hematoxylin and eosin (H&E) stained sections. The significance of rare IHC positive cells in a lymph node is unknown. This study investigates the prognostic significance of IHC positive cells in SLN of patients with melanoma.
Design: Clinical and diagnostic records from a tertiary care center were reviewed to identify melanoma patients who received a sentinel lymph node biopsy between 2000 and 2012. Clinical outcomes and disease specific survival of patients with rare IHC positive cells in their SLN were compared to patients with negative SLN and those with SLN positive for metastatic melanoma using Kaplan-Meier analysis.
Results: Overall, 826 patients with melanoma met the study criteria. Within this group, 127 patients had metastatic disease in their SLN, 639 patients had negative SLN, and 60 had rare solitary intraparenchymal IHC positive cells in their SLN (positive for either MART-1 or HMB45, and/or S-100 protein) without corresponding atypical cells seen on H&E stained sections. The mean follow-up time for all patients was 58.8 months.
To determine the disease specific survival, control groups were standardized. All 127 patients with positive SLN were compared to 127 patients from the negative SLN group, who were selected based on age and sex. Survival data was analyzed along with those patients who had rare IHC positive cells in their SLN.
The location within lymph nodes of IHC positive cells, histomorphology, presence of capsular nevi, disease recurrence, and histopathologic features of primary lesions were also evaluated.
Disease specific survival of patients with rare IHC positive cells in SLN was not significantly different from the 127 patients with negative SLN (P=0.69), but it was statistically different from patients with SLN positive for metastatic melanoma ($P < 0.0001$).
Conclusions: This study demonstrates that rare IHC positive cells in SLN without corresponding atypical cells seen on H&E stained sections have disease specific survival comparable to patients with negative SLN. Further studies with long term follow up are needed.

499 RNA Sequence Analysis of Spitzoid Melanocytic Tumors

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Background: Kinase activation by gene fusions has been recently described as a common mechanism that drives tumorigenesis in spitzoid melanocytic tumors (SMT). We performed whole-transcriptome sequencing (RNA-seq) in 5 SMT to characterize the landscape of structural variations in these lesions.
Design: RNA was extracted from formalin-fixed paraffin-embedded material in 5 SMT samples, including 4 primary tumors and 1 metastatic tumor, using the Maxwell system (Promega). RNA was quantitated by fluorescence dye, using the Quant-iT (Life Technology) RNA assay. RNA quality was evaluated by using a 2100 Bioanalyzer (Agilent Technologies) with a Nano RNA 6000 Chip. RNA-seq libraries enriched for coding regions were prepared by using the Truseq RNA Access Library Prep Kit (Illumina), following the manufacturer's protocol for RNA input quantity relative to RNA quality. The sequencing was performed on a HiSeq2000 to generate 100-bp paired-end reads. Structural variations (SV) were detected by using CICERO, a novel algorithm that uses local assembly to identify SV in RNA-seq. BAC clones (BACPAC Resources) were used to develop break-apart probes for the following genes: *BRAF* (RP11-837G3, RP11-948O19), *NTRK1* (CH17-67O18, RP11-1038N13), *ALK* (CytoCell), *PTPRZ1* (CH17-132B19, RP11-99L10), and *IL6R* (CH17-169C19, RP11-627K14).
Results: SMT occurred in 3 children (age 2–7 years) and 2 adolescents (age 13 and 14 years) and involved the lower extremities (n=3), ear (n=1), and trunk (n=1). One patient died of disseminated disease, and three patients developed large nodal metastasis. A kinase fusion was identified in each SMT, including TPM3-NTRK1 (2 tumors), BRAF-EML4 (1 tumor), BAIAP2L1-BRAF (1 tumor), and TPM3-ALK (1 tumor). All the predicted chimeric proteins were expressed at high levels and contained an intact kinase domain. In addition, we detected other fusion events in 3 SMT, including ARID1B-SNX9 (1 tumor), PTPRZ1-NFAM1 (1 tumor), IL6R-TPM3 (1 tumor), and IL6R intragenic SV (1 tumor). Gene rearrangements were confirmed by fluorescence in situ hybridization in each tumor.
Conclusions: We identified novel fusion partners for *BRAF* and several other fusion genes of unknown function in SMT. These findings demonstrate the diversity of gene fusions that define the molecular heterogeneity of these neoplasms.

