</p> <p>https://pubmed.ncbi.nlm.nih.gov/19335329</p>	III	<p>Retrospective Review</p> <p>38 Pts</p>	<p>ON-Q</p> <p>Lumbar Spinal Fusion</p>	<ul style="list-style-type: none"> No infections or wound healing complications 	<ul style="list-style-type: none"> Decreased morphine use in ON-Q group Decreased LOS in ON-Q group (1.8 vs. 2.9 days, P=.01)
38	<p>ON-Q pump for pain control after orbital implant surgery</p> <p>Samimi DB et al. Ophthal Plast Reconstr Surg. 2014 Sep-Oct; 30(5): 396-9</p> <p>Ophthalmology, University of Southern California - Los Angeles, CA</p> <p>https://pubmed.ncbi.nlm.nih.gov/24777268</p>	IV	<p>Retrospective Non-comparative consecutive case review</p> <p>20 Pts</p>	<p>On-Q with silver soaker catheters</p> <p>Enucleation Evisceration Secondary Orbital Implantation</p>	<ul style="list-style-type: none"> 2 Pts experienced postoperative nausea 1 catheter connector leaked 2 Pts with renal disease had signs/symptoms of local anesthetic toxicity; resolved with dose reduction No wound infection/healing disorders 	<ul style="list-style-type: none"> Among 20 patients, mean postoperative period pain score, with On-Q in place, was 1.3 (scale of 0 to 10) 9 patients (45%) did not require adjunctive oral narcotics
39	<p>Outpatient analgesia via paravertebral peripheral nerve block catheter and ON-Q pump – a case series</p> <p>Visoiu M. Paediatr Anaesth. 2014 Aug; 24(8): 875-8.</p> <p>Department of Anesthesiology, Children's Hospital of Pittsburgh of University of Pittsburgh Medical Center - Pittsburgh, PA</p> <p>https://pubmed.ncbi.nlm.nih.gov/24815589</p>	IV	<p>Case Report</p> <p>5 pediatric Pts</p> <p>0.2% ropivacaine @ 4-6mL/hr</p>	<p>ON-Q with SAF</p> <p>Iliac Crest Bone Harvesting</p>	<ul style="list-style-type: none"> No complications related to catheters 	<ul style="list-style-type: none"> Pain scores were low and analgesic medication consumption was minimal Outpatient PVB can be beneficial as part of multimodal analgesia for pediatric patients
40	<p>Continuous peripheral nerve blockade for inpatient and outpatient postoperative analgesia in children</p> <p>Ganesh et al. Anesth Analg 2007; 105: 1234-42.</p> <p>Anesthesiologist, The Children's Hospital of Philadelphia - Philadelphia, PA</p> <p>https://pubmed.ncbi.nlm.nih.gov/17959949</p>	IV	<p>Retrospective</p> <p>203 Pts (4-18 y/o)</p>	<p>ON-Q</p> <p>CPNB (orthopedic)</p>	<ul style="list-style-type: none"> Feasible to implement CPNB program at home Pt and family f/u critical to detect adverse events 2.8% of Pts had complications (resolved) 3 Pts had prolonged numbness > 24 h (resolved spontaneously) 1 Pt had superficial cellulitis 1 Pt had tinnitus 	<ul style="list-style-type: none"> Percentage of Pts not requiring opioids in the first 8, 24, and 48 h after surgery was 56%, 26%, and 21%, respectively 50% of Pts were discharged home with catheter(s) 99% of catheters were removed successfully at home Higher rate of dislodgement of interscalene catheters, possibly due to short insertion depth and securement

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41	<p>Successful continuous interscalene analgesia for ambulatory shoulder surgery in a private practice setting</p> <p>Fredrickson M et al. Reg Anesth Pain Med 2008; 33: 122-128.</p> <p>Anesthesiologist, The University of Auckland - Auckland, New Zealand</p> <p>https://pubmed.ncbi.nlm.nih.gov/18299092</p>	IV	Prospective Series 300 Pts	ON-Q with ONDEMAND CPNB (shoulder)	<ul style="list-style-type: none"> No S/S of LA toxicity, pneumothorax, or spinal/epidural anesthesia 	<ul style="list-style-type: none"> 98% of Pts avoided supplemental opioids Weight and cumbersome nature of the ambulatory pump mentioned by 16/100 Pts Majority of Pts would request again
42	<p>23-hour TKA in 10 opioid pills or less through 90 days: A non-selected 23-hour TKA in 10 opioid pills or less through 90 days: A non-selected prospective consecutive one year cohort</p> <p>Stevenson, M and Wickline, A. Journal of Orthopedic Experience and Innovation July 6, 2020.</p> <p>Surgeon, Genesee Orthopedics, St Elizabeth Medical Center - Utica, NY</p> <p>https://journaloei.scholasticahq.com/article/13423-23-hour-tka-in-10-opioid-pills-or-less-through-90-days-a-non-selected-prospective-consecutive-one-year-cohort</p>	IV	Prospective Case Series 386 Pts	ON-Q CACB (TKA)	<ul style="list-style-type: none"> 8 Pts (2%) had motor weakness on DOS; treated with knee immobilizer without sequela 3 Pts inadvertently pulled out CACB catheter 9 Pts (3.1%) discontinued CACB catheter earlier than necessary 2 Pts (1%) had uncontrolled pain on DOS and 2 on POD#1 2 Pts complained of bleeding from the CACB catheter site 14 falls over the 12-week post-op period without sequelae 1 Pt had saphenous paresthesia at 6 weeks post-op; resolved by week 12 	<ul style="list-style-type: none"> 86.3% Pts required 10 pills or less through 12 weeks 18.9% Pts required no opioid pills through 12 weeks 50.5% Pts took only tramadol rather than stronger opioids 85.4% Pts required no formal physical therapy (PT) through 12 weeks 63.2% Pts were discharged DOS 91.2% Pts were discharged by POD #1 311 of 386 (80.6%) Pts completed all KOOS Jr. evaluations Mean KOOS Jr score increased from 53.1 at baseline to 71.8 at 6 weeks; 90.0 at 12 weeks Mean flexion was 109.2 degrees at 3 weeks and 115.8 at 6 weeks 90-day readmission rate was 1.2% A novel multimodal protocol combining consistent and patient specific preoperative education, CACB, and self-directed and unsupervised postoperative rehabilitation dramatically reduces narcotic needs, formal physical therapy needs, and decreases length of stay following TKA

ABBREVIATIONS

ACL Anterior Cruciate Ligament
 DOS Day of Surgery
 CC Case Control
 LA Local Anesthetic
 LOS Length of Stay
 PCA Patient Controlled Analgesia

POD Post-op Day
 PONV Postoperative Nausea and Vomiting
 RCT Randomized Controlled Trial
 SQ Subcutaneous
 TKA Total knee arthroplasty

CABG Coronary Arterial Bypass Graft
 Cath Catheter
 CPNB Continuous Peripheral Nerve Block
 LOE Level of Evidence
 NS Not Significant

CACB Continuous Adductor Canal Block
 Pts Patients
 SAF Select-A-Flow
 S/S Signs and Symptoms
 VAS Visual Analog Score (Pain Scores)

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