

Laxmaiah Manchikanti *Editor-in-Chief*
Vijay Singh · Frank J. E. Falco · Alan D. Kaye ·
Amol Soin · Joshua A. Hirsch *Editors*

Essentials of Interventional Techniques in Managing Chronic Pain

Second Edition

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 Springer

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Manchikanti's Essentials of Interventional Techniques in Managing Chronic Pain, 2nd edition, is lovingly dedicated to my extraordinary grandmother, the late Gopamma Manchikanti, whose unwavering support and guidance propelled me into the world of medicine. She not only taught me the immeasurable value of education but also instilled in me the deep-rooted desire to make a difference in the lives of others.

To my incredible parents, the late Yadagiry and Laxmamma Manchikanti, I am forever indebted for their boundless love and unwavering support. Their belief in me has been a constant source of strength and motivation throughout my journey.

To my devoted wife, Chandrakala, your unwavering dedication and constant encouragement have been the driving force behind my accomplishments. I am incredibly fortunate to have you by my side, and I am endlessly grateful for your unwavering support.

To our beloved children, Anu and her husband, Alvaro, Sunil and his wife, Neena, Kavita (an interventional pain physician), and grandchildren, Nikhil and Mehr, you are the true joy and purpose of our lives. Your presence has filled our hearts with immeasurable happiness, and your love has given us a profound sense of fulfillment.

This dedication is a heartfelt tribute to all those who have shaped my path, nurtured my aspirations, and illuminated my life with love and inspiration.

This book is dedicated to Frank J.E. Falco, MD, co-editor of this book, who ultimately passed away in 2023, Dr. P. Prithvi Raj, one of the forefathers of pain management, who passed away in 2016, and all interventional pain physicians worldwide, who tirelessly work to bring relief to patients suffering from chronic pain. Your dedication and expertise have made a significant impact on the lives of countless individuals, providing them with the hope and comfort they desperately seek.

To the patients who endure the burden of chronic pain, this dedication is for you. Your resilience and strength in the face of adversity inspire us to continuously strive for better treatments and improved quality of life. May this book serve as a source of knowledge and empowerment on your journey toward pain relief.

Last but not least, a heartfelt dedication goes to my exceptional staff of the American Society of Interventional Pain Physicians (ASIPP), Pain Management Centers, and Ambulatory Surgery Center. Your unwavering commitment and support have been instrumental in the creation of this book. Your hard work and dedication behind the scenes have allowed me to pursue my passion and make a difference in the lives of others. Thank you for your invaluable contributions.

Together, let us continue to work toward a world where chronic pain is understood, treated, and ultimately relieved.

Foreword

Interventional Pain Management (IPM) is effective when it is practiced as intended and when there is an understanding of pain-triggering mechanisms. IPM's foundation comes from clinical and basic science research and publications. What is known about IPM has been widely reported in multiple books, articles, and journals; however, a lot of them have not covered all aspects of IPM. The authors of this book have been key figures in the evolution of IPM and the American Society of Interventional Pain Physicians (ASIPP). They deserve our gratitude for their major effort in making this book, *Manchikanti's Essentials of Interventional Techniques in Managing Chronic Pain*, possible. The Editor-in-Chief, Dr. Laxmaiah Manchikanti, and editors, Vijay Singh, MD, Alan D. Kaye, MD, PhD, Frank J.E. Falco (Honorary), MD, Amol Soin, MD, and Joshua A. Hirsch, MD, have taken on a challenge that future readers will appreciate.

It is evident that the intent of this updated book is to present a body of work, with each chapter authored by some of our very best clinicians. These chapters include evidence, outcomes, updated techniques, and basic and clinical research to help providers offer the very best treatment for each and every patient. Complications and medico-legal consequences are not included in a detailed and comprehensive manner because of the nature of the information. Looking at avoidable complications, one cannot rely upon one person's experience alone. One physician may go through a lifetime of practicing without complications, and another physician may have two or more disasters in a short period of time. The field has very little evidence regarding complications from so-called evidence-based studies; rather it comes from poorly collected and published medico-legal and clinical experiences.

The cost-effectiveness of IPM is favored when it is done appropriately, rather than when it is done because that is the only way a practitioner approaches the problems of patients seeking help. Treatment algorithms continually need to be updated as new therapeutic interventions and convincing evidence surface. Evaluating evidence is a peer-reviewed process, and it is not the right of payors or regulators to deny therapy without compelling negative evidence. Some clinical studies may take 5–6 years from the preliminary data gathering to the conclusive multi-center prospective randomized double-blind placebo-controlled trials [1–5].

The contributors have accepted responsibility for their part in presenting the material, as it has become an essential component of IPM as a distinct medical specialty. ASIPP has grown and matured since its founding in 1998 under the relentless leadership of Dr. Laxmaiah Manchikanti. Many individuals have grown professionally and contributed their time and effort freely to help educate physicians both young and old. Watching the development and growth of some of ASIPP's State Societies has been impressive. There has not been a vested interest as a reason for the above, except the obvious love of the specialty.

The contributors to this book have been chosen for their experience and knowledge of the field. The book is well structured. It represents and recognizes a long journey from John Bonica's first major effort of a similar-sized book entitled *The Management of Pain* [6] and *Raj's Management of Pain* [7]. The current book reflects much more pathophysiology, prin-

ciples, new technologies, and pain-related interventions in real-world practice. The reader appreciates more neurosurgical type principles that go back to the pragmatic approaches of Harvey Cushing. Cushing [8] recognized major reasons for neurosurgery and operating on the brain because of the development of local anesthesia and radiofrequency thermocoagulation. Cushing also made a comment that a good neurosurgeon is a good traveler. What he was implying was for a neurosurgeon to learn, go in, and visit those that were known to be excellent at whatever they were doing. Similarly, we can say that a good IPM physician attends many conferences, reads many articles, and reviews many other modern therapeutic educational opportunities to improve their safety and efficacy for providing care to their patients [8].

