

Pediatric interventional radiology workforce survey: 10-year follow-up

Claire S. Kaufman¹ · Charles A. James² · Roger K. Harned³ · Bairbre L. Connolly⁴ · Derek J. Roebuck⁵ · Anne M. Cahill⁶ · Josee Dubois⁷ · Frank P. Morello⁸ · Robin K. Morgan⁹ · Manrita K. Sidhu¹⁰

Received: 7 July 2016 / Revised: 2 October 2016 / Accepted: 2 February 2017 / Published online: 6 March 2017
© Springer-Verlag Berlin Heidelberg 2017

Abstract

Background Pediatric interventional radiology is a distinct subspecialty differing from both pediatric diagnostic radiology and adult interventional radiology. We conducted a workforce survey in 2005 to evaluate the state of pediatric interventional radiology at that time. Since then there have been many advancements to the subspecialty, including the founding of the Society for Pediatric Interventional Radiology (SPIR).

Objective To evaluate the current state of the pediatric interventional radiology workforce and compare findings with those of the initial 2005 workforce survey.

Materials and methods We sent a two-part survey electronically to members of SPIR, the Society for Pediatric Radiology

(SPR), the Society of Chairmen of Radiology in Children's Hospitals (SCORCH) and the Society of Interventional Radiology (SIR). Part 1 focused on individual practitioners ($n=177$), while part 2 focused on group practices and was answered by a leader from each group ($n=88$). We examined descriptive statistics and, when possible, compared the results to the study from 2005.

Results A total of 177 individuals replied (a 331% increase over the first study) and 88 pediatric interventional radiology (IR) service sites responded (a 131.6% increase). Pediatric IR has become a more clinically oriented specialty, with a statistically significant increase in services with admitting privileges, clinics and performance of daily rounds. Pediatric IR remains diverse in training and practice. Many challenges still

Electronic supplementary material The online version of this article (doi:10.1007/s00247-017-3796-y) contains supplementary material, which is available to authorized users.

✉ Claire S. Kaufman
Claire.Kaufman@gmail.com

¹ Department of Radiology,
University of California San Diego,
200 W. Arbor Drive, San Diego,
CA 92103, USA

² Department of Radiology,
Arkansas Children's Hospital,
University of Arkansas for Medical Sciences,
Little Rock, AR, USA

³ Department of Radiology,
Children's Hospital Colorado,
Aurora, CO, USA

⁴ Image Guided Therapy, Diagnostic Imaging,
The Hospital for Sick Children,
Toronto, ON, Canada

⁵ Great Ormond Street Hospital for Children,
London, UK

⁶ Division of Interventional Radiology,
Children's Hospital of Pennsylvania,
Philadelphia, PA, USA

⁷ Department of Radiology,
CU Sainte-Justine,
University of Montreal,
Montreal, QC, Canada

⁸ Department of Medical Imaging,
College of Medicine,
The University of Arizona,
Tucson, AZ, USA

⁹ Department of Radiology,
Phoenix Children's Hospital,
Phoenix, AZ, USA

¹⁰ Seattle Radiologists and Foundry10,
Seattle, WA, USA

exist, including anesthesia/hospital support, and the unknown impact of the new IR residency on pediatric IR training, although the workforce shortage has been somewhat alleviated, as demonstrated by the decreased mean call from 165 days/year to 67.2 days/year.

Conclusion Pediatric interventional radiology practitioners and services have grown significantly since 2005, although the profile of this small subspecialty has changed and some challenges remain.

Keywords Interventional radiology · Pediatrics · Survey · Workforce

Introduction

Pediatric interventional radiology (IR) is a distinct subspecialty that fuses both pediatric diagnostic radiology and adult interventional radiology. The first publications of angiography in children date to the 1950s [1–3]. Since that time the field has continued to dramatically grow and evolve. In 2005 the Vascular Interventional Radiology Committee of the Society for Pediatric Radiology (SPR) conducted a workforce survey to evaluate the state of pediatric interventional radiology at that time. This yielded responses from 41 centers, 3 of which did not have a pediatric IR service [4].

