

Redefine Recovery with ON-Q

CLINICAL RESEARCH BIBLIOGRAPHY

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The analgesic efficacy of patient-controlled ropivacaine instillation after cesarean delivery.

AUTHOR: Fredman B, et al.

REFERENCE: *Anesth Analg* 2000; 91:1436-1440

TYPE OF STUDY: Prospective, randomized, double-blind, placebo-controlled.

INSTITUTION: Meir Hospital, Tel Aviv, Israel, and University Hospital, Orebro, Sweden

NUMBER OF PATIENTS: 50

SUMMARY: Patients undergoing cesarean section were randomized to receive ropivacaine or saline by bolus administration via an elastomeric pump. Patients that received ropivacaine required significantly less rescue morphine, had less pain with deep breathing and coughing and reported higher levels of satisfaction than the control group. Unbound ropivacaine levels were measured in a subset of patients and mean and peak levels stayed well below toxic threshold.

A randomized trial of postoperative wound irrigation with local anesthetic for pain after cesarean delivery.

AUTHOR: Givens A, Lipscomb G, Meyer N

REFERENCE: *Am J Obstet Gynecol* 2002; 186: 1188-119

TYPE OF STUDY: Prospective, randomized, double-blind, placebo-controlled.

INSTITUTION: University of Tennessee, Memphis, TN

NUMBER OF PATIENTS: 36

SUMMARY: Patients undergoing C-Section were randomized to receive bupivacaine or saline (control) via ON-Q. While there was no difference in pain scores between the 2 groups, those receiving bupivacaine required significantly less morphine than

the control (72.7 mg vs. 128.4 mg at 72 hours). The study suggests that a substantial amount of post-op pain is superficial in origin vs. visceral.

Postoperative pain after abdominal hysterectomy: a double-blind comparison between placebo and local anesthetic infused intraperitoneally.

AUTHOR: Gupta A, et al

REFERENCE: *Anesth Analg* 2004; 99:1173-9.

TYPE OF STUDY: Prospective, randomized, double-blind, placebo-controlled.

INSTITUTION: University Hospital, Orebro, Sweden

NUMBER OF PATIENTS: 40

SUMMARY: Patients undergoing TAH were randomized to receive levobupivacaine 0.25% at vs. saline via ON-Q pump with the catheter placed in the peritoneum. Results showed significantly less incisional and visceral pain in the first 2 hrs, and significantly less narcotic usage and post op nausea from hrs. 4-24. Total and unbound serum levels were below toxic threshold and there were no reports of infection.

ON-Q system for managing trocar site pain after operative laparoscopy.

AUTHOR: Stringer N, et al

REFERENCE: *J Am Assoc Gynecol Laparosc* 2000;7(4): 552-555

TYPE OF STUDY: Technique paper

INSTITUTION: University of Chicago, IL

SUMMARY: Technique paper that discusses how to use the ON-Q pump after gynecologic laparoscopy placing the catheter subfascially at the trocar site.

Phase II study of ON-Q pain management system in patients undergoing surgery for gynecologic malignancy.

AUTHOR: Shahin M, Sanders L, and Sood A

REFERENCE: Presented at the 30th Annual Clinical Meeting of the Western Association of Gynecologic Oncologist. June 6-9, 2001. Sun Valley, ID.

TYPE OF STUDY: Prospective, observational study

INSTITUTION: University of Iowa

NUMBER OF PATIENTS: 40

SUMMARY: Patients undergoing surgery for gynecological malignancy received a continuous infusion of bupivacaine via ON-Q with the catheter placed subfascially. Median requirement for morphine on post-op day 1 was 10 mg and on post-op day 2 was 6.5 mg. Standard morphine use in this institution was reported as 120 mg and 114 mg respectively. There were no adverse effects or infections reported.

Continuous wound irrigation with ropivacaine or diclofenac for postoperative analgesia after cesarean section.

AUTHOR: Caulry C, Roelants F, Waterloos H, et al.

REFERENCE: Presented at ESRA Congress, Malta 2003.

TYPE OF STUDY: Prospective, randomized, blinded, placebo-controlled.

INSTITUTION: Cliniques Universitaires St. Luc, Brussels

NUMBER OF PATIENTS: 30

SUMMARY: Women undergoing laparotomy were randomized into three groups to receive ropivacaine, diclofenac, or saline (control) via ON-Q pump.

Results showed better pain relief with diclofenac than either ropivacaine or saline. Both diclofenac and ropivacaine resulted in less narcotic usage.

Continuous wound irrigation with ropivacaine or diclofenac after cesarean section: immediate and delayed benefits.

AUTHOR: Lacrosse D, Roelants F, Mercier V, Waterloos H, Lavand'homme P

REFERENCE: Presented at the Obstetric Anesthesia Association meeting April 17-18, 2004

TYPE OF STUDY: Prospective, randomized, double-blind, placebo-controlled.

INSTITUTION: Universite Catholique de Louvain, Brussels

NUMBER OF PATIENTS: 55

SUMMARY: C-Section patients randomized to receive ropivacaine 0.2%, diclofenac 300 mg or normal saline via ON-Q pump at 5 ml/hr for 48 hrs. All patients also received PCA morphine as needed. Results showed improved pain scores at 48 hrs. and lower narcotic usage in both ropivacaine and diclofenac groups. Residual pain at 1 and 6 months was reduced in diclofenac group.

ON-Q pain relief system in elective abdominal hysterectomy surgery, a pilot clinical outcomes study evaluating length of stay, postoperative pain, narcotic analgesia use and impact on costs and adverse effects.

AUTHOR: Zimberg S, Guillermo D, Seiler J, Neimark M

REFERENCE: *American Journal of Obstetrics and Gynecology* 2002; 99 (4) (SUPPLEMENT). Abstract presented at 50th Annual Clinical meeting ACOG, May 2002.

TYPE OF STUDY: Prospective, comparative study.

INSTITUTION: Cleveland Clinic Hospital, Fort Lauderdale, FL

NUMBER OF PATIENTS: 30

SUMMARY: Pilot study that evaluated the safety and efficacy of ON-Q in patients undergoing elective abdominal hysterectomy. Patients were randomized to receive ropivacaine, bupivacaine or lidocaine at 2 ml/hr with the catheter placed subfascial on a closed peritoneum. Pain was assessed using questionnaires. Length of stay, narcotic use and hospital costs were also evaluated. Serum samples for local anesthetic levels were obtained. Narcotic consumption was reduced in all patients and completely eliminated in 33.3% of the patients. Hospital costs were decreased by 30% and length of stay and nursing interventions were also reduced. Serum blood levels were well below toxic levels. No infections or other adverse effects were reported.