500 BRAF, KIT, NRAS, GNAQ and GNA11 Mutation Analysis in Common, Cellular and Malignant Blue Nevi

Ismail Yilmaz, Mehmet Gamsizkan, Sule Sari, Cuyan Demirkesen, Aylin Heper, Banu Yaman, Aylin Calli, Gizem Narli, Zafer Kucukodaci, Ufuk Berber, Dilaver Demirel, Taner Akalin, Nesimi Buyukbabani, Murat Demiriz. GATA, Istanbul, Turkey; Military Hospital, Erzurum, Turkey; I.U.I.F.M., Istanbul, Turkey; I.U.C.F.M., Istanbul, Turkey; A.U.F.M., Ankara, Turkey; E.U.F.M., Izmir, Turkey; I.A.U.F.M., Izmir, Turkey.
Background: Malignant blue nevi (MBN) are extremely rare dermal melanocytic tumors that arise in association with cellular blue nevi (CBN), common blue nevi (BN) or de novo. The frequency of BRAF, NRAS and KIT mutations differ between histological types and locations of malignant melanomas. These mutations are rarely observed in blue nevi. Recently, activating mutations in GNAQ/GNA11 genes have also been shown in BN and uveal melanomas. Molecular studies in MBN are limited and there is no large series. The aim of the present study was to analyze the prevalence of BRAF, NRAS, KIT, GNAQ and GNA11 gene mutations and their association with clinicopathological features in MBN cases.
Design: Eighty two cases (12 MBN, 35 CBN, 35 BN) from 7 different institution between 1996 and 2014 were included in our study. The diagnosis of MBN cases were confirmed in a meeting by the participation of all institutions. For mutation analysis, DNAs were isolated from manually microdissected unstained histological sections. Exon (ex.) 15 of BRAF, ex.9/11/13/17/18 of KIT, ex.2/3 of NRAS, ex.4/5 of GNAQ and GNA11 genes were amplified by PCR and the amplicons were submitted to direct sequencing in both directions by using Big Dye Terminator kit and analyzed in the ABI 3730 automatic sequencer.
Results: The female/male ratio of patients was 42/40, with a mean age of 32.7±19.7 years. GNAQ/GNA11 ex.5 mutation was the most frequent mutation along all cases (%48.8), with a ratio of 37.1% (13/35) in BN, 65.7% (23/35) in CBN and 33.3% (4/12) in MBN. BRAF V600E mutation was detected in 3 of 12 (%25) MBN cases while none of the CBN and BN cases harbored BRAF mutation. Two of BRAF mutant cases were located in scalp, one was located at toe and one of them had lymph node metastasis. GNA11-Q209L mutation was detected in 2 MBN cases. None of the cases harbored NRAS ex.2/3, KIT ex.9/11/13/17/18 and GNAQ/GNA11 ex.4 mutations.
Conclusions: GNAQ/GNA11 mutations are detected commonly in MBN, CBN and BN with the highest ratio in CBN group. It is a striking finding that BRAF V600E mutation was detected in 3 of MBN cases whereas we observed none in BN and CBN cases. Our findings support the suggestion that blue nevi and variants represent a different melanocytic neoplasia. We think that our study will contribute to the literature that has limited data about the molecular alterations in dermal melanocytic lesions.

Education

501 Evaluation of In-Service Training of Residents and Fellows for Fine Needle Aspiration (FNA) Biopsy on Phantom Lesions

Amarpreet Bhalla, Linette Mejias-Badillo, Yasin Ahmed, Daniel Neill, Michael Kruger, Dilip Batra, Vinod Shidham. Wayne State University, Detroit, MI; Quest Labs, Orlando, FL.
Background: FNA biopsy training on Phantom Lesion (PL) for Pathology residents and Cytopathology fellows at the beginning of the academic session was introduced at our institution in July 2010. It includes a didactic on the technique of FNA, followed by demonstration on the PL prepared from banana piece embedded in caulk (http://www.jove.com/video/1404). Thereafter, the trainees practice FNA proficiency with smear preparation from aspirates. We evaluated the requirement and utility of training, level of comfort in transitioning to actual patients, and its role as a career enhancement tool.
Design: A survey based on Kirkpatrick's training evaluation model was designed on Surveymonkey.com for 75 participants (present and past trainees from our program). A total of 45 responded. They were divided into 2 groups (Gp): Gp A- 14 trainees prior to introduction of FNA training and Gp B- 31 trainees who underwent the training. These anonymous responses were statistically analyzed.
Results: Training evaluation was scored on a summative scale by enumeration of responses and descriptive statistics for rank measures.

Kirkpatrick training level	Training level objective	Min score	Maxscore	Mean score
1	Perception of training	6	10	8.58
2	Learning by getting acquainted and practicing	3	9	5.29
3	Transfer by transitioning to patients	4	10	7.74
4a	Results by overall learning assesment	6	17	11.58
4b	Results by evaluation of role as career enhancement tool	1	6	3.23

The utility of training in performing FNA was measured on a scale of 1-5 and scored a collective mean of 4.2. The difference in perception of requirement of training between Gp A and Gp B was not statistically significant (p 0.421). Assessment of confidence level of performing FNA as a trainee was evaluated by Mann-Whitney U test with comparison of mean rank scores. Respondents with training scored 30.0 and without training scored 7.5 with statistically significant difference (p 0.001).
Conclusions: The training was perceived as excellent (score 8.58) on Kirkpatrick level 1. The learning and transfer components were above average with a potential for improvement. The utility and requirement of FNA training was considered high by all. They were neutral about the role of training as a career enhancement tool. The trainees in Gp B conveyed higher confidence level than those in Gp A.