Since this time there has been much advancement in the field of pediatric interventional radiology. In 2007 the Society for Pediatric Interventional Radiology (SPIR) was founded, and it has continued to grow. SPIR has 216 active members and 25 members-in-training from 18 countries. Dedicated pediatric IR meetings began on a biennial basis in 2004 at the Hospital for Sick Children in Toronto, and with the addition of biennial meetings of SPIR in 2009, annual meetings dedicated to pediatric IR content are now ongoing. In addition to the dedicated society (SPIR), pediatric interventional radiology is now recognized as a subcommittee within both the Society of Interventional Radiology (SIR) and the SPR.

There is no standardized training pathway for pediatric interventional radiologists. In North America there are no Accreditation Council for Graduate Medical Education (ACGME) accredited fellowships dedicated to pediatric interventional radiology. A radiologist can complete either a pediatric radiology or adult interventional radiology (IR) fellowship, followed by a second dedicated pediatric IR fellowship. Additionally, some practitioners are pediatric radiologists or adult interventionalists who have received on-the-job training. There is controversy as to the best method of training [5]. Currently only 11 dedicated pediatric IR fellowships are listed on the SPR website [6], although the authors are aware of several others within and outside the United States that are not listed.

Pediatric interventional radiology is practiced differently across the world. The community of physicians performing minimally invasive image-guided procedures in children is diverse, and only a small percentage practice 100% pediatric IR [5]. Pediatric interventionalists face specific challenges different from those of their pediatric radiology and adult IR colleagues. Compared to the typical pediatric radiologist, pediatric interventionalists may face longer workdays, challenging patient care responsibilities, and more call shifts. Compared to a typical adult IR physician, pediatric interventionalists have distinct challenges including the need for greater non-operator-provided sedation/anesthesia for the pediatric patient and different congenital anomalies, pathologies and patient–parent dynamics. The goal of our study was to evaluate the current state of pediatric interventional radiology and identify changes over the 10 years since the initial 2005 pediatric IR workforce survey.

Materials and methods

A two-part [Supplementary Material](#) was sent to members of the SPIR, SPR, SIR and SCORCH. The [Supplementary Material](#) was open for 19 weeks, from Jan. 15, 2015, to May 28, 2015. All survey respondents completed the first portion of the survey. This included topics such as training, call, service coverage, compensation, certification, job satisfaction, and the future of the specialty. Just one respondent per practice filled out the second portion; this was usually the designated IR group leader. The second section included topics based around practice infrastructure, hiring, facilities, case volumes from the prior year (2014, fiscal or calendar year), challenges and practice trends.

Whenever possible, we compared the results to the 2005 pediatric IR workforce survey using a chi-squared test to determine statistical significance. We evaluated means, trends and standard deviations.

Results

There were 177 individual practitioner respondents — 91 from SPIR, SPR, and SCORCH, and 86 from SIR. This is a 331.7% increase in survey response from 2005 ($n=41$). Eighty-eight service sites completed the second portion of the survey — 50 from SPIR, SPR and SCORCH, and 38 from SIR. This resulted in a 131.6% increase from 2005 ($n=38$).

Demographics

Twelve individuals who were the designated one for their practice did not answer the demographic question. Most responding pediatric interventional practices were in the United States ($n=56$), followed by Canada ($n=5$), Australia

Table 1 Types of practices represented in the 2005 and subsequent 2015 pediatric interventional radiology workforce surveys

Practice type	2005 (n=38)	2015 (n=88)
Academic	60% (n=23)	52% (n=46)
Private practice	29%(n=11)	26% (n=23)
Combined practices	11% (n=4)	5% (n=4)
Public or government institution		17% (n=15)

(n=4), and the United Kingdom (n=2). One site each responded from China, France, Argentina, Brazil, Egypt, Hungary, Ireland, Italy and New Zealand. Less than a quarter (n=19), were a children’s hospital or a pediatric ward within an adult hospital. Free-standing pediatric hospitals made up 41% of the sites represented (n=36), a 20% increase from 2005 (n=30). Fifteen practice sites (17%) were primarily adult hospitals with some pediatrics. The types of practices that responded were again mixed with a larger percentage of non-academic practices when compared to 2005 (Table 1).