Throughout this book, the significance of evidence that comes from publications is evident. Studies may look statistically significant and be published in a highly rated journal, only to realize years later that the foundation of the study was flawed. Appropriate use of neuromodulation in the treatment of upper extremity CRPS 1, published in *Neurosurgical Treatment of Pain* [9–11], showed over 50% returned to work and had many years of effectiveness from the use of neuromodulation in spinal cord as well as peripheral nerve stimulation.

The current book reflects the turning tide against the overuse of opioids and the increasing death rate from prescription use, abuse, and diversion. This restriction should be followed by a reduction in mortality figures; however, one has to remember that medications are needed, and if they are restricted, appropriately carried out IPM procedures will lead to a much-improved quality of life in our patients. The perceived morbidity and mortality from IPM procedures are low; however, not acceptable. The incidence of complications is similar to anesthesiology mortality statistics in the 1960–1970s, when it was 1 in 10,700. Because of the Anesthesia Patient Safety Foundation's recommendation of using improved monitoring with pulse oximetry, carbon dioxide, and oxygen monitoring and alarms, mortality has been reduced 20-fold.

The most impressive aspect of this book is the vision of Laxmaiah Manchikanti for working with an impressive group of pain physicians in gathering all this information into one location. Nevertheless, it is also critical for each practitioner, especially those newly entering our field, to build a network of respected colleagues and practitioners so they can turn to them for the best advice, especially in times of complication(s).

I strongly recommend this book. As one who has visited many homes of physicians that I have trained, instead of finding hungry young doctors eager to learn, nowadays I am finding experienced, respected, graying-haired physicians who are looking forward to going to work the next day. As each day brings new challenges, these challenges demand them to have an up-to-date library and *Manchikanti's Essentials of Interventional Techniques in Managing Chronic Pain*, 2nd edition, belongs there.

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Gabor B. Racz

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Foreword to the First Edition

This foreword was written by Dr. P. Prithvi Raj in 2015. Dr. Raj is considered as one of the forefathers of pain management, including John Bonica, Ronald Melzack, Patrick D. Wall, Alon P. Winnie, and, finally, Gabor B. Racz. His contributions and innovations are numerous. ASIPP has dedicated a distinguished lecture series provided at their annual meeting every year entitled “Raj/Racz Distinguished Lecture Series.” He passed away on February 27, 2016.

He was also one of the founders of the American Society of Regional Anesthesia (ASRA), the Texas Pain Society, and World Institute of Pain (WIP), along with fellowship examination in interventional pain management offered across the globe. He served as Director of the International Pain Institute and Co-director of the Pain Institute and was a Professor of Anesthesiology at multiple institutions, the last being at Texas Tech University in Lubbock, TX.

He also founded, or cofounded, multiple journals including *Pain Practice* and *Pain Digest*. He was a prolific writer and historian publishing over 140 peer-reviewed publications and 12 books.

He held multiple academic positions and was the recipient of numerous awards and honors.

Drs. Laxmaiah Manchikanti, Alan D. Kaye, Frank J.E. Falco, and Joshua A. Hirsch, all internationally renowned interventional pain physicians, have written *Essentials of Interventional Techniques in Managing Chronic Pain*. They have devoted most of their lives to improving the pain management of patients globally. I am honored to write a Foreword for this monumental undertaking.

To emphasize the importance of this book, I need to reiterate the definitions, statistics, and the multiple modalities of treatments available to us for treating chronic pain today and their potential adverse consequences. Chronic pain exists globally. The prevalence of chronic, persistent, disabling pain seems to be increasing with low back pain, neck pain, and other musculoskeletal disorders occupying the top five categories of disability with escalating costs, and there are numerous modalities of treatments ranging from over-the-counter acetaminophen to complex surgical fusions [1–12]. In addition to the costs and health economy impact, there are multiple issues related to diagnostic accuracy and therapeutic efficacy, as well as numerous complications related to these therapies with almost over 16,000 deaths due to opioid poisoning in 2012, an increase of 300% since 1999 [8, 13]. Methadone alone contributed to 4418 deaths in 2011 [13], and there were over 8000 unintentional drug poisoning deaths from heroin in 2013, a 39% increase from 2012, and nearly doubling the 4400 deaths in 2011 [13].

Acetaminophen has been implicated in 1000 deaths a year [14]. Nonsteroidal anti-inflammatory drugs (NSAIDs) have been reported to be responsible for almost 17,000 deaths with numerous gastrointestinal complications [9]. Spinal surgical fusions caused over 1000 deaths in 2008 [7]. Sadly, all modalities of treatments are increasing rapidly with evidence lacking for many of them. There are also numerous considerations, explosive use and safety, including the interventional techniques that are the subject of this book [11, 15, 16]. While accurate data is available in the United States and other developed countries, in many countries

pain may be undertreated and have a higher prevalence than thought; these people may be unable to enjoy the benefits of new advances in interventional pain management. Chronic pain is a complex and multidimensional problem.

Chronic pain is defined as pain that persists 6 months after an injury and beyond the usual course of an acute disease or a reasonable time for a comparable injury to heal; is associated with chronic pathologic processes that cause continuous or intermittent pain for months or years that may continue in the presence or absence of demonstrable pathologies; may not be amenable to routine pain control methods; and healing may never occur [17]. Interventional pain management is defined as the discipline of medicine devoted to the diagnosis and treatment of pain-related disorders principally with the application of interventional techniques in managing subacute, chronic, persistent, and intractable pain, independently or in conjunction with other modalities of treatment [17]. Similarly, interventional techniques have been defined as minimally invasive procedures, including percutaneous precision needle placement, with placement of drugs in targeted areas or ablation of targeted nerves; and some surgical techniques such as laser or endoscopic discectomy, intrathecal infusion pumps, and spinal cord stimulators for the diagnosis and management of chronic, persistent, or intractable pain [17]. Interventional pain management's origins go back to 1884 with neural blockade and regional analgesia [18]. Since then, regional anesthesia and interventional techniques have evolved by leaps and bounds, now reaching numerous claims of overuse, abuse, and fraud [17, 19]. Consequently, due to the changing dynamics of interventional pain management with the explosive increase in interventional techniques, accountable interventional pain management, and value-based practice, the performance of evidence-based, cost-effective, and clinically effective techniques is coming into play, which are enlightened in this book [17, 19].

