SPR 2013 Nuclear Medicine Session
Therapeutic Procedures in Pediatric Nuclear Medicine: Why, When, How
May 18, 2013
SAM Questionnaire

Updates from the Pediatric Nuclear Medicine Dose Reduction Working Group

S. Ted Treves, MD

1. What activities should be considered towards dose reduction in Pediatric Nuclear Medicine?

A. Education
B. Appropriateness of Indications
C. Optimization of acquisition and display protocols
D. Application of Advanced Image Processing
E. All of the above

Correct Answer: E

Reference

1. http://www.pedrad.org/associations/5364/files/ImGen11_Nu_Med_Poster.pdf

Multimodality Imaging of Neuroblastoma

Susan E. Sharp, MD

2. Which statement regarding the International Neuroblastoma Risk Group Staging System (INRGSS) is false?

A. Allows pre-surgical staging of localized tumors.
B. Requires CT and/or MRI of the primary tumor as part of the staging evaluation.
C. Requires I-123-MIBG as part of the staging evaluation.
D. Requires F-18-FDG PET as part of the staging evaluation.
E. None of the above.

Correct Answer: D

Reference

1. Monclair et al. *J Clin Oncol.* 2009;27(2): 298-303.

Curie Scoring - Prognostic Implications: How to do It
Marguerite T. Parisi, MD, MS Ed

3. At which of the following time points is the Curie score most predictive of patient survival in children with high risk neuroblastoma?

A) At diagnosis
B) At end of induction therapy
C) Following bone marrow transplant
D) After biotherapy

Correct Answer: B

Reference

1. Gregory A. Yanik, Marguerite T. Parisi, Barry L. Shulkin, et. Al. Semiquantitative mIBG Scoring as a Prognostic Indicator in Patients with Stage 4 Neuroblastoma: A Report from the Children's Oncology Group *J Nucl Med 2013 54:541-548 (10.2967/jnumed.112.112334).*

Advances in Neuroblastoma Therapy: The role of I-131 MIBG
Meaghan P. Granger, MD

4. The risk of thyroid hypofunction following I131-MIBG is minimized by which the following interventions?

A. Thyroid protection with lead shielding
B. Low dose potassium iodide (KI) administration prior to therapy
C. High dose potassium iodide (KI) administration prior to therapy and prolonged low dose following therapy
D. Potassium perchlorate ($KClO_4$) following therapy

Correct Answer: C

References

1. Quach A, Ji L, Mishra V, et al. Thyroid and hepatic function after high-dose 131 I-metaiodobenzylguanidine (131 I-MIBG) therapy for neuroblastoma. Pediatric blood & cancer 2011;56:191-201. 14. Picco P, Garaventa A, Claudiani F, Garibaldi L, Borrone C.
2. Primary hypothyroidism and 131I-MIBG therapy in neuroblastoma. Lancet 1993;342:57. 15. van Santen HM, de Kraker J, van Eck BL, de Vijlder JJ, Vulsma T.
3. High incidence of thyroid dysfunction despite prophylaxis with potassium iodide during (131)I-meta-iodobenzylguanidine treatment in children with neuroblastoma. Cancer 2002;94:2081-9.

5. Which of the following is the mechanism by which I131-MIBG is taken up into neuroblastoma cells?

A. GD2 receptor
B. IL-2 receptor
C. Retinoic Acid receptor
D. Norepinephrine transporter

Correct Answer: D

References

1. Glowniak JV, Kilty JE, Amara SG, et al. Evaluation of metaiodobenzylguanidine uptake by the norephinrine, dopamine, and serotonin transporters. J Nucl Med 1993; 34: 1140-1146.

Developing an Institutional I-131 MIBG Therapy Program: Key Issues
Frederic Fahey, PhD

6. Which of the following characteristics would NOT be considered an asset when selecting a hospital room for a pediatric patient receiving I-131 MIBG therapy?