502 Rapid Access and Dissemination of Pathology Knowledge Using an Open Access Wiki

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Background: Pathology information sources, whether electronic or paper based, are largely commercial, often difficult to search and rarely link to one another. They also infrequent use content management software to track revisions that facilitate an open and rapid review, allow discussion among editors or solicit input from readers.
Design: We assessed the usability, usage and development of a wiki-based, secondary source of free pathology information that leverages media, software and organizational elements from Wikipedia. The site was accessible to staff & residents at one health authority (trial site) for a year and a seminar on editing was held. Subsequently, the site was launched, usage data collected using the software 'awstats', and automated editing trialed to sort and change the virtual pathology cases on the main page.
Results: The site contained 1260 diagnoses, 1360 images, 5650 pages, a search function, summary boxes and page navigation boxes. The integrated case simulator was useful for self learning, including assessment of uncommon diagnoses, guiding choice of

ancillary testing and consultation. An informal poll found the perceived difficulty of editing varied from uncomplicated to challenging. Automated editing worked seamlessly but requires programming skills. Approximately 10000 edits were done over the trial year primarily by one individual. The first and second month after launch, the site had 1879 and 3125 unique visitors, from 62 and 80 identifiable countries/domains, 4691 and 7374 visits, and 52557 and 66242 page views (11.2 and 9.0 pages views/visit) respectively. The trial site's usage after launch was 2902 and 4057 page views/month. The track changes-like features, and discussion pages of the wiki allowed a modest international collaboration.

Conclusions: The site has the potential to further the understanding of pathology among interested with an internet connection. Users considered the interface intuitive, possibly due to the similarity to Wikipedia. Editing wikis was a significant challenge for a number of residents and pathologists who were interested, representing a barrier to fully utilizing this technology. This hurdle may be addressed by finding local technology champions and/or emphasizing that users cannot damage the wiki, as changes are tracked and can easily be undone. Further growth, the success and utility of the project will depend on participation of readers and editors, to continuously, scrutinize, revise and update the content.

503 Clinical Pathology: How Do You Do It?

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Background: Clinical pathology training is historically a weak point for most anatomic pathology / clinical pathology (AP/CP) residency programs. While most programs have a subject area or two within CP that they excel in, they are left struggling with how to train future pathologists in other areas. The goal of this study was to identify common methods of approach to residency training in CP and more specific methods utilized by programs.

Design: A survey regarding clinical pathology residency training was sent to all residency program directors from institutions that train in clinical pathology to discover how programs are educating in CP. The survey consisted of 94 questions regarding educational practices in blood bank, microbiology, chemistry, molecular/cytogenetics, lab management, general CP practices, and demographic information. Nine identical block questions were asked regarding the four major fields of CP with additional field specific questions. All responses were anonymous and specific program identification was not obtained.

Results: Out of a total of 142 programs, 38 (27%) of program directors responded. Of the respondees, the average program size was greater than 15 residents and over half of these offer a clinical pathology only residency option as well as a clinical pathology fellowship in at least one specialty. The results from such a survey are too extensive to list in this format; however, certain trends did emerge. For example, lab administration appears to be an area of concern and struggle for most programs. Also, while most programs have fellowship trained pathologists on site for blood bank, microbiology and molecular, the majority did not have trained pathologists in chemistry.

	BLOOD BANK	MICROBI-OLOGY	CHEM-ISTRY	MOLEC-ULAR
Are residents given examinations during the rotation?	No (61%)	Yes (50%) No (50%)	No (67%)	No (72%)
Are there fellowship trained pathologists for that field at your institution?	Yes (97%)	Yes (58%)	No (56%)	Yes (80%)

Certain questions showed almost all programs answering similarly, while with others there was a distinct divide.

Conclusions: While a lot of programs approach clinical pathology training in the same manner, there are clearly diverse ways in which to educate within the different fields. The hope is that putting these struggles on paper, as well as, outlining the various approaches taken by different institutions will help programs better develop their training methods. Clinical pathology is an integral part of pathology and by improving our education of the current generation, we improve the future of pathology.

