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No evidence of real progress in treatment of acute pain, 1993–2012: scientometric analysis

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Abstract: Over the past 2 decades, many new techniques and drugs for the treatment of acute pain have achieved widespread use. The main aim of this study was to assess the progress in their implementation using scientometric analysis. The following scientometric indices were used: 1) popularity index, representing the share of articles on a specific technique (or a drug) relative to all articles in the field of acute pain; 2) index of change, representing the degree of growth in publications on a topic compared to the previous period; and 3) index of expectations, representing the ratio of the number of articles on a topic in the top 20 journals relative to the number of articles in all (>5,000) biomedical journals covered by PubMed. Publications on specific topics (ten techniques and 21 drugs) were assessed during four time periods (1993–1997, 1998–2002, 2003–2007, and 2008–2012). In addition, to determine whether the status of routine acute pain management has improved over the past 20 years, we analyzed surveys designed to be representative of the national population that reflected direct responses of patients reporting pain scores. By the 2008–2012 period, popularity index had reached a substantial level (≥5%) only with techniques or drugs that were introduced 30–50 years ago or more (epidural analgesia, patient-controlled analgesia, nerve blocks, epidural analgesia for labor or delivery, bupivacaine, and acetaminophen). In 2008–2012, promising (although modest) changes of index of change and index of expectations were found only with dexamethasone. Six national surveys conducted for the past 20 years demonstrated an unacceptably high percentage of patients experiencing moderate or severe pain with not even a trend toward outcome improvement. Thus, techniques or drugs that were introduced and achieved widespread use for acute pain management within the past 20 years have produced no changes in scientometric indices that would indicate real progress and have failed to improve national outcomes for relief of acute pain. Two possible reasons for this are discussed: 1) the difference between the effectiveness of old and new techniques is not clinically meaningful; and 2) resources necessary for appropriate use of new techniques in routine pain management are not adequate.

Keywords: continuous nerve block, epidural analgesia, multimodal analgesia, nerve block, pain management, patient-controlled intravenous analgesia, patient-controlled epidural analgesia, postoperative pain

Introduction

In 1992, the Agency for Health Care Policy and Research (AHCPR), US Department of Health and Human Services, issued the Acute Pain Management Operative or Medical Procedures and Trauma guidelines.[1,2] These guidelines recognize the widespread inadequacy of pain management and set goals for reduction of the incidence and severity of patients' acute postoperative or posttraumatic pain. One year later, the first national patient-based survey providing reliable information on acute pain management in US

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hospitals confirmed the poor status of acute pain management: 77% of adults reported pain after surgery, with 80% of these experiencing moderate to extreme pain.[3] Another national patient-based survey conducted in 1992–1993 in English hospitals demonstrated similar inadequacy in acute pain management. Of the 61% of hospital patients who suffered pain, 87% had moderate or severe pain.[4]

During the past 2 decades, new technologies for improvement of acute pain management have achieved widespread use: patient-controlled analgesia has gained popularity; postoperative epidural analgesia has become commonplace; there has been a wide increase in the use of continuous peripheral nerve blocks; and acute pain nurse-based services have been designed.[5–8] In addition, new pharmacological agents have been developed and used for the treatment of pain.[8,9] The main aim of this study was to assess the progress in the development of new techniques and drugs for the treatment of acute pain over the past 20 years with the use of scientometric analysis. We also sought to answer the following question: have new developments changed the status of acute pain management since the issuance of the AHCPR guidelines?

Methods

To assess the development of new techniques and drugs for the treatment of acute pain, we used the following three publication parameters as signs of success in pain research. 1) Popularity index (PI) is the share of articles on a specific technique (or a drug) relative to all articles in the field of acute pain ("acute pain" OR "postoperative pain"). A specific threshold of 1% (arbitrary) was chosen to select topics on which the number of publications (2008–2012) reached a substantial level. 2) Index of change (IC) represents the change in number of publications during a 5-year period on a technique (or a drug) compared to that in the previous 5 years (immediately prior to the time period). It reflects the change in interest for a topic in general. A specific threshold for this index was the growth beyond the increase in number of publications in the whole field of acute pain during the same time interval. 3) Index of expectations (IE), or Top Journal Selectivity Index (TJSI),[10–14] represents the ratio of the number of all types of articles on a particular topic in the top 20 journals relative to number of articles in all (>5,000) biomedical journals covered by PubMed over 5 years. It reflects the predominance of interest in a topic in the top journals. A TJSI value ≥10 was selected to represent high expectations of success.