Pain practice today is fortunate to have many physicians making this practice a professional part of their career. They come from all specialties, and education now has to reflect the advances pain practice has made in all those specialties, not just those in anesthesiology.

The challenge today is to train pain physicians in such a way that they have a standardized curriculum during their residency and pain fellowship programs, followed by skilled practical training in anesthesiology, neurosurgery, physical medicine and rehabilitation, or psychiatry. Once trained, they need to be examined and tested periodically for their competency. This will raise the standard of pain practice, not only in the United States, but all over the world. Evidence-based medicine or evidence-based practice aims to apply the best available evidence gained from scientific methods to clinical decision-making [17, 18]. It seeks to assess the strength of evidence of the risks and benefits of treatments (including lack of treatment) and diagnostic tests. Evidence quality can range from meta-analyses and systematic reviews of double-blind, placebo-controlled clinical trials at the top end, down to conventional wisdom at the bottom. However, in the modern era, even with the development of comparative effectiveness research with numerous changes in healthcare philosophy, and without involvement of clinicians, evidence-based medicine has been minimized with overwhelming conflicts of interest, inappropriate analysis, and lack of application of the principles of evidence-based medicine, focusing more on cost savings and policy decisions rather than evidence itself.

This book, *Essentials of Interventional Techniques in Managing Chronic Pain*, fills the void where literature should conform to local necessities for information to be useful in that society. The format of the book is excellent; each chapter is consistent in describing an interventional technique in simple terms from history to complications and efficacy, stressing at all times technique and safety, encompassing evidence-based, cost effective, and value-based practice.

Essentials of Interventional Techniques in Managing Chronic Pain accomplishes the ambitious goal of directly addressing the field writ large.

Cincinnati, OH, USA

P. Prithvi Raj†

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Preface

The first edition of *Essentials of Interventional Techniques in Managing Chronic Pain* was published in 2018, which was received with extraordinary enthusiasm. Since then, many changes have occurred, and we lost one of our closest friends and contributors to interventional pain management, and particularly this book, Frank J.E. Falco, MD.

As we have described in the previous edition, during the course of our training and practice, the dynamics of what we today call interventional pain management changed from simple bedside injections to a full-fledged specialty with its own specialty designation (–09), explicit definition of interventional techniques, and mandated representation on the Centers for Medicare and Medicaid Services (CMS) Carrier Advisory Committee (CAC). Since the formation of the American Society of Interventional Pain Physicians (ASIPP) in 1998, there has been a dramatic increase in publications showing scientific basis, effectiveness, and cost utility analysis. However, this fledgling specialty has faced and continues to face multiple hurdles, ranging from inappropriate application of interventional techniques to abuse patterns and escalating growth patterns without demonstrated efficacy for some procedures and settings, and a convergence of regulations and policy making.

Interventional pain management is an evolving and dynamic specialty with a history dating back to 1901, including descriptions of epidural injections in managing pain. Today, a large body of literature has evolved related to the use of interventional techniques for the management of chronic pain. Even though there are numerous publications available for a clinician to reference, some texts have focused mostly on the technical aspects, whereas others have focused on the theoretical aspects without providing appropriate succinct information. Raj's *Practical Management of Pain*, with its multiple editions since 1986, has provided readers with a great resource for the study of pain. However, until the publication of *Interventional Techniques in Chronic Spinal Pain* and *Interventional Techniques in Chronic Non-Spinal Pain* by the present authors, there has not been a quick reference to the clinical and technical aspects of interventional techniques in the modern era. In 2007 and 2009, ASIPP published two separate books describing interventional techniques in chronic pain. This ambitious project, undertaken by the editors and ASIPP, exceeded everyone's expectations.

Subsequently, on behalf of ASIPP, we, the editors of this publication, have undertaken the task of revising and updating our previous publication, resulting in an entirely new publication with comprehensive, evidence-based, practical coverage of the specialty, while keeping the original intent of providing a clinician with technical information. Now, this revision brings an updated version of the *Essentials of Interventional Techniques in Managing Chronic Pain*.

With this encyclopedic work, covering the entire field of interventional pain management with a special focus on technical aspects, we have attempted to provide a comprehensive understanding without being cumbersome or long. From across the nation, leading experts in their respective fields have contributed chapters on specific topics following a single format to present a cogent and integrative understanding of the field of interventional pain management.

We have maintained the overall unique structure of the previous publication with an introduction to the subject, historical background, pathophysiology, evidence base, indications, anatomy, technical aspects, side effects and complications, precautions, and synoptic key

points for each topic when available and applicable. This edition of the book consists of 52 chapters, 781 Figures, and 134 Tables under the major sections of Basic Considerations, Spinal Interventional Techniques, Non-spinal and Peripheral Nerve Blocks, Sympathetic Interventional Techniques, Soft Tissue and Joint Injections, and Implantables.

The administrative and logistic exercise of developing this monumental task in the form of a publication and bringing it to the final stage has placed considerable responsibilities and demands on the editors, their families, the staff of ASIPP, and finally, the staff of Springer International Publishing. The editors wish to thank all of the players involved from development to publication for their time, efforts, and devotion. Apart from the editors, contributors, and publishers, significant efforts were afforded by Tonie Hatton, Diane Neihoff, Savannah Gold, and Vidyasagar Pampati, MSc. In addition, many others deserve mention and thanks including radiological technologists Kimberly Cash, Ruby Walters, Chelsea Roth, and Natalie Beyer for their contributions in providing high-quality fluoroscopic images. We are also indebted to many of the world leaders in interventional pain management and our families; without their guidance and patience, this work would have never been completed.