The majority of respondents (97%) in both workforce surveys completed a radiology residency. Fellowship training was varied, with no standardized pathway. The percentage of practitioners who completed a pediatric IR fellowship decreased from 46% to 24%, while those trained in adult IR increased from 41% to 63% (Fig. 1).

The number and variety of pediatric cases per year varied greatly among practices in 2014. In 2014 the mean number of pediatric cases performed was 899, with a standard deviation of 1,299. The types of cases performed ranged from low-

complexity procedures such as vascular access or biopsy/drainage, to more complex treatment of vascular anomalies and loco-regional tumor therapy (Fig. 2).

Clinical practice

There was a statistically significantly increase (P<0.0001) in pediatric IR clinics, from only 34% (n=13) of practices having a pediatric IR clinic in 2005 to 73% (n=64) in 2015. There was also a statistically significant increase in the number of practices performing daily rounds (P<0.0001), with 34% (n=13) in 2005 and 93% (n=82) in 2015. The percentage of interventional radiologist practices that admit patients to an IR service significantly increased from 30% in 2005 to 68% in 2015 (P=0.0002).

There was a trend toward more dedicated anesthesia coverage. In 2005 only 45% (n=17) of sites primarily used anesthesia-run sedation service versus 75% (n=66) in 2015 (P=0.002) (Fig. 3). Additionally, there was a trend toward more practices using pediatric intensivists to assist with sedation in 2015 (p=0.09).

In 2005 the mean call for a pediatric interventionalists was 165 days, approximately 45% of the year, with a standard deviation of 102 days. In 2015 the mean call time for pediatric interventionalists decreased to 67.2 days per year, with a standard deviation of 57.8 days. In both workforce surveys several interventionalists took both adult and pediatric interventional call or diagnostic and interventional call at the same time, with varied compensation for the extra call.

Fig. 1 Percentage of respondents who completed each type of training in 2005 compared with 2015