Specific topics with PI 1% or higher (in 2008–2012) were selected for assessment using the IC and IE during four time periods: 1993–1997, 1998–2002, 2003–2007, and 2008–2012. The articles were collected mainly using the National Library of Medicine's PubMed website (http://www.ncbi.nlm.nih.gov/pubmed/). Only articles published in English were included. Search terms related to the techniques or drugs used for the treatment of acute pain were taken from various articles[5–9,13,14] and textbooks.[15–17] The following techniques were included: acute pain service; continuous epidural anesthesia; continuous nerve block; epidural analgesia (all types); epidural analgesia for labor or delivery; multimodal analgesia; nerve blocks (all types); patient-controlled intravenous analgesia (PCA); patient-controlled epidural analgesia (PCEA); patient-controlled nerve block; preemptive analgesia; and wound infiltration. The following drugs were searched: acetaminophen; aspirin; bupivacaine; celecoxib; clonidine; dexamethasone; dexmedetomidine; diclofenac; fentanyl; gabapentin; hydrocodone; hydromorphone; ibuprofen; ketorolac; levobupivacaine; methadone; oxycodone; pregabalin; remifentanil; ropivacaine; and tramadol.

A technique or drug term was entered in the search box with the following keyword combination: AND ("acute pain" OR "postoperative pain"). If the name of a technique included the word "analgesia", the above combination was not added. To create separate categories of epidural analgesia (such as epidural analgesia for labor or delivery), the following additional terms were placed in the search box: AND (labor OR delivery). To separate articles on peripheral nerve blocks from those related to spinal or epidural blocks, the following addition was placed in the search box: NOT (spinal OR epidural). To eliminate articles on opioids used only as adjuncts to anesthesia, the following terms were added in the search box: NOT "general anesthesia". Filters for languages (English) and publication dates (custom range) were used. All types of articles were taken into account.

To determine IE (TJSI),[10–12] the 20 top journals were selected based on two factors: 1) their rank sorted by the impact factor, as indicated by Journal Citation Reports for 2012; and 2) the journal specialty area. The journals included anesthesiology, pain, neurology, and surgery journals (ten journals) and general biomedical journals (also ten): *American Journal of Surgery*; *Anesthesiology*; *Annals of Internal Medicine*; *Annals of Neurology*; *Annual Review of Pharmacology and Toxicology*; *Annals of Surgery*; *Archives of Surgery*; *British Journal of Anaesthesia*; *Journal of the American Academy of Orthopedic Surgery*; *Journal of Clinical Investigation*; *JAMA*; *Lancet*; *Lancet Neurology*; *New England Journal of Medicine*; *Nature Medicine*; *Nature Reviews Drug Discovery*; *Pain*;

Pharmacological Reviews; *Surgery*; and *Trends in Pharmacological Sciences*.

To assess whether routine acute pain management has improved over the past 20 years, the following survey search was performed. We analyzed only surveys designed to be representative of the national population that reflected direct responses of patients reporting pain scores (or pain relief scores). Articles published in English (1993–2012) were selected mainly using the National Library of Medicine's PubMed website. The following combination of search terms was used: ("acute pain" OR "postoperative pain") AND ("pain control" OR "pain relief" OR "pain treatment" OR "pain management") AND ("pain intensity" OR "pain score") AND (survey OR audit OR evaluation). In addition to the electronic search of articles, related publications appearing in the reference lists of reports and reviews were also searched manually. The results of an initial search were reviewed to exclude the following types of articles: 1) articles representing the opinions of physicians or nurses involved in pain treatment rather than direct responses of patients; 2) surveys not reporting pain scores or pain relief scores; 3) surveys based solely on results from a single institution; and 4) surveys based on data exclusively on one type of surgery, one type of acute pain, or one modality of pain treatment. (The exclusion of specialized systems of pain management, which usually can afford additional resources for specific aims, should better reflect routine pain treatment.) Thus, surveys represent routine pain treatment of patients with multiple types of acute pain treated in the various types of institutions using multiple pain treatment modalities. These surveys reflect reports on pain intensity by indicating its numerical value.