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Reducing pain and costs with innovative postoperative pain management.

AUTHOR: Zimberg S

REFERENCE: *Managed Care Quarterly* 2003; 11(1):34-36

TYPE OF STUDY: Review of two prospective studies.

INSTITUTION: Cleveland Clinic, Fort Lauderdale, FL

NUMBER OF PATIENTS: 30 TAH and 130 colorectal

SUMMARY: This is a general overview of the problem of managing pain, including the associated physiologic complications with narcotics, and the cost of care related to managing pain. The paper discusses the results of two studies using ON-Q; one on TAH patients (Zimberg), and the other on bowel surgery patients (Thorson). The author discusses the cost savings when using ON-Q related to reduced LOS and nursing interventions.

Postoperative continuous wound irrigation versus patient controlled epidural analgesia (PCEA) following Cesarean delivery: a randomized study.

AUTHOR: Devroe S, et al

REFERENCE: Presented at Obstetric Anaesthesia meeting, Versailles 2004

TYPE OF STUDY: Open prospective, randomized.

INSTITUTION: University Hospital Gasthuisberg, Leuven, Belgium

NUMBER OF PATIENTS: 60

SUMMARY: Cesarean section patients, who all received PCEA, were randomized to receive ropivacaine 0.2% at 5 ml/hr via subcutaneous wound infusion catheters versus saline placebo for 48 hrs. post delivery. Results showed significantly less epidural analgesia used by the study group (420 ± 77 vs. 157 ± 53 mg.)

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Continuous wound instillation after cesarean section: local analgesic effect of diclofenac.

AUTHOR: Lavand'homme P, et al

REFERENCE: *Anesthesiology* 2004; 100: Supp 1 Abstract

TYPE OF STUDY: Prospective, randomized, double-blind, placebo-controlled.

INSTITUTION: Universite Catholique de Louvain, Brussels

NUMBER OF PATIENTS: 60

SUMMARY: C-Section patients randomized to receive ropivacaine 0.2%, diclofenac 300 mg or normal saline via ON-Q pump at 5 ml/hr for 48 hrs. All patients also received PCA morphine as needed. Results showed significant reduction in VAS pain scores in ropivacaine group with movement at 12

hrs and in diclofenac group at 24 and 48 hrs. PCA morphine usage was significantly decreased in both ropivacaine and diclofenac groups. Residual pain was significantly less at 1 month and 6 months in the diclofenac group.

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The analgesic efficacy of regional levobupivacaine compared to epidural analgesia after caesarean delivery (CD).

AUTHOR: Ranta P, Kukkonen J, Rawal N et al

REFERENCE: *Finnanest* 2004;37(5): 479. Abstract

TYPE OF STUDY: Prospective, randomized, double-blind, placebo-controlled.

INSTITUTION: University Hospital Oulu

NUMBER OF PATIENTS: 40

SUMMARY: C-Section patients randomized to receive subfascial levobupivacaine 0.25% 10 ml by nurse-controlled bolus administration along with saline epidural, or an epidural with levobupivacaine 0.125% with saline wound infusion. There was no difference between the two groups in pain scores, consumption of local anesthetic, opioid administration or patient satisfaction scores. Conclusion: incisional local anesthetics were comparable to epidural analgesia.

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ON-Q pump infusion of ropivacaine at the incision for pain management after gynecological surgery.

AUTHOR: Tyagaraj K, et al.

REFERENCE: Presented at ASA, Atlanta, GA. October 2005

TYPE OF STUDY: Prospective, randomized, double blind, placebo-controlled

INSTITUTION: Maimonides Hospital, Brooklyn, NY

NUMBER OF PATIENTS: 90

SUMMARY: Patients undergoing lower abdominal gyn surgery were randomized to receive ropivacaine 0.25%, 0.5% or saline by ON-Q at 4 ml/hr. Results showed significantly lower VAS scores at rest at 6 hrs post-op and with coughing and leg raising at all time points for 48 hrs in ropivacaine 0.5% group but not in 0.25% group. Significantly less vomiting occurred in both ON-Q groups compared to placebo. All catheter tips were cultured and showed no bacterial growth and no infections.

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Incisional self-administration of bupivacaine or ropivacaine provides effective analgesia after inguinal hernia repair.

AUTHOR: Vintar N, Pozlen G, Rawal N, Godec M, and Rakovec, S

REFERENCE: *Can J Anesth.* 2002; 49(5): 481-6.

TYPE OF STUDY: Prospective, randomized, double-blind, placebo-controlled.

INSTITUTION: University Hospital, Orebro, Sweden

NUMBER OF PATIENTS: 60

SUMMARY: Patients undergoing inguinal hernia repair were randomly assigned to receive either bupivacaine or ropivacaine via an elastomeric pump. Patients self-administered the medication by opening the clamp for 6 minutes to give a 10 ml delivery when needed with instruction to repeat every 20 minutes as needed. Study concluded that this technique provided effective pain relief. Patients expressed a high level of satisfaction. In 2 patients from each group, the clamp was not closed properly and each patient received 60 ml in approx. 35 minutes. No signs of toxicity were observed.

Local anesthetic infusion pumps improve postoperative pain after inguinal hernia repair: a randomized trial.

AUTHOR: Sanchez B, Waxman K, et al

REFERENCE: *The American Surgeon* 2004;70: 1002-6.

TYPE OF STUDY: Prospective, randomized, double-blind, placebo-controlled.

INSTITUTION: Santa Barbara Cottage Hospital, Santa Barbara, CA

NUMBER OF PATIENTS: 45

SUMMARY: Patients having open inguinal hernia repair randomized to receive 0.25% Marcaine at 2 ml/hr vs. saline via ON-Q pump for 48 hrs. Patients with ON-Q had significantly lower pain scores on POD 2-5. ($p < 0.05$). There continued to be a difference in pain scores for 2 days after the catheter and pump were removed. There were no complications or wound infections.

Evaluation of a continuous infusion of 0.5% Marcaine via elastomeric pump for postoperative pain management following open inguinal hernia repair.

AUTHOR: LeBlanc K, et al

REFERENCE: *J Am Coll Surg*, Feb 2005;200(2): 198-202.