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Important Notice

The information provided in this book is based on the best available evidence and does not constitute inflexible treatment recommendations. Due to the changing body of evidence, this document is not intended to be a “standard of care.” The material and guidance in this book are meant to provide a basis for the understanding behind the role of interventional techniques, to provide a source of appropriate indications for the use of interventional techniques, to facilitate and help standardize interventional pain management, and to encourage the performance of high-quality studies in an effort to document outcomes and advance this field.

This book has been prepared with utmost care and diligence. Appropriate care has been taken to confirm the accuracy of the information presented and to describe generally accepted practices. However, the authors, editors, and publishers are not responsible for errors or omissions or for any consequences from application of the information in this book and make no warranty, expressed or implied, with respect to the contents of this book.

Readers must apply standard safety precautions and perform the techniques described only with appropriate experience. As new research and clinical experience broaden our knowledge of interventional pain management, changes in interventional modalities and drug therapy become necessary and appropriate. Readers are advised to keep abreast of the latest developments by reading journals, by checking the product information currently provided by the manufacturer of each drug to be administered to verify the recommended dosage, the method and duration of administration, and the contraindications. Some drugs and medical devices presented in this publication may have Food and Drug Administration approval only for limited use. It is the responsibility of the healthcare provider to ascertain the FDA’s approval status for each biologic, drug, or device planned for use in his/her clinical practice. This text will only provide guidance; however, it does not provide any standards. It is the responsibility of the treating physician, relying on individual experience and technical expertise, along with appropriate history, physical examination, and laboratory investigations of the patient to determine the appropriateness of interventional techniques and drugs administered for each individual patient.

Neither the publisher, the editors, nor the contributors assume any responsibility for any injury and/or damage to persons or property arising from this publication.

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About the Editors



Laxmaiah Manchikanti, MD, is a physician specializing in interventional pain management, a professor, philanthropist, and author.

He is the founder of American Society of Interventional Pain Physicians, Society of Interventional Pain Management Surgery Centers, multiple state societies, American Board of Interventional Pain Physicians, as well as *Pain Physician* and *Pain Medicine Case Reports* medical journals.

He has been credited with advancing the evolution and development of interventional pain management as a specialty. Interventional pain management was recognized as a specialty in 2002 by the Centers for Medicare and Medicaid Services. In March 2005, interventional pain management was provided with mandatory representation on the Medicare Carrier Advisory Committee.

He founded the MGM scholarship fund, the Manchikanti Charitable Trust, Chandrakala and Laxmaiah Manchikanti Foundation, and sponsored the Manchikanti Library at McCracken County High School. In addition, he also founded and operates the Manchikanti Gopamma Primary School, Manchikanti Gopamma High School, and Manchikanti Yadagiry Junior College, donated fully equipped facilities for Manchikanti Yadagiry Memorial welfare residential school, and sponsored multiple other activities in Bodangparthy, Nalgonda District, Telangana state, and other areas. He is cofounder of the Gandhi Medical College Global Alliance and sponsored Manchikanti Auditorium at Gandhi Medical College, Hyderabad, Telangana state.

Dr. Manchikanti has been serving as Clinical Professor of Anesthesiology and Perioperative Medicine at the University of Louisville, Louisville, KY, since 2012, and Professor of Anesthesiology-Research, Department of Anesthesiology, School of Medicine, at the LSU Health Sciences Center, New Orleans and Shreveport, LA, since 2017.

He is serving as Chairman of the Board and Chief Executive Officer of American Society of Interventional Pain Physicians (ASIPP) and Society of Interventional Pain Management Surgery Centers (SIPMS). He has also served as President of ASIPP and SIPMS before being named Chairman of the Board of both ASIPP and SIPMS.

He is subspecialty certified in pain medicine by the American Board of Anesthesiology, Diplomate of American

Board of Interventional Pain Physicians, and American Board of Pain Medicine, and competency certified in regenerative medicine.

He has been in practice in Paducah, KY, since completion of a fellowship in anesthesiology and critical care medicine in 1980. He graduated from Gandhi Medical College, Osmania University, Hyderabad, India. He completed his internship and residency in anesthesiology at Gandhi Hospital, Youngstown Hospital Association (Northeastern Ohio School of Medicine), Allegheny General Hospital, and his fellowship in anesthesiology and critical care medicine at the University of Pittsburgh School of Medicine.

Dr. Manchikanti has published over 600 publications and serves on several editorial boards. He is also the editor of 14 books designed for interventionalists.

Dr. Manchikanti has been recognized for his dedicated efforts by several prestigious organizations, including:

AAPI Presidential Recognition Award, 2023

Trailblazer Award, World Institute of Pain, 2019

Giants in Pain Management Award, American Society of Interventional Pain Physicians, 2017

Distinguished Alumni Award, Gandhi Medical College Global Association, 2016

Becker's Healthcare Leadership Award, Becker's Hospital Review

Interventional Pain management Visionary Award, National Spine and Pain Centers-2015

Distinguished Service Award, Osmania, Gandhi and Kakatiya Medical Alumni Association of America, 2006

House of Representatives Presented in honor of Dr. Laxmaiah Manchikanti, MD, by Congressman Ed Whitfield, 109th Congress First Session, 2005–2006



Vijay Singh, MD, is a highly experienced medical professional who has been serving as the Medical Director of Wisconsin Michigan Physicians and the Niagara Health Center (ASC) in Niagara, Wisconsin, since 1989. His expertise lies in providing Interventional Pain Management services to the Upper Peninsula and Northern Wisconsin region.

Dr. Singh holds board certifications in anesthesiology and interventional pain management from the American Board of Anesthesiology (ABA). He is also certified by the American Board of Interventional Pain Physicians (ABIPP) and is recognized as a Fellow of Interventional Pain Practice (FIPP).