We also performed a specific analysis of the results of studies directly comparing the pain relief effectiveness of two treatment modalities: PCA and PCEA. Only prospective, randomized studies reporting pain scores and having more than 20 patients per treatment group were collected. The differences in pain intensity scores reported in these studies on the first postoperative day were assessed from both statistical and clinical points of view. Statistically significant differences ($P<0.05$) and clinically noticeable differences (differences $\geq$13 on a pain scale of 0–100[18,19]) were noted for pain at rest and with activity.

Results

Scientometrics

Techniques

A scientometric assessment of techniques for the treatment of acute pain is presented in Table 1. During 2008–2012,

Table 1 Techniques for the treatment of acute pain

Technique	Duration of publications (number of years)[b]	Number of articles (2008–2012)	Popularity index[c] (2008–2012)	Index of change (%)[e]				Index of expectations (TJSI[10–12])[g]			
				1993–1997	1998–2002	2003–2007	2008–2012	1993–1997	1998–2002	2003–2007	2008–2012
Epidural analgesia (all types)	40	1,568	**15.1**	+37	+16	–3	–5	**15.4**	**15.3**	**12.7**	8.1
PCA	23	1,014	**10.6**	+55	–2	+32	+3	**15.0**	**16.1**	**12.2**	7.0
Nerve block (all types)[a]	25	607	**6.3**	+61	**+43**	**>100**	+36	6.9	**11.9**	**10.0**	7.9
Epidural analgesia for labor or delivery	35	584	**6.1**	+59	+25	–10	–0.8	**14.4**	**16.9**	8.0	5.0
Continuous nerve block[a]	10	137	**1.4**	+33	**+46**	**>100**	+37	**10.7**	**14.6**	**10.0**	**13.9**
Multimodal analgesia	4	124	**1.3**	–	**>100**	**>100**	**+88**	–	**11.5**	6.0	4.0
PCEA	12	110	**1.2**	**>100**	**+72**	**+49**	–7	6.5	**13.9**	**11.9**	**10.9**

Notes: The following items did not reach the threshold of 1% for the whole field: preemptive analgesia (0.9%); wound infiltration (0.9%); patient-controlled nerve block (0.8%); acute pain service (0.6%); continuous epidural analgesia (0.5%). [a]These treatments were entered along with AND ("acute pain" OR "postoperative pain"); [b]after the first 100 articles; [c]share of all field publications in 2008–2012; [e]changes in the number of publications compared to the number of publications on the same topic in the previous 5 years. Figures in bold indicate increases higher than those in the whole field; [g]an index assessing probability of success (TJSI is the ratio of the number of all types of articles on a particular topic in the top 20 journals relative to number of articles in all [>5,000] biomedical journals covered by MEDLINE over 5 years). Figures in bold indicate high expectations.

Abbreviations: PCA, patient-controlled intravenous analgesia; PCEA, patient-controlled epidural analgesia; TJSI, Top Journal Selectivity Index.

the PI was greater than 5% for only four techniques of acute pain treatment: epidural analgesia, PCA, nerve blocks, and epidural analgesia for labor or delivery. PI did not exceed 1.5% for continuous nerve block, multimodal analgesia, or PCEA. Because the PIs for wound infiltration, preemptive analgesia, and acute pain service were all under 1% (0.9%, 0.9%, and 0.6%, respectively), these terms are not included in the table.

Two relatively new treatment techniques, continuous nerve block and PCEA, demonstrated impressive increases in IC and IE over the past 20 years. However, during the last 5-year period (2008–2012), despite high IE (13.9 for continuous nerve block and 10.9 for PCEA), IC growth slowed with continuous nerve block and even declined with PCEA (Table 1). IC with multimodal analgesia has shown consistent growth since 1998; however, IE was rather low in both the 2003–2007 and 2008–2012 periods (6.0 and 4.0, respectively).