TYPE OF STUDY: Randomized, double blind, placebo controlled

INSTITUTION: Surgical Specialty Group, Baton Rouge, LA

NUMBER OF PATIENTS: 52

SUMMARY: Patients having open inguinal hernia repair received Marcaine 0.5% or saline via ON-Q pump at 2 ml/hr for 48 hrs. Results showed significantly less narcotic usage in study group ($p < 0.05$). 24% of patients in study group used no narcotic, vs. 4% in control ($p < 0.05$).

Postoperative pain relief using intermittent injections of 0.5% ropivacaine through a catheter after laparoscopic cholecystectomy.

AUTHOR: Gupta A, Thorn S, Axelsson K, Larsson L, Goran A, Holmstrom B, and Rawal N

REFERENCE: *Anesth Analg* 2002; 95:450-456

TYPE OF STUDY: Prospective, randomized, double-blind, placebo-controlled.

INSTITUTION: University Hospital, Orebro, Sweden

NUMBER OF PATIENTS: 40

SUMMARY: Patients undergoing laparoscopic cholecystectomy received either ropivacaine or saline via patient activated boluses, delivered via an elastomeric pump. Catheters were placed into the gall bladder bed. Patients self-administered either ropivacaine or saline by opening the clamp for a period of 6 minutes to deliver a 10 ml bolus. Scores for deep visceral pain were lower in the ropivacaine group during the first 4 hours after surgery. No difference noted between the groups with regard to pain medication consumption or time to recovery. All catheter tips were cultured and showed no growth and no infections. Plasma levels of levobupivacaine were well below toxicity.

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Patient outcomes after axillary lymph node dissection for breast cancer: Use of postoperative continuous local anesthesia infusion.

AUTHOR: Schell SR

REFERENCE: *Journal of Surgical Research* 2006 (epub ahead of print)

TYPE OF STUDY: Prospective, randomized, double-blind (to drug, not to pump/no pump), placebo-controlled.

INSTITUTION: University of Florida

NUMBER OF PATIENTS: 25

SUMMARY: Three groups of patients undergoing ALND for breast cancer randomized to receive 1) bupivacaine via pump; 2) saline via pump or 3) no pump. Bupivacaine group had significantly lower pain scores than the other two groups (p=0.002) for 5 days; used significantly less narcotics for 14 days; and had less nausea and sedation scores for 14 days. No pump related complications, including infection or seroma. Study was terminated early because interim analysis showed significant differences between groups.

Short-term continuous local anesthesia delivery reduces long-term shoulder pain and disability following axillary lymph node dissection (ALND).

AUTHOR: Schell SR

REFERENCE: Presented at Society of University Surgeons 66th Annual Meeting, February 2005. Nashville, TN

TYPE OF STUDY: Randomized, blinded, placebo-controlled.

INSTITUTION: Cancer Institute of New Jersey, Robert Wood Johnson Medical School

NUMBER OF PATIENTS: 25

SUMMARY: Same study described above with report of long-term results after mean of 2.4 years. Patients that received an ON-Q with bupivacaine show significantly less pain and improved shoulder function than no pump group as measured by SPADI (Shoulder Pain and Disability Index) assessment tool.

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Postoperative patient-controlled local anesthetic administration at home.

AUTHOR: Rawal N, et al

REFERENCE: *Anesth Analg* 1998; 86:86-9

TYPE OF STUDY: Open prospective study

INSTITUTION: University Hosp., Orebro, Sweden

NUMBER OF PATIENTS: 70

SUMMARY: Open prospective study of 70 patients both in hospital (35) and at home (35) receiving bupivacaine by intermittent infusion after various surgical procedures. Patients were instructed to open the clamp for 6 minutes to deliver 10 ml as needed for pain. Results showed excellent pain management in 89% of patients, without complications.

Reduction or elimination of postoperative pain medication after mastectomy through the use of a temporarily placed local anesthetic pump vs. control group.

AUTHOR: Morrison JE, Jacobs VR

REFERENCE: *Zentralblatt fur Gynakologie.* 2003; 125:17-22

TYPE OF STUDY: Retrospective, comparative.

INSTITUTION: Fayette Hospital, Fayette, AL

NUMBER OF PATIENTS: 49

SUMMARY: Forty nine consecutive mastectomy patients were retrospectively reviewed, 22 of which were treated with the ON-Q with bupivacaine 0.25% at 4 ml/hr. and 27 who were treated without the ON-Q. The number of patients who did not request any postoperative opioid was 18.2% in the ON-Q group and 3.7% in the non ON-Q group.

Randomized clinical trial of postoperative subfascial infusion with bupivacaine following ambulatory open mesh repair of inguinal hernia

AUTHOR: Lau H, Patil NG, Lee F

REFERENCE: *Digestive Surg.* 2003; 20(4): 285-9.

TYPE OF STUDY: Open prospective, randomized

INSTITUTION: Tung Wah Hospital, Hong Kong, China

NUMBER OF PATIENTS: 44

SUMMARY: Randomized study of 44 patients to receive either bupivacaine 0.5% by pump or oral narcotics and diclofenac following inguinal hernia repair. Results showed significantly reduced postoperative pain and analgesic requirements following ambulatory hernioplasty in the pump group. The pump allowed local analgesia to be

administered at home while avoiding systemic side effects from narcotics.

Continuous quality improvement initiative on the use of continuous infusions of local anesthetics following inguinal hernia repair in an ambulatory care setting.

AUTHOR: Varner L, Cottrell L

REFERENCE: Presented at FASA May 2006, Orlando, FL

TYPE OF STUDY: Open prospective

INSTITUTION: Baptist Physicians' Surgery Center, Lexington, KY

NUMBER OF PATIENTS: 78

SUMMARY: Patients who had outpatient inguinal hernia repair and received an ON-Q (#44) were compared with a similar group who did not received the pump (#34). The ON-Q group reported significantly less pain ($P < 0.001$), required significantly less IV narcotic in PACU ($P < 0.001$), and less oral narcotics on day one ($P < 0.001$). They also required less anti-emetic medication in PACU.

Continuous postoperative analgesia in anorectal surgery-hemorrhoidectomy. Novel Concepts.

AUTHOR: Kumar S

REFERENCE: Presented at the Am Society of Colorectal Surgeons Annual Meeting. June 2002

TYPE OF STUDY: Open prospective.