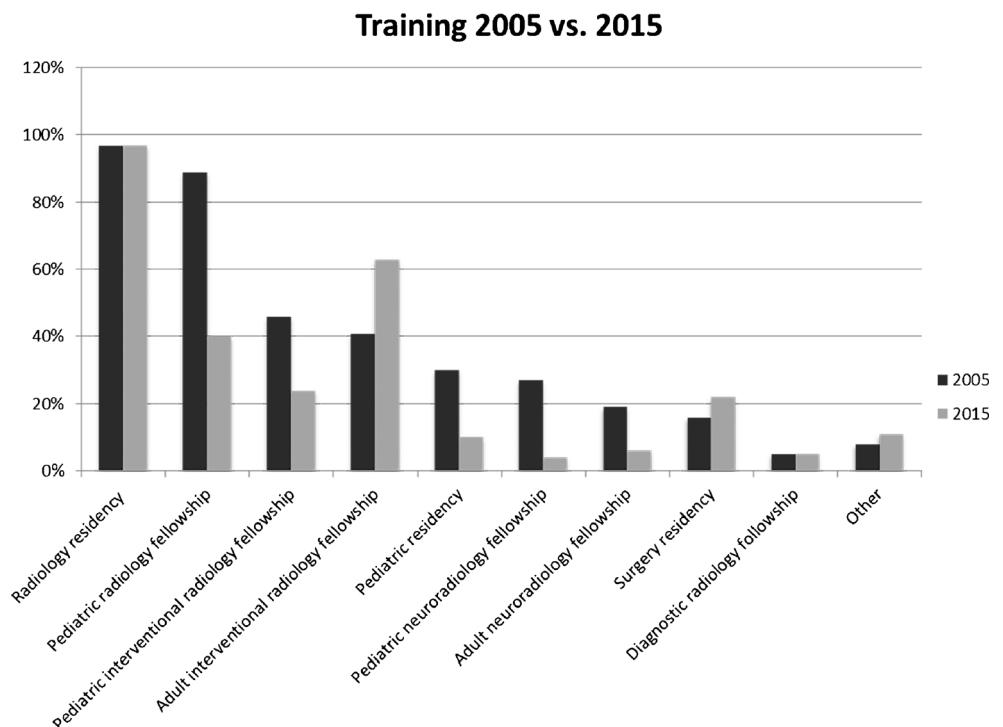
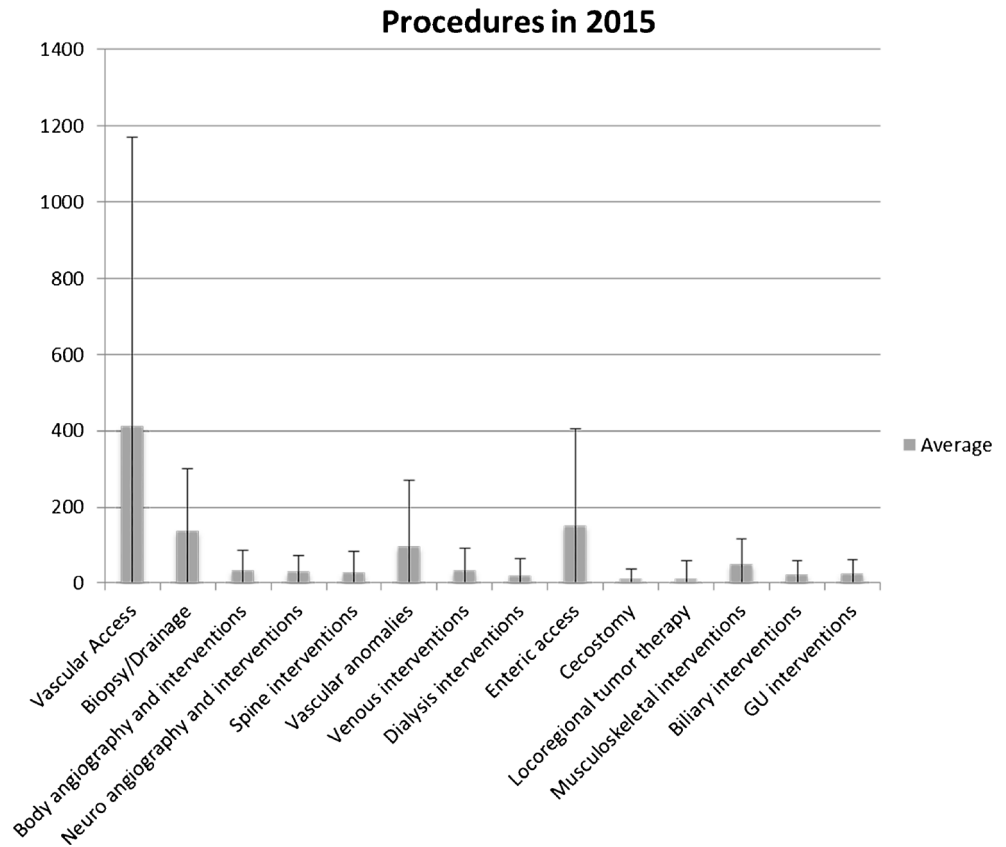


Fig. 2 Reported mean number and standard deviation of the types of pediatric procedures from the 2015 workforce survey. *GU* genitourinary