Drugs

Of 21 drugs used in acute pain management that were included in the search, the 13 with PI greater than 1% in 2008–2012 are presented in Table 2. Of those, the PI of both bupivacaine and acetaminophen was more than 5% (7.4% and 5.4%, respectively). In 2008–2012, only dexamethasone showed impressive increases in both IC and IE (88 and 12.0, respectively). Ketamine-related IC and IE consistently increased over the entire 20-year period (1993–2012). However, in 2008–2012, those increases slowed and the increase in IC for ketamine (36) was even less than that for publications in the whole field of acute pain (42). The levobupivacaine-related increases in 2003–2007 and 2008–2012 were substantial only for IC (see Table 2).

National surveys

The initial search identified 115 articles published in the past 20 years (1993–2012), from which only 30 surveys relevant to the treatment of acute pain were selected (see Figure 1 and "Supplementary material"). In the next step, four other types of articles were excluded (as described in "Methods"), leaving only six articles that represent national surveys and reflect routine patient care (Table 3).[3,4,13,20–22] Each of them has several hundred to several thousand patients with multiple types of acute pain treated in various types of treatment centers using multiple pain treatment modalities. Three surveys are US national studies and the others are national surveys conducted in England, France, and Germany. All surveys reported unacceptably high (according to AHCPR)

Table 2 Drugs for the treatment of acute pain

Drug[a]	Duration of publications (number of years)[b]	Number of articles (2008–2012)	Popularity index[c] (2008–2012)	Index of change (%)[e]				Index of expectations (TJSI[10–12])[g]			
				1993–1997	1998–2002	2003–2007	2008–2012	1993–1997	1998–2002	2003–2007	2008–2012
Bupivacaine	27	709	**7.4**	+65	+7	+18	+15	**15.0**	**13.7**	8.3	5.9
Acetaminophen	26	516	**5.4**	**>100**	**+54**	+43	+32	**10.2**	7.7	**10.2**	6.4
Fentanyl	24	387	**4.0**	**+80**	–9	+32	+19	**14.8**	**16.7**	**15.3**	8.3
Ropivacaine	11	386	**4.0**	–	**>100**	**+76**	+33	**17.6**	**12.7**	**11.4**	7.2
Tramadol	11	253	**2.6**	–	**>100**	**+79**	+32	**19.4**	**9.3**	9.3	4.0
Diclofenac	18	190	**2.0**	**>100**	+16	**+53**	–2	8.2	**12.6**	3.6	1.0
Ketorolac	18	166	**1.7**	**>100**	–25	–1	+19	9.5	**12.7**	7.9	5.4
Ketamine	11	158	**1.6**	**>100**	**>100**	**+57**	+36	**16.0**	**23.0**	**12.9**	**10.0**
Ibuprofen	19	151	**1.6**	+66	**+65**	+21	+30	6.9	**10.4**	7.8	4.0
Levobupivacaine	4	149	**1.6**	–	–	**>100**	**>100**	–	–	8.2	8.7
Dexamethasone	6	123	**1.3**	–	**>100**	**+77**	**+88**	–	–	5.0	**12.0**
Oxycodone	–	113	**1.2**	**+73**	**+65**	**>100**	+19	**15.4**	7.0	9.5	6.2
Gabapentin	5	110	**1.2**	–	–	**>100**	+10	–	**36.4**	**14.4**	4.5

Notes: The following items did not reach the threshold of 1% for the whole field: clonidine (0.9%); remifentanil (0.8%); dexmedetomidine (0.8%); hydromorphone (0.7%); ketoprofen (0.6%); celecoxib (0.6%); hydrocodone (0.4%); aspirin (0.3%); methadone (0.3%). [a]Each drug was entered along with AND ("acute pain" OR "postoperative pain"); [b]after the first 100 articles; [c]share of all field publications in 2008–2012; [e]changes in the number of publications compared to the number of publications on the same topic in the previous 5 years. Figures in bold indicate increases higher than those in the whole field; [g]an index assessing probability of success (TJSI is the ratio of the number of all types of articles on a particular topic in the top 20 journals relative to number of articles in all [>5,000] biomedical journals covered by PubMed over 5 years). Figures in bold indicate high expectations.
Abbreviation: TJSI, Top Journal Selectivity Index.