INSTITUTION: University of IL, Chicago, IL

NUMBER OF PATIENTS: 54

SUMMARY: Prospective study of 54 patients undergoing hemorrhoidectomy who received lidocaine wound infusion via ON-Q pump. Results showed excellent pain relief and patient satisfaction.

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Randomized clinical trial of local bupivacaine perfusion versus parenteral morphine infusion for pain relief after laparotomy.

AUTHOR: Cheong WK, et al

REFERENCE: *British J Surg* 2001; 88:357-9.

TYPE OF STUDY: Prospective, randomized, placebo-controlled.

INSTITUTION: Singapore General Hospital, Singapore

NUMBER OF PATIENTS: 70

SUMMARY: Patients undergoing colorectal surgery received either morphine via PCA pump, or a continuous infusion of bupivacaine into the wound site using the ON-Q pump. Total morphine used was significantly greater in the PCA group (38 mg) vs. the ON-Q group (0 mg.) No toxic side effects were observed. Study concluded that direct continuous local wound perfusion is as effective as PCA for postoperative relief after laparotomy, and is a safe and feasible alternative.

Use of the ON-Q pain management system is associated with decreased postoperative analgesic requirement: double blind randomized placebo pilot study.

AUTHOR: Baig MK, Zmora O, Derdemezi J, Weiss EG, Nogueras JJ, Wexner SD

REFERENCE: *J Am Coll Surg* 2006;202:297-305.

TYPE OF STUDY: Prospective, randomized, placebo-controlled

INSTITUTION: Cleveland Clinic, Weston, FL

NUMBER OF PATIENTS: 70

SUMMARY: Patients having midline laparotomy received bupivacaine 0.5% or saline via ON-Q pump for 72 hrs. The study group had earlier ambulation, significantly less narcotic usage and 50% less PCA attempts. There was one infection in each group (2.9%) which is much lower than the national average of 7.2%.

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The ON-Q pain management system in the control of post-operative pain in colon and rectal surgery.

AUTHOR: Thorson A, et al

REFERENCE: *United European Gastroenterology Week*, 2001.

TYPE OF STUDY: Retrospective review

INSTITUTION: Colon and Rectal Specialties and Creighton University, Omaha, NE

NUMBER OF PATIENTS: 64

SUMMARY: Retrospective study of patients with ON-Q who underwent abdominal surgery for colorectal disease. Patients with the ON-Q system were compared to a similar group without ON-Q. Study found that those patients who used ON-Q had a reduction in hospital stay, a significantly

more rapid return of bowel function and used fewer narcotics than the group that did not use the ON-Q system. There was no increase in the incidence of wound complications.

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Pilot study examining safety of extended ropivacaine infusion into the incision-site following right hemicolectomy.

AUTHOR: Corso OH, Karatassas A, Hewett PJ, Morris RG

REFERENCE: Presented at Australasian Society of Clinical & Experimental Pharmacologists & Toxicologists (ASCEPT) conference. Melbourne, AU. December 2005

TYPE OF STUDY: Pilot observational study

INSTITUTION: The Queen Elizabeth Hospital, Woodville, SA, and University of Adelaide, SA. Australia

NUMBER OF PATIENTS: 5

SUMMARY: This safety study measured plasma levels for total and unbound ropivacaine, as well as α acid-1 glycoprotein (AAG) during and after a 96 hr infusion of ropivacaine 0.2% at 5 ml/hr after right hemicolectomy with catheters positioned between internal and external oblique muscle layers. The results demonstrated that unbound plasma ropivacaine concentrations were well below published toxic thresholds. No signs of toxicity were observed in any patient. AAG was noted to rise after surgery, which binds to ropivacaine and makes it inactive. This study showed that measuring total ropivacaine levels alone can be misleading, since a rise in AAG provides a safety factor against toxicity. While pain scores were measured, they were not analyzed.

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Use of a new pain control mechanism for post operative analgesia after percutaneous nephrolithotomy.

AUTHOR: Tamaddon K, Santiago L, Bellman G

REFERENCE: Presented at World Congress of EndoUrology and ESWL, 2000

TYPE OF STUDY: Prospective randomized study.

INSTITUTION: Kaiser Hospital, Los Angeles, CA

NUMBER OF PATIENTS: 15

SUMMARY: Patients having percutaneous nephrolithotomy were randomized into three groups: group 1 received PCA morphine, group 2 received morphine subcutaneous as needed, and group 3 received Marcaine by ON-Q pump. Results showed a decrease in narcotic requirements, pain scores, and length of stay in the ON-Q group compared to the narcotic groups.

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The ON-Q pain management system to reduce narcotic requirement after hand assisted laparoscopic nephrectomy.

AUTHOR: Patel, V

REFERENCE: Presented at World Congress of EndoUrology Sept. 2002 and at AUA, May 2003

TYPE OF STUDY: Comparative study ON-Q vs. no ON-Q

INSTITUTION: University of Miami, FL

NUMBER OF PATIENTS: 20

SUMMARY: Patients undergoing HAL nephrectomy; half received bupivacaine 0.25% via ON-Q, and half did not. Study group had 50% reduction in narcotics and 1-day earlier return of bowel function and 1-day decrease in LOS.

Local anesthetic infiltration increases subcutaneous tissue oxygenation after lower abdominal surgery.

AUTHOR: Ahmad M, et al.

REFERENCE: Presented at ASA, 2004, Las Vegas NV

TYPE OF STUDY: Prospective, randomized, blinded, placebo-controlled.

INSTITUTION: Washington University, St. Louis, MO

NUMBER OF PATIENTS: 45

SUMMARY: Patients undergoing radical prostatectomy randomly assigned to receive bupivacaine 0.5%, ropivacaine 0.5%, or saline by wound infusion for 18-24 hrs. PsqO₂ (subcutaneous oxygen pressure) was measured in the wound and in the upper arm during surgery, in recovery, and on the 1st post-op day. Results showed that bupivacaine increased the PsqO₂ in the wound, most likely due to vasodilation. The author concludes: "This may enhance wound healing and prevent postoperative infections."

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Use of continuous local anesthetic infusion pumps in urological surgery.

AUTHOR: Mistry S, Miles B, Lipshultz L

REFERENCE: *Contemporary Urology* 2004 Oct: 12-13.