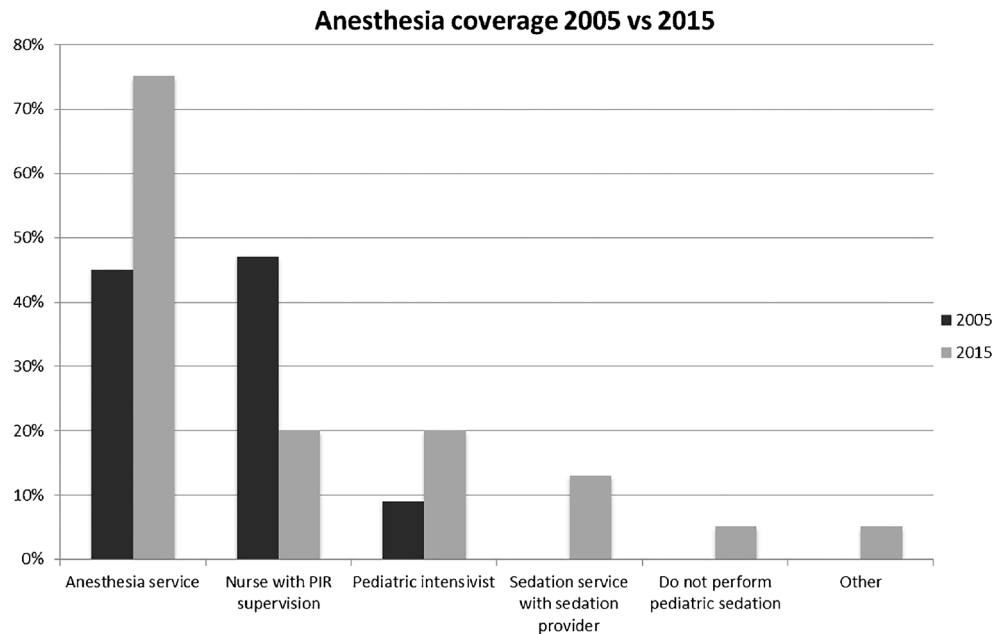


Interventional radiology residency

Among individual respondents, 148 practitioners from the U.S. responded to questions regarding the new IR residency. There was no consensus on the effect of the new IR residency: overall 35% thought it would be beneficial, 28% thought it

would not be beneficial, and 37% were unsure. Additionally, the respondents were split when asked specifically about the effects of the new residency: 41 thought there would be increased training opportunities, while 37 thought there would be decreased opportunities; 46 thought there would be increased awareness while 33 thought there would be decreased

Fig. 3 Trends in anesthesia coverage when comparing the 2005 and 2015 workforce surveys. *PIR* pediatric interventional radiologist



awareness; 28 thought the new IR residency would lead to increased interest in training in pediatric IR, while 32 thought it would lead to decreased interest.

Challenges

In 2015, 68% of practices were satisfied with their ability to provide quality pediatric interventional radiology. In this sense, the perceived challenges to the pediatric IR service have greatly changed during the last 10 years. In 2005 the largest concern was a lack of appropriately trained pediatric IRs and physician burnout, while more recently the concerns related to lack of dedicated sedation and room space, and disparate skill sets (Fig. 4).

Discussion

There have been many changes and advancements in the field of pediatric interventional radiology over the last 10 years. In 2005, 38 sites reported having pediatric interventional radiology as compared to 88 in 2015 [4]. Since the initial survey, the Society for Pediatric Interventional Radiology has been founded and there has been increased recognition and support of the subspecialty from SIR and SPR. However the practice of pediatric IR remains varied among clinical practices and countries.

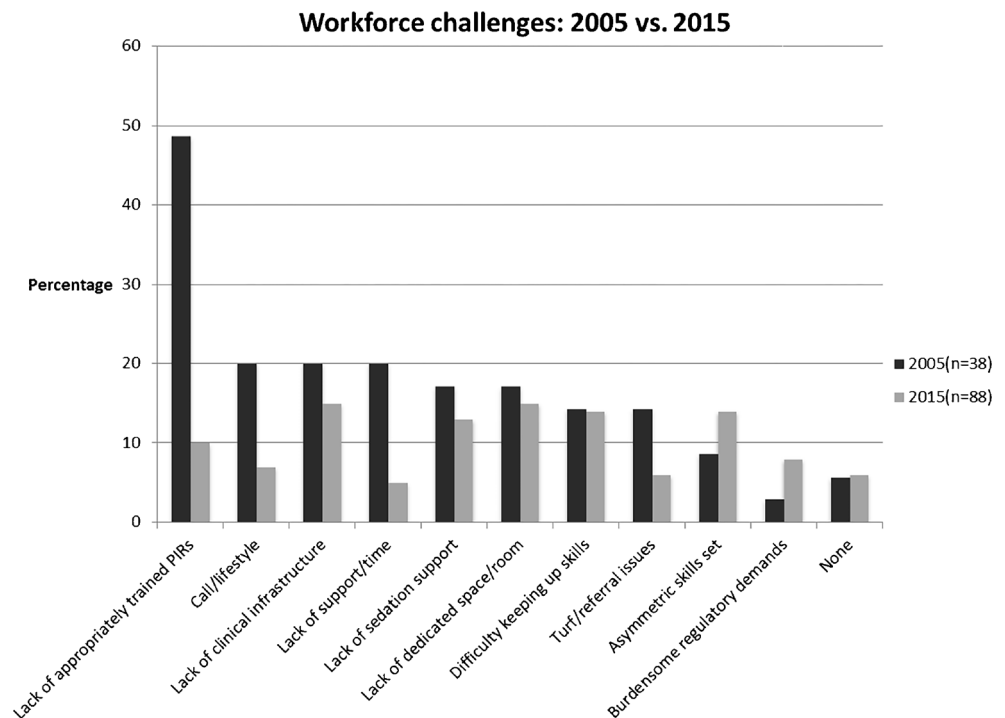
Radiology remains the home of pediatric IR, with 97% of respondents completing a radiology residency. Only small percentages of pediatric interventionalists enter through a pediatric or surgery residency. Fellowship training remains