Throughout his career, Dr. Singh has made significant contributions to the field of interventional pain management. He has authored pioneering articles on percutaneous intradiscal therapeutic interventions and coauthored numerous scientific papers in peer-reviewed journals. Additionally, he has contributed chapters to textbooks aimed at educating fellow interventional pain specialists. Some notable publications include *Principles of Documentation, Billing, Coding, and Practice Management for the Interventional Pain Professional* (2004),

Interventional Pain Medicine Documentation, Coding and Billing: A Practical Guide for Physicians and ASCs (2002), and *Interventional Pain Management: Low Back Pain-Diagnosis and Treatment* (2002). Dr. Singh has also co-edited two books with Dr. Laxmaiah Manchikanti: *Interventional Techniques in Chronic Spinal Pain* (2007) and *Interventional Techniques in Chronic Non-Spinal Pain* (2009).

Recognized as an esteemed speaker and faculty member, Dr. Singh has participated in numerous national and international continuing education meetings. He has lectured at events such as EuroSpine 2002 in France, EuroSpine 2003 in the Czech Republic, World Spine II 2003 in Chicago, World Congress 2000 of Minimally Invasive Spinal Medicine and Surgery in Las Vegas, as well as annual and semi-annual ASIPP meetings and cadaver workshops.

Dr. Singh has been a Lifetime Director of the American Society of Interventional Pain Physicians (ASIPP) since its inception. He has held various leadership positions within the organization, including serving as president in 2006–2007. He has also served as the Executive Director and President of the Wisconsin chapter of ASIPP and currently sits on the Board of the American Board of Interventional Pain Physicians (ABIPP).

Driven by a commitment to advancing the field of Interventional Pain Management, Dr. Singh has dedicated his professional career to collaborating with ASIPP and contributing to its growth and development.



Alan D. Kaye, MD, PhD, is Interventional Pain Fellowship Director, Vice Chairman of Research, and Professor within the Department of Anesthesiology at LSU Health Shreveport and also serves as Professor within the Department of Pharmacology, Toxicology, and Neurosciences. He is the immediate former Provost, Chief Academic Officer, and Vice Chancellor of Academic Affairs at LSU Health Shreveport, serving the past 3 years completing his term on Jan 1, 2023. Dr. Kaye served for 15 years as Professor, Program Director, Director of Interventional Pain Medicine, and Chairman of the Department of Anesthesiology at LSU Health in New Orleans. Before coming to LSU Health Shreveport, he was Professor, Program Director, and Chairman for 6 years of the Texas Tech University Health Sciences Center Department of Anesthesiology in Lubbock, Texas. Prior, he was the Medical Director of the Greater New Orleans Surgical Center, the Director of Resident Recruitment, Program Director, and an Attending Staff of the Department of Anesthesiology at Tulane University Medical Center in New Orleans.

He was born in New York and raised in Los Angeles and Tucson. He is a first-generation American and both his parents are World War 2 survivors. Dr. Kaye was accepted to college at the age of 16 years and skipped the 12th grade with an academic full tuition college scholarship. Dr. Kaye received two BS degrees and a MD degree from the University of Arizona. He was a national finalist for a Rhodes Scholarship, Honors

Student of the Year, Who's Who, Phi Beta Kappa, and the Outstanding Graduating Senior in his class. He completed an internship in Internal Medicine at the Alton Ochsner Clinic and trained in Anesthesiology at Massachusetts General Hospital and Tulane University where he served as chief resident and president of the Louisiana State Residents Component of the American Society of Anesthesiology. He also completed a pain management fellowship at Texas Tech Health Sciences Center under Dr. Gabor Racz, Dr. Prithvi Raj, and Dr. Miles Day. He is Board Certified as a Consultant in Anesthesiology and has a special certificate in Pain Management for the American Board of Anesthesiology. He is also a Diplomate of the American Board of Pain Medicine and the American Board of Interventional Pain Physicians. He is on the Board of Directors for ASIPP and ABIPP.

Dr. Kaye completed his PhD in vascular pharmacology in May 1997. He has authored or coauthored over 1200 articles, numerous book chapters, and multiple books in the fields of pharmacology, pain medicine, and anesthesiology. He is editor-in-chief of the journals *Pain Physician* and *Current Pain and Headache Reports* and served for 8 years from 2012–2020 on the FDA Advisory Board on Anesthetics and Analgesics. He has been awarded the ASIPP Academic Award, the ASIPP Racz Award, and the ASIPP Lifetime Achievement Award for his accomplishments. He is also an inductee in 3 Hall of Fames: The Sahuaro High School Hall of Fame, the Texas Tech Dept of Anesthesia Hall of Fame, and the New Orleans Anesthesia Hall of Fame. He and his wife Dr. Kim Kaye, MD, have two children, Dr. Aaron Kaye, MD, an anesthesiologist, and Dr. Rachel Klapper, MD, a radiology resident at LSUHSC.



Amol Sooin, MD, is a full-time practicing interventional pain management physician in Dayton, OH, at the Ohio Pain Clinic. Raised in Dayton, Ohio, Dr. Sooin earned his medical degree at the University of Akron in Akron, Ohio. He completed a residency in anesthesiology at Rush University in Chicago and later finished his fellowship training in pain management at the Cleveland Clinic in Cleveland, Ohio. Throughout his training, Dr. Sooin remained actively involved in research studies and authored multiple papers and textbook chapters about pain management.

In addition to his clinical work, Dr. Sooin has been involved in medical research since medical school. He is the author of the book *Curing America: A Look Inside America's Failing Health Care System*, which focuses on the millions of Americans living without health insurance in a country that boasts the world's largest economy. Dr. Sooin promoted his book on affiliates of NBC and CBS and numerous radio stations, and his work earned him recognition with multiple awards.