TYPE OF STUDY: Procedure review of varicocele and comparative study in radical prostatectomy

INSTITUTION: Baylor College of Medicine, Houston

NUMBER OF PATIENTS: 54

SUMMARY: This paper is an overview of the use of infusion pumps for postoperative pain control, discusses the technique used in their facility for varicocele repair, and reports the results of a comparative study with radical prostatectomy

patients. The study showed equivalent pain control and a 65% reduction in narcotic use.

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Reduction of post operative surgical discomfort after robotic radical prostatectomy via the use of the non-narcotic ON-Q pain relief system.

AUTHOR: Patel V

REFERENCE: Presented at the American College of Surgeons Annual Meeting 10/2004

TYPE OF STUDY: Prospective, randomized study

INSTITUTION: Urology Centers of Alabama, Birmingham, AL

NUMBER OF PATIENTS: 150

SUMMARY: Patients having robotically assisted radical prostatectomy for prostate cancer were randomized to receive either ketorolac IM plus morphine IV as needed vs. ketorolac IM plus Marcaine 0.5% at 4 ml/hr via ON-Q pump for 72 hrs. Results showed lower pain scores on POD 1, lower narcotic usage, and earlier return of bowel activity in the ON-Q group.

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Improved pain control after cardiac surgery: results of a randomized double-blind clinical trial.

AUTHOR: Dowling R, et al

REFERENCE: *J Thoracic CV Surgery* 2003; 126(5): 1271-8.

TYPE OF STUDY: Randomized, blinded, placebo-controlled.

INSTITUTION: Jewish Hospital, Louisville, KY

NUMBER OF PATIENTS: 35

SUMMARY: Patients undergoing median sternotomy for coronary artery bypass graft surgery using ropivacaine vs. saline in the ON-Q pump. Results showed a significant decrease in narcotic use and in pain scores, as well as reduction in hospital length of stay, hospital charges, and overall costs. There were no wound complications.

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Use of continuous local anesthetic infusion for pain management after median sternotomy.

AUTHOR: White PF, et al

REFERENCE: *Anesthesiology* 2003; 99(4): 918-23

TYPE OF STUDY: Prospective, randomized, blinded, placebo-controlled.

INSTITUTION: UT Southwestern, Dallas, TX

NUMBER OF PATIENTS: 36

SUMMARY: Patients undergoing median sternotomy for open-heart surgery were randomized to receive normal saline (control), bupivacaine 0.25% or bupivacaine 0.5% via ON-Q at 4 ml/hr x 48 hrs. Results showed that patients in the 0.5% group used significantly less narcotic by PCA, had earlier removal of urinary catheter, ambulated earlier, and had shorter LOS compared to control or 0.25% group. Both study groups had significantly less pain

than controls. Serum bupivacaine concentrations in all bupivacaine-treated patients were less than 4 µg/ml at the end of the infusion, which is below toxic levels.

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Improved pain management outcomes with continuous infusion of a local anesthetic after thoracotomy.

AUTHOR: Wheatley GH, DiMaio JM

REFERENCE: *J Thoracic CV Surg* 2005; 130(2):464-8.

TYPE OF STUDY: Retrospective comparative

INSTITUTION: UT Southwestern, Dallas, TX

NUMBER OF PATIENTS: 110

SUMMARY: Open, retrospective review of patients who had thoracotomy and were managed with either ON-Q with bupivacaine, continuous epidural infusion, or single shot epidural plus ON-Q for relief of postoperative pain. Results showed a significantly lower use of narcotics and improved pain scores in both ON-Q groups. (P<.001). There were no wound complications.

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The use of ON-Q pump after thoracoabdominal aortic aneurysm repair.

AUTHOR: Imperial-Aubin D, Seaton D, Coselli J

REFERENCE: Presented at American Association Critical Care Nurses National Teaching Institute, New Orleans, LA, May 2005

TYPE OF STUDY: Review paper of pilot study

INSTITUTION: Methodist De-Bakey Heart Center, Houston, TX

SUMMARY: Describes the use of ON-Q for

postoperative management of TAAA patients; catheters are placed along rib anteriorly and posteriorly along incision approximation line creating an intercostal nerve block with bupivacaine 0.5% infused at 2 ml/hr per each catheter. Initial experience has shown decreased pain, decreased narcotics, improved pulmonary function, and no infections.

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Efficacy of methods of intercostal nerve blockade for pain relief after thoracotomy.

AUTHOR: Detterbeck FC

REFERENCE: *Ann Thorac Surg* 2005;80:1550-9.

INSTITUTION: Univ of North Carolina, Chapel Hill, NC

TYPE OF STUDY: Meta-analysis review paper

NUMBER OF PATIENTS: 653 total in all studies reviewed related to extrapleural technique

SUMMARY: This paper describes and analyzes 4 techniques for providing pain relief after thoracotomy through meta-analysis of published prospective, randomized studies: Extrapleural infusion of local anesthetics (ON-Q described), interpleural administration of local anesthetics, cryoanalgesia, and direct intercostal nerve block. Only extrapleural infusion showed efficacy compared to narcotics or epidural analgesia. Overall, the data demonstrate that extrapleural analgesia is superior to systemic narcotics, and is at least as good as epidural, with fewer risks and side effects.

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Subpleural catheter placement for pain relief after thoracoscopic resection.

AUTHOR: Detterbeck FC

REFERENCE: *Ann Thorac Surg* 2006;81:1522-3.

INSTITUTION: Univ of North Carolina, Chapel Hill, NC

TYPE OF STUDY: Technique review paper

SUMMARY: Describes the technique of placing an ON-Q Soaker catheter in the paravertebral extrapleural space to provide a multi-level intercostal nerve block for thoracoscopic lung resection. The author uses a DeBakey vascular clamp to tunnel the catheter to the destination.

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Randomized controlled phase III trial of paravertebral catheter vs epidural catheter for post thoracotomy pain control.

AUTHOR: Liptay MJ, et al.

REFERENCE: Presented at Western Thoracic Surgical Association Annual Meeting, June 2006.

TYPE OF STUDY: Prospective, randomized, open controls

INSTITUTION: Evanston Northwestern Healthcare, Evanston, IL and Indiana University, Indianapolis, IN

NUMBER OF PATIENTS: 37

SUMMARY: Patients undergoing thoracotomy for lung resection were randomized to receive ON-Q by paravertebral block or thoracic epidural for postoperative pain management. Lower pain scores at 24 hours and 48 hours were reported in the paravertebral group (P = NS). There was no difference in narcotic usage or PCA attempts. Paravertebral catheter infusion post thoracotomy provided equal pain relief to thoracic epidurals making it an effective alternative.