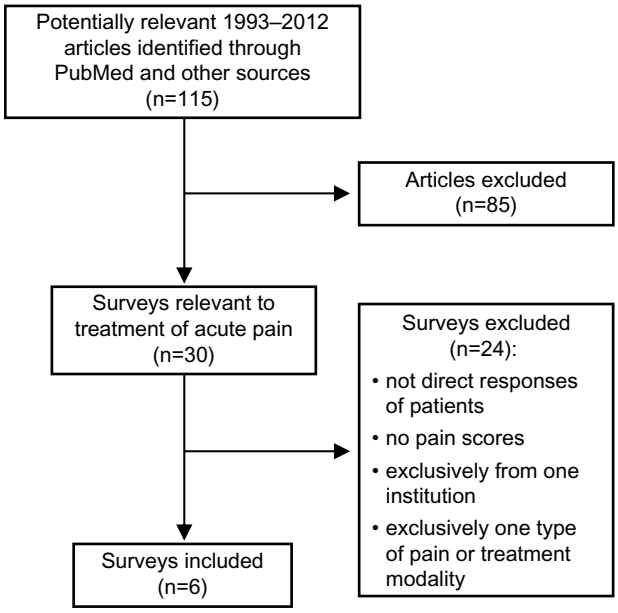

Figure 1 Flowchart of screened, excluded, and included articles representing national surveys on the treatment of acute pain, 1993–2012.

percentages of patients experiencing moderate or severe pain. Two US national surveys[3,20] with similar methodological approaches were performed approximately a decade apart. Not only did these two surveys find nearly the same incidence of unacceptably high pain intensity (80% and 86% of patients, respectively, experienced moderate, severe, or extreme pain), but extreme pain was actually more common in the second survey. One of the surveys[22] was on the treatment of patients preselected as having moderate or severe acute pain lasting for less than 3 months, and concluded that acute pain continued to be widely undertreated in outpatient settings in the US.

Discussion

Our results indicate that, among techniques and drugs used for the treatment of acute pain, those introduced at least 30–50 years ago were the subject of the highest number of current publications. In 2008–2013, the share of articles related to epidural analgesia (all types) was 15.1% of articles published in the whole field of acute pain, and the share of articles related to PCA was 10.6%. PCA is "younger" than epidural analgesia: its "on-demand" analgesia system was suggested by Sechzer[23,24] in 1968. However, at that time, it was impractical because of the demands it placed on nursing personnel.[25] With the development of systems that administer intravenous analgesics automatically, starting in 1980 the number of PCA-related articles began to grow. The threshold of 100 PCA-related articles (see Table 1) was reached 23 years ago, and over the last 5 years (2008–2012), 1,014 articles were published on PCA.

In fact, no technique considered for the management of acute pain during the past 20 years achieved a level of publication success comparable to that of PCA. For example, PCEA began to be used for the management of acute pain around 1988;[26–28] related publications reached the threshold of 100 articles in 2000. For the last 5-year period (2008–2012), only 110 articles on PCEA were published, making the share of PCEA-related publications only 1.2% of the field – almost tenfold fewer than PCA. This is despite convincing evidence that PCEA is more effective than PCA.[7,29] The superior effectiveness of PCEA is not surprising: unlike PCA, it has epidural local anesthetics that suppress nociceptive input into the central nervous system. Notably, during 2008–2012, not a single technique showed an impressive increase in both of the indices demonstrating continuing success (IC and IE). This apparent contradiction between increased effectiveness and low publication indices supports the contention of White that there is a disconnect between demonstration of the effectiveness of new treatment modalities for the management of acute pain and application of these modalities in clinical practice.[30]

The most rapid "change in fortune" was with preemptive analgesia. This topic ("preemptive analgesia" OR "preventive analgesia") was not included in Table 1 because, in 2008–2012, its share of publications was less than 1% (0.9%). However, in 1998–2002, this percentage was much higher (1.7%). IC and IE for preemptive analgesia dramatically increased during 1993–1997 (>100 and 31.4, respectively); however, in 2003–2007, IC declined to 6.2 and IE to 8.1. These abrupt changes were probably related to the multiple difficulties of measuring preemptive effect.[31,32]