Dr. Sooin brings his extensive knowledge and uses the latest techniques available in pain management to Ohio Pain Clinic for the benefit of his patients. He is known for his compassion-

ate approach and commitment to ethical patient care that focuses on holistic treatments to minimize the use of narcotics in pain management.

In addition to his MD degree, Dr. Soin holds an MBA from the University of Tennessee, a Master of Science from Brown University and from Dartmouth College. He holds multiple worldwide patents and founded multiple startups in the neuro-modulation/pain management space as well as in drug development. His startups have exited in deals with a transaction value of over \$1 Billion making Dr. Soin one of the most successful physician entrepreneurs in the field.

Over the years, Dr. Soin has held multiple positions driving medical innovation and education on a national scale. Some of those positions include:

- Physician representative to Medicare via the Clinical Advisory Committee for Ohio and Kentucky for pain management.
- President/CEO of the Ohio Society of Interventional Pain Physicians (OSIPP)
- President-Elect of TriState Pain Society
- President of the Society of Interventional Pain Management Surgery Centers
- President of the American Society of Interventional Pain Physicians
- Dr. Soin has been appointed to the State Medical Board of Ohio by Governor Kasich and Governor Dewine in 2012, 2017, and again in 2023 for 5 year terms. He was also appointed by the governor to the Ohio Medical Marijuana Commission.
- Dr. Soin is also the head of the Clinical Advisory Board of Neuronoff, Inc, Neuros Medical, and is the Chief Medical Officer of JanOne in addition to founding and running eight different biotech companies.



Joshua A. Hirsch, MD, is Director of Interventional Neuroradiology, Chief of the Interventional Spine Service, Vice Chair of Procedural Services, and Associate Departmental Quality Chair in the Department of Radiology at the Massachusetts General Hospital. He has extensive experience and research in diagnosis, management, and treatment of cerebrovascular disease such as intracranial aneurysms (both ruptured and unruptured), arterio-venous malformations, and large vessel occlusions leading to stroke. Dr. Hirsch was early among neurointerventionalists to appreciate the opportunity to improve patient lives through minimally invasive spine treatments.

His research includes many important projects related to vertebral augmentation including one of the largest series in the peer-reviewed literature for these minimally invasive treatment of both malignant and benign vertebral compression fractures. He has focused more recently on futuristic elements such as the treatment of new sites and new theories of treatment,

while at the same time being very active in defining standards for systematic reviews and meta-analyses in interventional pain management (IPM). To that end, he has published extensively including in the IPM space. Specifically, Dr. Hirsch has published over 600 papers in the peer reviewed literature, been an author of over 50 chapters, and edited multiple scientific textbooks over a broad range of topics. Beyond that, Dr. Hirsch has been featured or moderated numerous webinars, podcasts, and other non-traditional media.

Dr. Hirsch is a founding editor of the *Journal of NeuroInterventional Surgery* and is a past president of the American Society of Spine Radiology (ASSR), the Society of NeuroInterventional Surgery (SNIS), and the American Society of Neuroradiology (ASNR). He has been elected to the board of the American Society of Interventional Pain Physicians (ASIPP).

Dr. Hirsch is a senior affiliate research fellow of the Neiman Policy Institute. He was an advisor to the RVS Update Committee (RUC), chairs the health policy committee at the SNIS, and holds numerous other leadership positions in a variety of professional societies.

In addition to the Lifetime Achievement Award from ASIPP, Dr. Hirsch has received numerous awards including ones for transformational leadership at the ASSR, distinguished service at the ASNR, and academic achievement at ASIPP. He has been named an inaugural fellow of the SNIS for his many contributions to the field of Neurointerventional Surgery and is also a Fellow of the American College of Radiology and Society of Interventional Radiology.



Frank J. E. Falco, MD (Honorary), established Mid Atlantic Spine and Pain Physicians and held the positions of founder, Chief Executive Officer, and Medical Director. Additionally, he served as an Adjunct Associate Professor at Temple University Medical School and led the Pain Medicine Fellowship Program at Temple University Hospital. Dr. Falco notably initiated the first accredited pain management fellowship program within a private practice setting. He possessed certifications from the American Board of Interventional Pain Physicians (ABIPP), American Board of Pain Medicine (ABPM), American Board of Electrodiagnostic Medicine (ABEM), and American Board of Physical Medicine and Rehabilitation (ABPMR). He also held the title of Fellow of Interventional Pain Practice.

Furthermore, Dr. Falco held board certifications in pain medicine and sports medicine through ABPM and served as a former President of the American Society of Interventional Pain Physicians (ASIPP). He contributed to the editorial board of *Spine Universe* and held the position of President of the Delaware Society of Interventional Pain Physicians in the past.

Dr. Falco's extensive publications include numerous articles, book chapters, and textbooks such as *Foundations of Pain Medicine and Interventional Pain Management: A*

Comprehensive Review, Clinical Aspects of Pain Medicine and Interventional Pain Management: A Comprehensive Review, Pain Medicine and Interventional Pain Management Board Review Self-Assessment, Essentials of Practice Management: Billing, Coding, and Compliance in Interventional Pain Management, and Essentials of Interventional Techniques in Managing Chronic Spinal Pain.

Throughout his career, Dr. Falco received several accolades, including the esteemed Giants in Pain Management award from ASIPP. He is survived by his wife Regina, his son Andrew, and his daughter Isabella.

Part I

Basic Considerations



Evolution of Interventional Pain Management

1

Laxmaiah Manchikanti, Vijay Singh, and Joshua A. Hirsch

Introduction

Chronic pain is a complex and multidimensional problem. Chronic pain is defined as “pain that persists 6 months after an injury and beyond the usual course of an acute disease or a reasonable time for a comparable injury to heal that is associated with chronic pathologic processes that cause continuous or intermittent pain for months or years, that may continue in the presence or absence of demonstrable pathologies, and that may not be amenable to routine pain control methods; and healing may never occur” [1–3]. Other definitions include pain that persists beyond the usual course of an acute disease or a reasonable time for an injury to heal that is associated with chronic pathologic processes that cause continuous pain or pain at intervals for months or years [1–3].