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Interscalene brachial plexus block with a continuous catheter insertion system and a disposable infusion pump.

AUTHOR: Klein, S., et al

REFERENCE: *Anesth Analg* 2000;91:1473-1478

INSTITUTION: Duke University, Durham, SC

TYPE OF STUDY: Randomized, blinded, placebo-controlled.

NUMBER OF PATIENTS: 40

SUMMARY: Continuous interscalene brachial plexus block using a continuous catheter and disposable elastomeric pump in the ambulatory setting. Patients in the continuous infusion group had less pain and used 50% less morphine than the placebo group over 24 hours. Serum ropivacaine levels were only slightly greater than with a single injection block.

The use of a continuous popliteal sciatic nerve block after surgery involving the foot and ankle: does it improve the quality of recovery?

AUTHOR: White PF, et al.

REFERENCE: *Anesth Analg* 2003;97:1303-9.

TYPE OF STUDY: Prospective, randomized, double-blinded, placebo-controlled

INSTITUTION: UT Southwestern, Dallas, TX

NUMBER OF PATIENTS: 24

SUMMARY: Patients undergoing foot or ankle procedures were randomized to receive a continuous popliteal nerve block with either bupivacaine 0.25% or saline at 5 ml/hr for 48 hrs. All patients had an initial nerve block performed for the surgery followed by general anesthesia. The bupivacaine group was discharged from PACU and hospital earlier, was more likely to be discharged on day of surgery, and had

lower mean and peak pain scores. They also used 70% less PCA, required less antiemetic than the control group, and had higher patient satisfaction scores.

Continuous ropivacaine for pain relief after iliac crest bone grafting for shoulder surgery.

AUTHOR: Dullenkopf, A. et al

REFERENCE: *Swiss Med Wkly* 2003; 133(suppl 137). Abstract #28

TYPE OF STUDY: Randomized, blinded, placebo-controlled.

INSTITUTION: Orthopedic University Clinic, Zurich, Switzerland

NUMBER OF PATIENTS: 24

SUMMARY: Randomized, double blind study of patients undergoing iliac crest bone grafting for shoulder surgery placing catheters at both the shoulder and iliac crest site. Pain scores were assessed at 48 hrs. and at 3 months post op, as well as opioid requirements. Results showed significantly better pain scores at both the 48 hr and 3-month points, and statistically less morphine in the study group compared to saline placebo.

A multi-modal approach to pain management following total joint replacement surgery with the ON-Q pain relief system: a prospective, historical control study.

AUTHOR: Ford PJ, Salvagno RT, Pianta T, Dine A

REFERENCE: Presented at NAON 24th Annual congress, May 2004. Nashville, TN.

TYPE OF STUDY: Retrospective, historical comparison

INSTITUTION: Center for Joint Replacement, Washington County Hospital, Hagerstown, MD

NUMBER OF PATIENTS: 36

SUMMARY: A prospective study comparing patients who had total hip or knee replacements pain management using ON-Q, with historical controls from prior 7 years of the same procedure without use of the ON-Q. Results showed significantly less narcotic usage and significantly less post-op nausea and vomiting. The researchers were able to eliminate the use of PCA following the initiation of the ON-Q for post-op pain management in this group.

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Continuous wound infiltration with ropivacaine reduces pain and analgesic requirements after shoulder surgery.

AUTHOR: Gottschalk A et al

REFERENCE: *Anesth Analg* 2003; 97:1086-91

TYPE OF STUDY: Randomized, blinded, placebo-controlled

INSTITUTION: Department of Anesthesiology, University Hospital Eppendorf, Hamburg Germany

NUMBER OF PATIENTS: 41

SUMMARY: Randomized prospective study comparing the use of ropivacaine 0.2%, ropivacaine 0.375% and saline via the ON-Q pump after shoulder surgery in inpatient and outpatient procedures. Results showed a significant reduction in narcotic use and pain scores, especially in the group with 0.375% ropivacaine. There were no wound complications and plasma levels were below toxic threshold.

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The efficacy of continuous bupivacaine infiltration for pain management following orthopedic knee surgery: anterior cruciate ligament (ACL) reconstruction and total knee arthroplasty (TKA).

AUTHOR: Morris BA, Pullido-Thompson P

REFERENCE: Presented at Advances in Pain Management: From Research to Practice. 2001

TYPE OF STUDY: Prospective, randomized, double-blind, placebo-controlled

INSTITUTION: Scripps Clinic, La Jolla, CA

NUMBER OF PATIENTS: 46

SUMMARY: Prospective, randomized, blinded study on patients undergoing knee surgery, half of which had continuous infusion of bupivacaine via ON-Q pain pump. Results showed significantly less narcotic usage in the bupivacaine group in the total knee arthroplasty group, and significantly lower pain scores in the ACL group. They reported no complications. 54% of the patients were able to remove their catheters at home.

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Patient-controlled regional anesthesia (PCRA) at home: controlled comparison between bupivacaine and ropivacaine brachial plexus analgesia.

AUTHOR: Rawal N, et al

REFERENCE: *Anesthesiology* 2002; 96(6): 1290-6

TYPE OF STUDY: Prospective, randomized, double blind, placebo-controlled.

INSTITUTION: University Hospital, Orebro, Sweden

NUMBER OF PATIENTS: 60

SUMMARY: Patients having hand surgery had an axillary nerve block with a catheter connected to the ON-Q Home Pump with either bupivacaine 0.125% or ropivacaine 0.125%. They were instructed to self-administer 10 ml of the drug as needed by opening the clamp. Results showed effective pain relief in both group, with significantly better satisfaction with ropivacaine on the day of surgery. No patients had signs of infection or local anesthetic toxicity.

Effect of a local anesthetic infusion at the surgical site on postoperative pain and recovery after major orthopedic surgery procedures.

AUTHOR: Coloma M, et al.

REFERENCE: Presented at ASA, October 2003

TYPE OF STUDY: Randomized, prospective, double-blind

INSTITUTION: UT Southwestern, Dallas, TX

NUMBER OF PATIENTS: 50

SUMMARY: Study of patients undergoing unilateral knee or hip replacement surgery randomized to receive bupivacaine 0.25%, 0.5% or saline control at 5 ml/hr x 72 hrs. Results showed a decrease in PCA morphine usage in the bupivacaine 0.5% group.