greatly varied, with pediatric IR practitioners trained through a diagnostic pediatric radiology fellowship and/or adult interventional fellowship, plus a possible second fellowship dedicated to pediatric IR [6]. While there are several recognized fellowships in North America, none is accredited by the ACGME. Standardization of training remains challenging because of the relatively low volume of complex procedures, which are generally concentrated in major centers [3, 5]. Our current workforce study showed a decrease in the percentage of trainees completing a dedicated pediatric interventional radiology fellowship when compared with 2005. However we believe this is likely a result of the different study population and inclusion of adult interventionalists who do pediatric procedures, not an indication that there are actually fewer practitioners completing dedicated pediatric IR fellowships.

In the 2015 workforce survey we included members of SIR who perform pediatric procedures in order to try to get a more global view of the current state of pediatric interventionalists. These individuals made up 86 of the 177 total responses (48.5%). Many members of this society are primarily adult IR trained and adult IR clinicians who do pediatric IR cases on occasion. This difference in survey population also helps to explain the greatly varied pediatric case volume and breadth among the respondents.

Recently in the practice of interventional radiology there has been a great focus on moving toward more ownership of one’s patients and a strong clinical practice, and away from the traditional pure technical consult service. This trend may have originally been promoted as a way to fight turf battles, but it has been recognized to have greatly benefited patient care

Fig. 4 Perceived challenges to the pediatric interventional radiology service from the 2005 workforce compared the 2015 workforce. *PIR* pediatric interventional radiologist



[7–9]. Our survey showed this same trend to be occurring in the pediatric IR workforce, with a significant increase in the percentage of sites holding a pediatric IR clinic, performing daily rounds and admitting their own patients.

Sedation for procedures in pediatric patients can be very challenging. Many pediatric procedures require a sedation plan, with potential options including anesthesia service, IR service (IR nurse sedation with pediatric IR supervision), referring service sedation (intensivist) or a sedation service. Frequently sedation is used for pediatric patients not only for the patient's comfort but also for control of unwanted behaviors that could prolong the procedure or even put a child at risk of undue harm [10]. Pediatric sedation can be very challenging because it requires close monitoring, weight-based dosing, and possibly different medications [11, 12]. Per Joint Commission on Accreditation of Healthcare Organizations (JCAHO) guidelines, "Individuals administering moderate or deep sedation and anesthesia are qualified and have the appropriate credentials to manage patients at whatever level of sedation or anesthesia is achieved, either intentionally or unintentionally" [13]. These issues are clearly reflected in the trend over the last 10 years of more anesthesia-service-run pediatric sedation for pediatric IR procedures.

In 2012 the American Board of Medical Specialties (ABMS) approved IR as a primary specialty in medicine. In 2016 the first class of interventional radiology residents matched to matriculate in 2017. The traditional 1-year adult IR fellowships will end in 2020. The new curriculum incorporates more interventional radiology throughout the training as well as 2 focused years and other clinical rotations such as an intensive care unit rotation [14–16]. The pediatric IR community is clearly divided and unsure as to the effect this will have on the specialty. Only time will tell the true effect this change in training will have on pediatric interventional radiology.