Interventional pain management started with the origins of neural blockade and regional analgesia in 1884 [4]. Since then, regional anesthesia and interventional techniques have evolved by leaps and bounds. Today, the field is complicated by claims of overuse, abuse, and fraud [5, 6].

Due to the increase of utilization of interventional techniques, accountable interventional pain management, and value-based practice, the performance of evidence-based, cost-effective, and clinically effective techniques has been mandated [4–28].

History

The development of interventional techniques dates back to the 1884 invention of regional anesthesia by Koller (a colleague of Sigmund Freud) [4, 29]. Based on this foundation, regional analgesia developed into interventional pain management. Subsequently, in 1899, Tuffer [30] described therapeutic nerve blocks in pain management using spinal injections of cocaine to control pain from sarcoma of the leg. In 1903, Cushing described pain relief with nerve blocks [31] along with reports of trigeminal alcohol blockade [32]. During the same time, spinal interventional techniques also started developing, dating back to 1901, with descriptions of caudal epidural injections by three independent investigators in 1 year [33–35].

Around the same time, epidural injections with local anesthetic and various types of nerve blocks were developing. Epidural steroids were described by Robechhi and Capra [36] and Lievre [37] by transforaminal approach in 1952 and 1953. Steroids were reported by Cappio in 1957 [38]. The wide use of epidural steroid injections, since then by multiple approaches, has become very popular [2, 39].

Diagnostic blocks originated from the descriptions of von Gasa [40] in 1924 followed by White [41] conceptualizing the diagnostic utility of procaine block of sensory sympathetic nerves to determine the pathways of peripheral nerves. Subsequently, Steindler and Luck [42] in 1938 described applications for diagnostic interventional techniques. MacNab [43] in 1971 demonstrated the value of diagnostic, selective nerve root blocks in the preoperative evaluation of patients with negative or inconclusive imaging studies and clinical findings of nerve root irritation. The concept of controlled diagnostic blocks was developed by many authors; however, it was popularized by Bogduk et al. [44–47] and Manchikanti et al. [6, 48–54]. Bogduk et al. [44–47] described two philosophical approaches which described an acute pain model wherein local anesthetic relief was limited to the pharmacological duration of the local anesthetic,

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whereas Manchikanti et al. [6, 48–54] described a chronic pain model wherein the relief lasted much longer and beyond the expected pharmacological action of local anesthetics.

John Bonica nurtured interest in pain medicine and published a seminal work, *The Management of Pain*, in 1953 and started a multidisciplinary clinic in 1960 [55]. Vandam and Eckenhoff [56], in 1954, described the integrative approach.

- Vandam and Eckenhoff [56], a year after the publication of Bonica's text, *The Management of Pain* [55], suggested that the focus should not only be on pain relief from nerve blocks but also on the basic nature of pain and an integrated approach to treatment.

Subsequently, the twenty-first century has been marked by numerous developments of interest to interventional pain physicians and pain sufferers. The unprecedented development and progress in managing chronic pain, specifically utilizing interventional techniques, heralded the evolution of interventional pain management [1–28].

Definitions

- The National Uniform Claim Committee (NUCC) [57] defined interventional pain management as “the discipline of medicine devoted to the diagnosis and treatment of pain-related disorders principally with the application of interventional techniques in managing subacute, chronic, persistent, and intractable pain, independently or in conjunction with other modalities of treatments.”
- MedPAC [58] defined interventional techniques as “minimally invasive procedures including percutaneous precision needle placement, with placement of drugs in targeted areas or ablation of targeted nerves, and some surgical techniques for the diagnosis and management of chronic, persistent, or intractable pain such as laser or endoscopic discectomy, intrathecal infusion pumps, and spinal cord stimulators.”

Development

Organizations

- The first organization devoted to interventional pain management was started in 1998.
 - The American Society of Interventional Pain Physicians (ASIPP) was conceived in 1998 and has evolved into a premier organization representing more than 50% of interventional pain physicians in the United States.

- The first multidisciplinary organization, titled the International Association for the Study of Pain (IASP), was started by Bonica in 1974. It eventually took shape as a biopsychosocial organization.
 - The American Pain Society, the American Chapter of IASP, was established in 1977 and was dissolved in June 2019.
 - This was followed by the American Academy of Pain Medicine (AAPM), which was founded in 1983.

Specialty Designation

- Due to the efforts of ASIPP, a specialty code for interventional pain management was conceived in 2001. However, it was converted into pain management (–72) and, later on, pain medicine [59].
 - A specific code for interventional pain management (–09) was provided by the Centers for Medicare and Medicaid Services (CMS), along with a definition of interventional pain management in 2003 [60].
 - CMS has recognized interventional pain management as an evolving, but crucial specialty, leading to representation on the Carrier Advisory Committees (CACs) in each state in the United States [61].

Board Certification

- The American Board of Anesthesiology (ABA) provided its first subspecialty certification in pain medicine in 1993.
 - The American Board of Pain Medicine (ABPM) provided a board certification in 1993.
 - In 2005, the American Board of Interventional Pain Physicians (ABIPP) was established.
 - On the international front, the World Institute of Pain (WIP) established a fellow of interventional pain practice, testing the competency of physicians in performing interventional techniques.
 - A subspecialty in pain medicine is now provided by the American Board of Anesthesiology, the American Board of Physical Medicine and Rehabilitation (ABPMR), the American Board of Psychiatry and Neurology (ABPN), American Board of Family Medicine (ABFM), American Board of Radiology (ABR), and American Board of Emergency Medicine (ABEM). They are ABMS-recognized boards; others are in consideration.
- ABIPP, specifically established for interventional pain physicians to promote didactic and practical competency, provides a comprehensive examination system. Part I establishes a candidate's didactic knowledge, followed by

competency testing via oral examination and a practical examination that assesses competency of interventional techniques.