A. Dedicated bathroom with sink
B. Adjacent to other patient rooms
C. Corner or isolated location
D. Nearby area for family and caregivers
E. Access to oncologic nurses, child life professionals and other support staff

Correct Answer: B

Reference

1. Shusterman S, Grant FD, Lorenzen W, Davis RT, Laffin S, Drubach LA, Fahey FH, Treves ST. 131I-MIBG therapy of children with neuroblastoma: Program planning and initial experience. Semin Nucl Med. 2011;41:354-363.

Reducing Dose to Nuclear Medicine Personnel During I-131 MIBG Therapy
Michael J. Gelfand, MD

7. When very large therapeutic dosages are being administered to patients, key factors in reduction of radiation dose absorbed by nuclear medicine technologists are:

A. Use of shielding appropriate for the radionuclide and the task.
B. Analysis of the individual tasks by careful estimation of time and distance from the radioactive source for each individual task.
C. Measurement of absorbed radiation dose received during each task.
D. A and B
E. A and C.

Correct Answer: E

Reference

1. Turpin BK, Morris VR, Lemen L, Weiss BD, Gelfand MJ. Minimizing nuclear medicine technologist radiation exposure during 131I-MIBG therapy. Health Phys. 2013;104(2 Suppl 1):S43-6.

Radiolabeled Somatostatin Analogues for Treatment of Neuroendocrine Tumors

Yusuf Menda, MD

8. The dose limiting toxicity with peptide receptor radionuclide therapy with Yttrium-90 DOTATOC is:

A. renal toxicity
B. hepatotoxicity
C. salivary gland toxicity
D. bone marrow toxicity

Correct Answer: A

9. The target for In-111 Octreotide is:

A. somatostatin receptor subtype 2
B. glucose transporter 2
C. melanocortin receptor subtype 2
D. NaI symporter

Correct Answer: A

Reference

1. Menda Y, O'Dorisio MS, Kao S, Khanna G, Michael S, Connolly M, Babich J, O'Dorisio T, Bushnell D, Madsen M. Phase I trial of 90Y-DOTATOC therapy in children and young adults with refractory solid tumors that express somatostatin receptors. J of Nuc Med. 2010 Oct;51(10):1524-31. doi: 10.2967/jnumed.110.075226. Epub 2010

Imaging in Pediatric Thyroid diseases

Deepa R. Biyyam, MBBS

10. Which of the following sonographic features of a thyroid nodule is concerning for malignancy?

A. Peripheral egg shell calcification
B. Comet tail artifact
C. Microcalcifications
D. Smooth hypoechoic halo surrounding the nodule

Correct Answer: C

Reference

1. Diane S. Babcock. Thyroid disease in the pediatric patient: emphasizing imaging with sonography. *Pediatr Radiol* (2006) 36: 299–308

11. Which of the following imaging modalities is most sensitive to detect ectopic thyroid tissue when evaluating for congenital hypothyroidism?

A. US
B. NM Scintigraphy
C. CT
D. MRI

Correct Answer: B

References

1. Supakul et al. Ultrasound for Primary Imaging of Congenital Hypothyroidism. *AJR*: 199, September 2012.
2. Chang et al. Congenital Hypothyroidism: Analysis of Discordant US and Scintigraphic Findings. ***Radiology:*** Volume 258: Number 3—March 2011.

Fine Needle Biopsy in Children with Thyroid Nodules

Ganesh Krishnamurthy, MD

12. Following ultrasound features of a thyroid nodule are highly suggestive of PTC malignancy <u>EXCEPT:</u>

A. Presence of micro calcifications
B. Irregular infiltrative margins
C. Solid nodule appearing hypoechoic compared to normal thyroid parenchyma
D. Increased nodular vascularity
E. Spongiform appearance

Correct Answer: E

References

1. Leenhardt L, Hejblum G, Franc B, Fediaevsky LD, Delbot T, Le Guillouzic D, Me´ne´gaux F, Guillausseau C, Hoang C, Turpin G, Aurengo A. 1999 Indications and limits of ultrasound-guided cytology in the management of nonpalpable thyroid nodules. J Clin Endocrinol Metab 199;84:24–28.
2. Papini E, Guglielmi R, Bianchini A, Crescenzi A, Taccogna S, Nardi F, Panunzi C, Rinaldi R, Toscano V, Pacella CM. Risk of malignancy in nonpalpable thyroid nodules: predictive value of ultrasound and color-Doppler features. J Clin Endocrinol Metab 2002;87:1941–1946.
3. Nam-Goong IS, Kim HY, Gong G, Lee HK, Hong SJ, Kim WB, Shong YK. Ultrasonography-guided fine-needle aspiration of thyroid incidentaloma: correlation with pathological findings. Clin Endocrinol (Oxf) 2004;60:21–28.