Our findings with drugs used for the treatment of acute pain demonstrated the same pattern as techniques: no impressive increases in the number of publications. In 2008–2012, only dexamethasone showed substantial IC growth (to 88), with a promising rise of IE to 12. Nevertheless, the share of dexamethasone-related publications was rather small (PI of 1.2%). Dexamethasone was previously administered primarily to reduce postoperative nausea and vomiting, and its analgesic effect was recognized only relatively recently. Now the drug is considered an effective adjunct in multimodal strategies to reduce postoperative pain.[33] The change in the perception of its usefulness in pain is probably reflected in a dramatic increase in IE, from 5.0 in 2003–2007 to 12.0 in 2008–2012.

It is of interest that ketamine-related IC and IE increased consistently through the whole 20-year period (1993–2012).

Table 3 Surveys on acute postoperative pain

Author, year	Type of survey	Patients	Type of pain	Treatment modalities	Conclusion
Bruster et al,[4] 1994 (1992–1993)	Direct interview using a structured questionnaire. National survey of 36 acute care hospitals in England of National Health Service. Survey was structured for all aspects of patients' hospital experiences, including pain.	A total of 5,150 adult patients at home 2 to 4 weeks after discharge from hospitals.	Acute pain after surgery and acute nonsurgical pain.	Opioid and non-opioid medications.	Of the 3,163 (61%) patients who suffered pain, 2,755 (87%) had moderate or severe pain (verbal categorical scale). Thirty-three percent of patients were in pain all or most of the time. Pain was worse than expected in 17% of cases. Forty-two percent of patients had to ask for drugs.
Warfield and Kahn,[3] 1995	Telephone interviews with patients in their households in USA. Interviews with physicians also conducted in another part of the survey.	A random sample of 500 adults who had had surgery within the last 5 years.	Acute pain after surgery in a hospital or as an outpatient.	Medications. Thirteen percent of patients used patient-controlled analgesia.	Seventy-seven percent of patients reported pain after surgery, with 80% of these experiencing moderate (49%), severe (23%), or extreme (8%) pain (verbal categorical scale).
Apfelbaum et al,[20] 2003	Telephone interviews with US patients in their households.	A random sample of 250 adults who had had surgery within the last 5 years.	Acute pain after surgery in a hospital or as an outpatient.	Medications (morphine, meperidine, acetaminophen, codeine, ibuprofen).	Eighty-two percent of patients reported some pain during the period from surgery until 2 weeks after discharge, with 86% of these patients experiencing moderate (47%), severe (21%), or extreme (18%) pain (verbal categorical scale).
Fletcher et al,[13] 2008 (2004–2006)	Survey of 76 surgical centers in France that included pain intensity reported by the patients at the time of auditor's visit.	A sample of 750 adult patients 24 hours after surgery at the center.	Acute pain after various types of surgery.	Medications (morphine, tramadol, codeine, paracetamol, ketoprofen, nefopam). Patient-controlled analgesia (21.4%), epidural blocks (1.5%), and peripheral nerve blocks (4.7%).	Frequency of postoperative pain since surgery was 87%. Severe pain as maximal pain since surgery (numerical rating scale >7/10) was reported in 50.9% of patients, severe pain at rest was reported in 4.2%, and severe pain on movement in 26.9%.
Maier et al,[21] 2010 (2004–2006)	Survey of 25 German hospitals, in which patients anonymously completed survey questionnaire.	2,252 adult patients who returned questionnaires had undergone surgery and 999 were treated non-surgically (included chronic conditions).	Acute pain after surgery in a hospital.	Opioid and nonopioid analgesics. Five percent of surgical patients received regional analgesia.	Pain 24 hours after surgery was reported by 88% of patients. Moderate-to-severe pain (numerical rating scale >3/10) was reported at rest by 29.5% and on movement by 55% of surgical patients. The nonsurgical group of patients had even higher pain intensity: 36.8% reported moderate-to-severe pain at rest.
Moskovitz et al,[22] 2011 (September 2008–November 2008)	Direct written survey of patients with moderate-to-severe acute pain identified by 5,982 US physicians (ten patients per physician).	A total of 50,869 patients completed surveys at the time of their visit to primary care physician or specialist.	Acute pain lasting less than 3 months associated with trauma, surgery, low back pain, osteoarthritis, or shingles.	Medications (weak opioids [43%], strong opioids [35%], and nonopioids [17%]).	Forty-four percent of patients with moderate or severe pain (numerical rating scale >3/10) had received potentially inadequate analgesia. Thirty-two percent of them received a weak opioid when their worst pain was severe (numerical rating scale >7). A substantial percentage of patients (17%) who were treated with a strong opioid discontinued their medication before the pain resolved; 37% of them had significant side effects (constipation 20%, nausea 14%, sleepiness 11%).