- The ABIPP also provides multiple competency examinations in controlled substance management, practice management, fluoroscopic safety, and regenerative medicine.

Costs and Utilization of Interventional Techniques

The use of interventional techniques for the treatment of spinal pain and musculoskeletal disorders increased until 2009, at which point utilization began to decrease [5–16]. Analysis of growth of utilization of interventional techniques in managing chronic pain in the Medicare population [11] showed an overall decline in utilization of interventional techniques from 2010 to 2019 of 4%, with an annual decline of 0.4% per 100,000 fee-for-service (FFS) recipients, despite an increase of 0.7% per year of population growth (4.3%) of those 65 years or older, and a 3.3% annual increase in Medicare participation from 2010 to 2019. These data of utilization patterns also showed significant decreases in utilization patterns from 2019 to 2020 due to COVID-19 pandemic with an overall decrease of 18.7% as shown in Fig. 1.1. Similar to all

interventional techniques, due to the pandemic, utilization of epidural interventions, including percutaneous adhesiolysis, decreased 19% from 2019 to 2020. Further, analysis of utilization patterns of epidural procedures [13] showed epidural procedures have declined at a rate of 20.7% per 100,000 Medicare enrollees from 2009 to 2018, with an annual decline of 2.5%. This analysis [13] also showed a decline in all categories, with an annual decrease of 4.9% for lumbar interlaminar and caudal epidural injections, 5.6% decline for cervical/thoracic transforaminal epidural injections, 1.8% decline for lumbar/sacral transforaminal injections, and a 0.9% decline for cervical/thoracic interlaminar epidural injections. Overall, declines were higher for lumbar interlaminar epidural injections with a decline of 4.1%, compared to a decline of lumbar/sacral transforaminal epidural injections of 1.4% (Fig. 1.2) from 2010 to 2019. From 2019 to 2020, epidural procedures declined 19% per 100,000 Medicare enrollees.

Manchikanti et al. [14], in an analysis of utilization of facet joint interventions, showed a significant impact of COVID-19 with an overall decline of 18.5% of all facet joint interventions per 100,000 Medicare population compared to 20.2% and 20.5% decreases for lumbar and cervical facet joint injections and 15% and 13.1% decreases per 100,000 Medicare population of lumbosacral and cervicthoracic facet joint neurolysis procedures. Consequently, these results

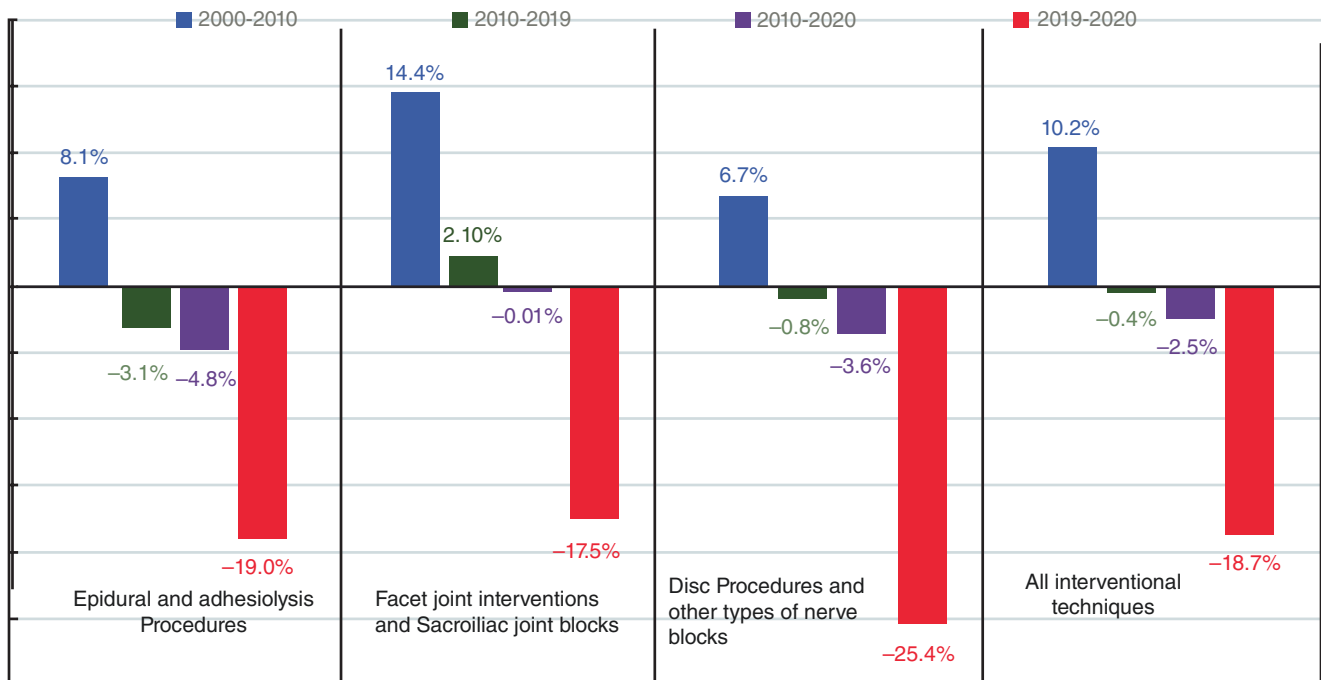


Fig. 1.1 Comparative analysis of rate (per 100,000 Medicare recipients) of usage patterns for epidural and adhesiolysis procedures, facet joint interventions and sacroiliac joint blocks, disc procedures, and other types of nerve blocks, all interventional techniques (geometric average annual change in rates). Source: Manchikanti L, Pampati V,

Sanapati MR, et al. COVID-19 pandemic reduced utilization of interventional techniques 18.7% in managing chronic pain in the Medicare population in 2020: Analysis of utilization data from 2000 to 2020. *Pain Physician* 2022; 25:223–238 [11]