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A prospective, randomized, double blind study evaluating the efficacy of postoperative continuous local anesthetic infusion at the iliac crest bone graft site after spinal arthrodesis.

AUTHOR: Singh K, et al.

REFERENCE: *Spine* 2005;30:2477-83.

TYPE OF STUDY: Prospective, double-blind, randomized, placebo-controlled

INSTITUTION: Rush University, Chicago, IL

NUMBER OF PATIENTS: 37

SUMMARY: Patients undergoing iliac crest bone graft (ICBG) harvesting for lumbar or cervical arthrodesis randomized to receive 0.5% Marcaine vs. saline at 2 ml/hr x 48 hrs at the bone harvest site. Study group had significantly less narcotic usage (50%), PCA demand frequency, and VAS scores. (p<0.001). No complications.

Periarticular local anesthetic infusion with I-Flow elastomeric pump provides superb analgesia, reduces opioid use and facilitates early ambulation.

AUTHOR: Ganapathy S, et al

REFERENCE: Presented at ASA October 2005, San Francisco, CA

TYPE OF STUDY: Randomized, open, controlled

INSTITUTION: St. Joseph Health Care, University of Western Ontario, Ontario, Canada

NUMBER: 18 THA, 27 TKJA

SUMMARY: Patients having either total knee arthroplasty (TKJA) or total hip arthroplasty (THA) were randomized to receive ON-Q with ropivacaine 0.375% vs. saline via wound catheters for 72 hrs. TKJA patients received 3 catheters, one posterior at 5 ml/hr, and two anterior at 2 ml/hr each. THA patients received two catheters at 2 ml/hr each. Results showed significantly less narcotic requirement in TKJA group which extended to 7 days. Less nausea and dizziness experienced in ON-Q group allowing easier ambulation. No infections, toxicity or DVT. LOS was the same in both TKJA groups but readiness for discharge earlier in ON-Q. The THA data did not reach significance on any parameters.

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Postoperative continuous paravertebral anesthetic infusion for pain control in lumbar spine fusion surgery: a case-controlled study.

AUTHORS: Elder JB, Wang MY

REFERENCE: Presented at Congress of Neurological Surgeons Annual meeting, September 2006. Chicago, IL. Abstract published in *Neurosurgery* Aug 2006;59(2):471-2.

TYPE OF STUDY: Open prospective with retrospective case-controls

INSTITUTION: LA County Medical Center,
Los Angeles, CA

NUMBER OF PATIENTS: 26 in each group.

SUMMARY: After posterior lumbar fusion surgery, patients received continuous infusion of Marcaine 0.5% into the paravertebral subfascial aspects of the wound via an elastomeric pump. Pain scores and opioid use were compared to case-controlled patients who did not receive this therapy. Patients with the infusion used less narcotics for the first 3 postoperative days and reported lower pain scores during the first 5 postoperative days.

Concept for postoperative analgesia after pedicled TRAM flaps: continuous wound instillation with 0.2% ropivacaine via multilumen catheters. A report of two cases.

AUTHOR: Kampe S, et al.

REFERENCE: *The British Association of Plastic Surgeons* 2003;56:478-483

TYPE OF STUDY: Case report of two cases.

INSTITUTION: University of Cologne, Cologne, Germany

SUMMARY: Case report on two patients undergoing TRAM procedure who received ropivacaine 0.2% by wound instillation using two ON-Q 12.5 cm Soaker catheters, connected to B. Braun Multifuse pump to deliver ropivacaine 0.2% at 10 ml/hr. Both patients had no need for rescue pain medication, and had VAS of 10-30 (out of 100) for first 24 hrs, and 0 after. Neither woman had adverse events, and reported high satisfaction.

Continuous bupivacaine wound perfusion following immediate tissue expander breast reconstruction.

AUTHOR: Spann MD, et al

REFERENCE: Presented at the 49th Annual Meeting of the Plastic Surgery Research Council, June 9-14, 2004

TYPE OF STUDY: Retrospective study

INSTITUTION: NY Presbyterian Hospital

NUMBER OF PATIENTS: 23

SUMMARY: Retrospective review of patients who had breast reconstruction by a single surgeon over a 12 month period to evaluate use on ON-Q with bupivacaine 0.25% compared to a like non-ON-Q group. Results showed a 51% reduction in hospital LOS, an 82% reduction in total narcotic

requirements, and an 85% reduction in non-narcotic analgesic usage in the ON-Q group.

Breast augmentation and abdominoplasty: postoperative management with pain pumps.

AUTHOR: Paul M

REFERENCE: *Aesthetic Surg J* 2005;25:69-71

TYPE OF STUDY: Technique review paper

INSTITUTION: Author is from Newport Beach, CA

SUMMARY: This is a description of the procedure used by this surgeon to use the ON-Q pain pump following breast augmentation and abdominoplasty. He uses an areolar subpectoral approach for breast augmentation, and places catheters (dual) subfascial for abdominoplasty, using 0.25% bupivacaine for both. Benefits include ability to ambulate the evening of surgery, and use of less pain medication. Potential benefits include reduced DVT and PE due to early ambulation, and improved pulmonary function.

Pain management in augmentation mammoplasty: a randomized, comparative study of the use of a continuous infusion versus self-administration intermittent bolus of a local anesthetic.

AUTHOR: Pacik PT

REFERENCE: *Aesthetic Surg Journal* 2004; 24:523-30

TYPE OF STUDY: Prospective, randomized. Patients served as own controls

INSTITUTION: Outpatient Surgery Center, Manchester, NH

NUMBER OF PATIENTS: 41

SUMMARY: Patients undergoing augmentation

mammoplasty were given bupivacaine 0.25% with epinephrine via intermittent self-administration with an attached syringe to one breast, and continuous infusion of bupivacaine 0.25% via ON-Q to the other breast. The group was divided into one group that self administered 20 ml every 6 hours as needed, and the other was instructed to self-administer 10 ml every 4 hrs regardless of need. The results showed that patients preferred continuous infusion with ON-Q in both groups and had better pain relief with ON-Q in group two.

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A continuous incisional infusion of either levobupivacaine 0.25% or bupivacaine 0.25% in pediatric patients.