The reason for this was the realization that the effect of ketamine on the N-methyl-D-aspartate receptor could be useful in pain management.[34,35] However, despite published randomized trials,[36,37] the role of ketamine in perioperative analgesia remains unclear. This fact is probably reflected in the decline of IC and IE over time (Table 2). In the last 5-year period (2008–2012), the increase of IC with ketamine was even less than that with publications in the whole field of acute pain. It is important to add that, among drugs used for the treatment of acute pain, morphine continued to dominate, despite a persistent decline during 1993–2012. In 2008–2012, the number of morphine-related articles constituted 11.6% of all field articles.

National surveys that assessed the status of routine acute pain management over the past 20 years demonstrated an unacceptably high percentage of patients experiencing moderate or severe pain (Table 3). In addition, the outcomes of two US national surveys a decade apart that had similar methodological approaches did not reveal even a tendency for outcome improvement. Thus, both the scientometric data on the new techniques and drugs used for the management of acute pain for the past 20 years and the national surveys' results on the effectiveness of pain relief during the same period indicate a failure to offer any evidence of real progress in the treatment of acute pain.

Perhaps the most intriguing question is why techniques for the treatment of acute pain, such as PCEA, continuous nerve block, and patient-controlled nerve block (all of which show reliably better analgesic effectiveness than PCA), did not improve national outcomes for the relief of acute pain or changes in the scientometric indices indicative of success. One of the possible answers is that the difference in the effectiveness of new techniques compared to the old (PCA), although statistically significant, is not clinically noticeable. Liu and Wu, who compared the effectiveness of various analgesic techniques in postoperative pain, concluded that the difference between PCA and continuous epidural analgesia or PCEA is not necessarily clinically meaningful.[38] In Table 4,[39–44] we list studies that compared the effects of two techniques – PCA and PCEA (see "Methods"). The results of this comparison confirm the conclusion by Liu and Wu.[38] Table 4 shows that clinically noticeable differences between PCA and PCEA for pain at rest were reported in only two of six studies, and in only two of five studies for pain with activities.

Lack of available resources for adequate use of the newer techniques might be another factor in the absence of real progress in routine pain management. This can be illustrated by comparing clinical staff resources necessary for PCA and PCEA. PCEA requires greater attention by care providers, especially by the anesthesiologist. Not counting the time for epidural catheter insertion, the anesthesiologist has to provide more supervision with PCEA than with PCA. Greater vigilance is necessary due to the possibility of such complications/adverse effects of epidural analgesia as epidural hematoma, neurologic complications, hypotension, leg weakness, and concomitant thromboprophylaxis, as well as catheter migration or time required to ensure optimal catheter functioning (eg, adjusting catheter depth).

The analgesic effectiveness and safety of a new technique or drug are determined in prospective controlled randomized studies usually performed in academic departments with the use of additional resources provided for research. As a result, the per-patient time, one of the components of patient safety, is usually sufficiently good. At the same time, national surveys reflect routine pain management that often takes place in establishments in which clinical staff resources for pain management are limited. Moreover, responses to questionnaires sent to departments of anesthesiology often suggest that these limited financial resources for pain management are declining.[45,46] Thus, compared to PCA, the greater risk of possible complications with PCEA requires additional clinical staff resources – a big price to pay for some improvement in pain relief. The gap between the greater effectiveness of new treatment modalities and actual application of these modalities in clinical practice depends on the balance between the clinical meaningfulness of a possible improvement in pain relief and the availability of resources necessary to use that new treatment modality. It seems that this balance is viewed quite differently by academic institutions and providers of routine pain management, with the latter tending to find the clinical value of additional pain relief not worth the greater drain on resources.