4. Cappelli C, Castellano M, Pirola I, Cumetti D, Agosti B, Gandossi E, Agabiti Rosei E. The predictive value of ultrasound findings in the management of thyroid nodules. QJM 2007;100:29–35.
5. Frates MC, Benson CB, Doubilet PM, Kunreuther E, Contreras M, Cibas ES, Orcutt J, Moore FD Jr, Larsen PR, Marqusee E, Alexander EK. Prevalence and distribution of carcinoma in patients with solitary and multiple thyroid nodules on sonography. J Clin Endocrinol Metab 2006;91:3411–3417.
6. Bonavita JA, Mayo J, Babb J, Bennett G, Oweity T, Macari M, Yee J. Pattern recognition of benign nodules at ultrasound of the thyroid: which nodules can be left alone? AJR Am J Roentgenol 2009;193:207–213.

13. Indications for routine FNA (fine needle aspiration) for a sub centimeter nodule include all of the following <u>EXCEPT:</u>

A. Family history of PTC
B. History of external beam radiation in childhood
C. Well defined nodule, but hypoechoic as compared to adjacent normal thyroid parenchyma
D. PET positive nodule
E. 5 mm nodule associated with abnormal adjacent lymph node
F. Small nodule associated with micro calcifications

Correct Answer: C

References

1. Wada N, Duh QY, Sugino K, Iwasaki H, Kameyama K, Mimura T, Ito K, Takami H, Takanashi Y. Lymph node metastasis from 259 papillary thyroid microcarcinomas: frequency, pattern of occurrence and recurrence, and optimal strategy for neck dissection. Ann Surg 2003;237:399–407.
2. Ito Y, Tomoda C, Uruno T, Takamura Y, Miya A, Kobayashi K, Matsuzuka F, Kuma K, Miyauchi A. Preoperative ultrasonographic examination for lymph node metastasis: usefulness when designing lymph node dissection for papillary microcarcinoma of the thyroid. World J Surg 2004;28:498–501.
3. Hemminki K, Eng C, Chen B. Familial risks for nonmedullarythyroid cancer. J Clin Endocrinol Metab 2005;90:5747–5753.
4. Schneider AB, Ron E, Lubin J, Stovall M, Gierlowski TC. Dose-response relationships for radiation-induced thyroid cancer and thyroid nodules: evidence for the prolonged effects of radiation on the thyroid. J Clin Endocrinol Metab 1993;77:362–369.
5. Shibata Y, Yamashita S, Masyakin VB, Panasyuk GD, Nagataki S. 15 years after Chernobyl: new evidence of thyroid cancer. Lancet 2001;358:1965–1966.

I-131 Radiotherapy of Pediatric Thyroid Cancer

Steven G. Waguespack, MD

14. A 7-year-old, 25 kg girl is diagnosed with a follicular variant PTC, mT3N1bMx, and is status post total thyroidectomy and a comprehensive compartment-focused neck dissection by an experienced thyroid surgeon who performs over 100 thyroid cancer surgeries a year. A CXR at diagnosis was negative for pulmonary metastases and the lung fields on a pre-operative contrast-enhanced CT neck did not reveal pulmonary metastases in the upper lung fields. After a documented normal 24-hour urine iodine level, she is now ready for further evaluation and possible treatment with ^{131}I. Recognizing that the treatment of pediatric PTC is evolving, which of the following statements is correct?