AUTHOR: Tirota C, et al

REFERENCE: Presented at ASA conference October 2005, Atlanta, GA

TYPE OF STUDY: Prospective, randomized, double-blind

INSTITUTION: Miami Children’s Hospital and Arnold Palmer Hospital, Miami and Orlando, FL

NUMBER OF PATIENTS: 40 pediatric patients from 5 kg to 31.5 kg weight

SUMMARY: Compared levobupivacaine 0.25% or bupivacaine 0.25% to saline by ON-Q after median sternotomy. Dosage was set to deliver < 0.4 mg/kg/hr. Patients were evaluated for analgesic effect and narcotic administration. Plasma drug levels were done at 12, 24, 48, and 72 hrs. Results showed a 50% reduction in total morphine in the study group compared to placebo (P = NS). All plasma levels were below toxic threshold.

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Predictors of wound infection following laparoscopic roux-en-Y gastric bypass.

AUTHOR: Dao T, Fisher T, Arnold D, Barnes G, McCarty T

REFERENCE: Presented at North Texas American College of Surgeons meeting. February 2006

TYPE OF STUDY: Prospective database review.

INSTITUTION: Baylor University Medical Center, Dallas, TX

NUMBER OF PATIENTS: 2072

SUMMARY: Database was queried to determine variables that affect infection rate in patients who had laparoscopic roux-en-Y gastric bypass. Of the total, 1064 had ON-Q, 1008 did not have ON-Q. The study showed identical infection rates (0.9%) for both groups. Of the other factors considered, only the presence of diabetes mellitus was an independent variable that predicted infection.

Effectiveness of a soaker catheter system on the recovery of bariatric surgery patients.

AUTHOR: Iyer CP, Robertson BD, Lenkovsky F, Ross L, and Joshi GP

REFERENCE: Presented at International Anesthesia Research Society (IARS) 80th Clinical Scientific Congress, San Francisco, March 2006.

TYPE OF STUDY: Prospective, double-blind randomized study

INSTITUTION: Dallas VA Medical Center

NUMBER OF PATIENTS: 23

SUMMARY: Patients undergoing Roux-en-Y gastric bypass surgery were randomized to receive either ropivacaine 0.2% (n=11) or saline (n=12) via dual catheters placed in the subfascial and subcutaneous

plane. Most notably, the patients were able to ambulate and sit up quicker in the ropivacaine group. This may be very beneficial in reducing complications in this high risk patient population.

Use of local anesthetic infusion catheter in laparoscopic roux-en-y gastric bypass patients.

AUTHOR: Hilliard SM, McCarty TM, et al

REFERENCE: Presented at Southwest Surgical Congress, San Antonio, TX, April 2005

TYPE OF STUDY: Retrospective review

INSTITUTION: Baylor University Medical Center, Dallas, TX

NUMBER OF PATIENTS: 200

SUMMARY: A retrospective chart review compared 100 patients who underwent laparoscopic roux-en-Y gastric bypass surgery who had local anesthetic infusion into the left subcostal trocar site to 100 consecutive patients who underwent the same procedure without an infusion catheter. Results showed a statistically significant decrease in narcotic requirements in the study group (63.89 vs. 116.14 morphine equivalents; $p < 0.05$) There was also a statistically significant improvement in the number of patients discharged within 23 hours for the infusion catheter patients compared to the patients without the infusion catheter (87% vs. 80%) ($p < 0.05$). There were two study group patients who had wound erythema requiring antibiotics, compared to three infections in control group, two of which required incision and drainage.

Subcutaneous Marcaine® pain pumps can eliminate PCA use, reduce hospital costs and narcotic usage while providing similar pain relief to IV PCA.

AUTHORS: Cottam DR, Fisher B, Atkinson J, Link D, Volk P, Friesen C, Link D, Grace B, Trovar R.

REFERENCE: Presented at ASBS, June 2006,
San Francisco, CA

TYPE OF STUDY: Prospective, randomized,
open controls

INSTITUTION: Surgical Weight Control Center,
Las Vegas, NV

NUMBER OF PATIENTS: 20

SUMMARY: Laparoscopic roux-en-y gastric bypass surgery patients were randomized to receive ON-Q Marcaine pain pump vs Demerol PCA postoperatively. There was a significant difference in narcotic use in the Marcaine group from the time the patients left surgery to 6 am the following day. This should reduce the costs for hospitals and reduce the incidence of respiratory failure from oversedation.

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Using regional blockade for adjunct pain relief

AUTHOR: D'Arcy Y

REFERENCE: *Nursing* 2004; 34(11):74-5.

INSTITUTION: Author is from Suburban Hospital, Bethesda, MD

SUMMARY: This is a review paper geared for Registered Nurses and discusses the principles and technique of using local anesthetics for continuous wound site or peripheral nerve block for postoperative pain management.

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Reduced rates of surgical site infection with the use of continuous incisional infusions of local anesthetic with ON-Q PainBuster: a meta-analysis of clinical studies.

AUTHORS: Dine A, Johnson S, Saint John B

REFERENCE: Presented at International Conference on Surgical Infections, 9/2006. Stockholm, Sweden

TYPE OF STUDY: Meta-analysis of 49 studies.

NUMBER OF PATIENTS: 4087

SUMMARY: Published and presented studies using ON-Q were evaluated for surgical site infection rates and compared to the reported rate provided by the National Nosocomial Infection Surveillance (2004). The meta-analysis showed significant reduction of risk for surgical site infection when continuous wound catheters were used. (OR 0.435 p<0.001). The overall rate of infection in ON-Q studies was 0.7% compared to 2.11% reported by NNIS.

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Efficacy of continuous wound catheters delivering local anesthetic for postoperative analgesia: a quantitative and qualitative systematic review of randomized controlled trials.

AUTHORS: Liu SS, Richman JM, Thirlby RC, Wu CL

REFERENCE: *J Am Coll Surg* 2006;203(6): 914-32.

TYPE OF STUDY: Meta-analysis of 44 studies

NUMBER OF PATIENTS: 2141 total

SUMMARY: A systematic review of published randomized trials was conducted to determine efficacy and risk of continuous infusion of local anesthetics through a catheter placed into the surgical site by the surgeon. Studies were included if they reported median and mean values of either visual analogue pain scores or opioid consumption. The results showed statistically significant differences in terms of pain scores or opioid use for all surgical subgroups, despite various procedures, catheter placements and mode and dose of local anesthetic delivery. While opioid related side effects were not always reported, there was an overall reduction in PONV, increased patient satisfaction, and decreased length of stay of one day. Reported infection rates were 0.7% in the active group (with local) vs 1.2% in the control (saline) group. The conclusion states that "Both the efficacy and technical simplicity of this technique encourage its widespread clinical use."

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