The disconnect between demonstration of the greater analgesic effectiveness of newer treatment modalities and actual application of these modalities in routine clinical practice likely reflects the complex interaction of many diverse factors, such as institution and specialty clinical culture; provider viewpoint and prioritization (which may differ somewhat among surgeons, anesthesiologists, and nurses); health care economics (length of hospital stay, in-house specialist coverage, duration of interventional pain management, etc); and the patient's ability to participate in decision-making. Balancing realities of pain management include many of these factors. Figure 2 is an attempt to illustrate two dimensions of the dynamic balance between potential benefits

Table 4 Prospective, randomized studies reporting PCA-PCEA pain intensity differences

Author, year	Type of surgery	Type of study	Type of analgesics	Visual analog scale scores on first postoperative day							
				At rest				With activities			
				PCA	PCEA	Clinically noticeable[b]	Statistically significant[c]	PCA	PCEA	Clinically noticeable[b]	Statistically significant[c]
Mann et al,[39] 2000	Major abdominal surgery in elderly patients	Prospective, randomized, with 35 patients per group	PCA: morphine PCEA: bupivacaine with sufentanil	22[a]	14[a]	No	Yes	40[a]	34[a]	No	Yes
Carli et al,[40] 2001	Colorectal surgery	Prospective, randomized, with 21 patients per group	PCA: morphine PCEA: bupivacaine with fentanyl	24	7	Yes	Yes	40	10	Yes	Yes
Norris et al,[41] 2001	Abdominal aortic surgery	Prospective, randomized, double-blind, with 37–38 patients per group	PCA: fentanyl PCEA: bupivacaine with fentanyl	–	–	No	No	–	–	No	No
Weinbroum,[42] 2005	Oncologic orthopedic surgery	Prospective, randomized, with 31–32 patients per group	PCA: morphine PCEA: ropivacaine with fentanyl	40[a]	27[a]	Yes	Yes	–	–	–	–
Gupta et al,[43] 2006	Radical retropubic prostatectomy	Prospective, randomized, double-blind, with 28 patients per group	PCA: morphine PCEA: ropivacaine with fentanyl	10[a]	0[a]	No	Yes	40[a]	10[a]	Yes	Yes
Ferguson et al,[44] 2009	Major gynecologic cancer surgery	Prospective, randomized, with 67–68 patients per group	PCA: morphine PCEA: bupivacaine with morphine	43	33	No	Yes	67	55	No	Yes

Notes: [a]Determined from figures; [b]more than 13 on a scale of 0–100; [c]$P<0.05$.
Abbreviations: PCA, patient-controlled intravenous analgesia; PCEA, patient-controlled epidural analgesia.

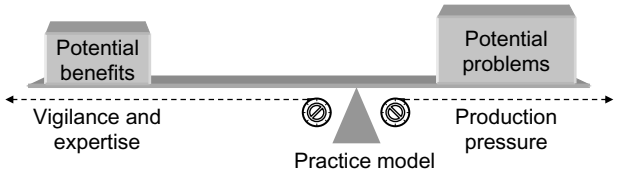

Figure 2 Balancing realities of postoperative pain management.
Notes: With increase in invested time (vigilance) and level of expertise of pain management providers, potential benefits can outweigh potential problems; with increase in production pressure, dictated by health care economics, potential problems can outweigh potential benefits.

and potential problems in postoperative pain management. With increase in invested time (vigilance) and level of expertise of pain management providers, potential benefits can outweigh potential problems; with increase in production pressure, mostly dictated by health care economics, potential problems can outweigh potential benefits.

Conclusion

Techniques or drugs that were introduced and achieved widespread use over the past 20 years for acute pain management have neither produced the changes in scientometric indices that indicate real progress nor improved national outcomes for the relief of acute pain.

Disclosure

The authors report no conflicts of interest in this work.

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Supplementary material

List of articles on the treatment of acute pain, 1993–2012

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