A. A diagnostic scan using ^{123}I is unlikely to add any additional diagnostic information; based upon her pathological findings and high risk of pulmonary metastases, the patient should receive an empiric dose of 150 mCi ^{131}I and have a post-treatment scan performed 7 days after treatment
B. Dosimetry should be planned and the patient administered the highest ^{131}I dose that will limit her blood/bone marrow radiation dose to <200cGy
C. If pulmonary metastases are identified, due to her increased risk of death from PTC, a second high dose of ^{131}I should be planned for 6 months after the first dose
D. Treatment using rhTSH (instead of thyroid hormone withdrawal) is preferred because large randomized clinical trials have demonstrated safety and efficacy in pediatric patients with similar clinical presentations
E. A diagnostic scan using ^{123}I and a stimulated thyroglobulin at the time of the diagnostic scan may help to determine the appropriate dose of RAI, if needed

Correct Answer: E

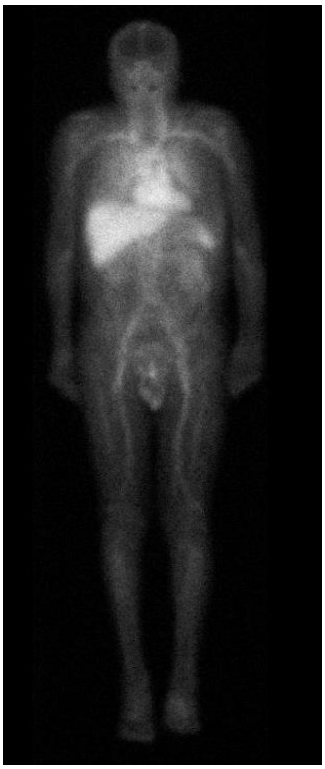
References

1. Biko J, Reiners C, Kreissl MC, Verburg FA, Demidchik Y, Drozd V. Favourable course of disease after incomplete remission on (131)I therapy in children with pulmonary metastases of papillary thyroid carcinoma: 10 years follow-up. Eur J Nucl Med Mol Imaging 2011;38(4): 651-5.
2. Chen MK, Yasrebi M, Samii J, Staib LH, Doddamane I, Cheng DW. The utility of I-123 pretherapy scan in I-131 radioiodine therapy for thyroid cancer. Thyroid 2012;22(3): 304-9.
3. Cooper DS, Doherty GM, Haugen BR, et al. Revised American Thyroid Association management guidelines for patients with thyroid nodules and differentiated thyroid cancer. Thyroid 2009;19(11): 1167-214.
4. Hay ID, Gonzalez-Losada T, Reinalda MS, Honetschlager JA, Richards ML, Thompson GB. Long-term outcome in 215 children and adolescents with papillary thyroid cancer treated during 1940 through 2008. World J Surg 2010;34(6): 1192-202.
5. Waguespack SG, Francis G. Initial Management and Follow-up of Differentiated Thyroid Cancer in Children. J Natl Compr Canc Netw 2010;8(11): 1289-300.

Radioimmunotherapy of Lymphoma

Hedieh Eslamy, MD

15. A bio-distribution scan for the ^{90}Y- ibritumomab tiuxetan radioimmunotherapy regimen is shown below. Which choice is FALSE?



A. This regimen was FDA approved for the treatment of relapsed low-grade and follicular NHL in 2002
B. Rituximab is a murine monoclonal antibody (MAb)
C. ^{111}Indium is the radiotracer used for imaging
D. Prior to the injection of the radiolabelled MAb, preloading is performed with unlabeled MAb to minimize the antigen sinking effect
E. ^{90}Yttrium is a beta emitter

Correct Answer: B

References

1. Chamarthy MR, Williams SC, Moadel RM. Radioimmunotherapy of non-Hodgkin's lymphoma: from the 'magic bullets' to 'radioactive magic bullets'. Yale J Biol Med. 2011 Dec;84(4):391-407
2. Stanley J. Goldsmith. Radioimmunotherapy of Lymphoma: Bexxar and Zevalin. Seminars in Nuclear Medicine, Volume 40, Issue 2, March 2010, Pages 122-135
3. Witzig, T. E., Fishkin, P., Gordon, L. I., et al. (2011). Treatment recommendations for radioimmunotherapy in follicular lymphoma: a consensus conference report. Leukemia & Lymphoma, 52(7), 1188-1199