Pediatric IR has a distinct set of challenges when compared to diagnostic pediatric radiology and adult IR. Challenges include the small size of the subspecialty, the pediatric patient population and family dynamics, non-standardization of training, disparate skill sets, and support issues including anesthesia time, procedure room space, and clinical infrastructure [4, 5]. The perceived greatest challenge to the specialty has changed over the last 10 years, reflecting changes in the specialty. In 2005 the largest concern was a lack of pediatric IR workforce, which was clearly demonstrated with the mean call for a pediatric IR being approximately 45% of the year, or 165 days [4]. Currently the greatest challenges relate to lack of adequate sedation support and room space, and differing operator skill sets.

Conclusion

Pediatric interventional radiology practitioners and services have grown significantly since 2005. The specialty has

become more clinically focused over the last 10 years, with an increase in admitting services, clinics and rounding. Despite advances in the field, many challenges remain including anesthesia and hospital support and the uncertain impact of the new interventional radiology residency on pediatric interventional radiology training.

Compliance with ethical standards

Conflicts of interest None

References

1. Faure C, Lefebvre J, Lepintre J et al (1956) Resultants de l'angiographie cerebrale et cours des hemiplegia cerebrales infantiles [Results of cerebral angiography in cerebral hemiplegia in children]. *Acta Radiol* 46:456–465
2. Snyder CH, Bost RB, Platou RV (1955) Hypertension in infancy, with anomalous renal artery; diagnosis by renal arteriography, apparent cure after nephrectomy. *Pediatrics* 15:88–92
3. Roebuck D (2009) Paediatric interventional radiology. *Pediatr Radiol* 39:491–495
4. Sidhu MK, James CA, Hamed RK 2nd et al (2007) Pediatric interventional radiology workforce survey summary. *Pediatr Radiol* 37:113–115
5. Lord DJ (2011) The practice of pediatric interventional radiology. *Tech Vasc Interv Radiol* 14:2–7
6. (2016) Pediatric interventional radiology training opportunities. Society for Pediatric Radiology web site. <http://www.pedrad.org/Education/Training-Opportunities/Pediatric-Interventional-Training-Opportunities>. Accessed 20 May 2016
7. Kwan SW, Valji K (2012) Interventional radiologists' involvement in evaluation and management services and association with practice characteristics. *J Vasc Interv Radiol* 23:887–892
8. Siskin GP, Bagla S, Sansivero GE et al (2005) The interventional radiology clinic: what you need to know. *Semin Interv Radiol* 22:39–44
9. Soares GM (2011) The value of clinical interventional radiology. *J Am Coll Radiol* 8:318–324
10. American Academy of Pediatrics, American Academy of Pediatric Dentistry, Coté CJ et al (2006) Guidelines for monitoring and management of pediatric patients during and after sedation for diagnostic and therapeutic procedures: an update. *Pediatrics* 118:2587–2602
11. Mason KP (2008) The pediatric sedation service: who is appropriate to sedate, which medications should I use, who should prescribe the drugs, how do I bill? *Pediatr Radiol* 38:S218–S224
12. Norman J (2001) Practical pediatric interventional radiology. *Curr Probl Diagn Radiol* 30:61–86
13. Joint Commission for Accreditation of Hospitals (2007) Operative or other high-risk procedures and/or the administration of moderate or deep sedation or anesthesia. The comprehensive accreditation manual for hospitals: official handbook. Joint Commission on Accreditation of Healthcare Organizations, Oakbrook Terrace, IL.
14. Di Marco L, Anderson MB (2016) The new interventional radiology/diagnostic radiology dual certificate: 'higher standards, better education'. *Insights Imaging* 7:163–165
15. Kaufman JA (2014) The interventional radiology/diagnostic radiology certificate and interventional radiology residency. *Radiology* 273:318–321
16. Marx MV, Sabri SS (2015) Interventional radiology residency: steps to implementation. *J Am Coll Radiol* 12:854–859