504 Comparison of Electronic To Conventional Live Training for a Companion Diagnostics Immunohistochemical Algorithm

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Background: An immunohistochemical (IHC) algorithm had been developed for selecting non-small-cell lung cancer patients in trials for treatment with a MET-targeting therapy. The scoring algorithm utilized a combination of both the percentage of tumor cells exhibiting specific membrane and/or cytoplasmic staining and the intensity of staining. For global pathologist training an electronic (e-) training system was seen as a potentially cost-effective, rapid alternative to live training.

Design: An e-training curriculum patterned after live training consisted of a self-paced didactic tutorial followed by interactive known and then unknown case examples, with progression in operator diagnostic decision making. The final module featured a 30-case proficiency test. A similar test with glass slides was included in the comparison live training program. Images from whole slide digital scans were operator activated simulating virtual microscopy. The study took place at a single facility over a 2 month period. Board-certified pathologists participated in one or the other training program in groups of up to 9. A single trainer conducted all the live training. A 51-case glass slide "Post-Test" was administered to both groups upon completion of the Proficiency Test. All training sessions were subpervised by a clinical trial monotor.

Results: Of 64 pathologists 31 underwent e-learning and 33 live training. Profiling showed similarity between the two arms, with regard to practice experience, specialty training, experience in biomarker quantitation, and computer proficiency. When comparing outcomes in IHC assay interpretation, the e-learning arm achieved higher proficiency scores than did live training . Whereas all e-trainees passed the proficiency test, only 19 of the 33 live-trainees did so. Six of the e-trainees subsequently failed the 51 glass slide Post-Test, albeit with grades all above 80% (passing score 85%). Seven of the 14 live-trainees who failed the 30-case Proficiency Test went on to pass the 51 case Post-Test.

Conclusions: An e-learning system effectively trained pathologists in a complex IHC diagnostic assay using idealized conditions. Retrospectively, several factors might explain the discrepancy in performance between the live and e-training participants. E-learning programs can offer significant advantages over live, in-person programs.

505 Whole-Slide Images Versus Glass Slides for Pathology Resident Education

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Background: Digital pathology is increasingly important to resident education. Trainees are now required to assess virtual slides when taking board exams, and as digital images can be viewed remotely, they offer on-demand access to educational material. However, glass slides remain a clinical standard, and the effect of employing digital media for educational purposes remains unknown. We designed a multi-modal assessment of whole slide images (WSIs) as compared to glass slides in a standard resident educational activity to better understand the role for each in the training process.

Design: Residents viewed a list of unknown cases in either WSI or glass slide format. WSIs were created from glass H&E slides using a Philips UFS scanner, and displayed using a web-based viewer. Glass H&E slides were viewed through an Olympus BX43 microscope connected to a digital camera. Through this method, the diagnostic material and viewing screen could be controlled across both modalities. A Tobii X2-60 eyetracker was used to collect gaze data, including fixation count and duration. In addition, residents were surveyed regarding their preparedness for educational conferences when using WSIs as compared to glass slides for review.

Results: Trainees required less time for evaluation of individual WSIs as compared to glass slides, although the duration of individual fixations, as well as the pattern of gaze around features of interest, were not significantly different between these two modalities. Glass slides required a greater number of slide movements compared to use of WSIs; however, gaze covered a greater area of the slide with WSIs. Specific diagnoses requiring high power magnification were more frequently correct with WSIs than with glass slides, and residents expressed greater confidence with the use of WSIs.

Conclusions: A comparison of resident use of WSIs and glass slides for evaluation of unknown cases demonstrates potential utility for WSIs in this educational format. As digital pathology becomes increasingly utilized in the diagnostic workflow, the development of a digital skill set during residency assumes more importance. Thus the ability to assess and refine the acquisition of visual expertise becomes a crucial part of resident education.

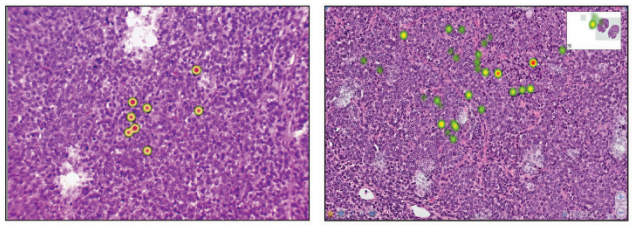

Figure 1: Heatmap of gaze time on a glass slide (left) and WSI (right).

506 Impact of Resident Education in Lymph Node Dissection of Gastrointestinal Resection Specimens

Kanchan Kantekure, Elizabeth Genega, Stephen Naber, Yvelisse Suarez. Tufts Medical Center and Tufts University School of Medicine, Boston, MA.

Background: Proper lymph node dissection (LND) is often considered a marker of the quality of grossing technique and is an important prognostic factor in colorectal carcinoma staging. Current guidelines suggest a minimal harvest of 12 lymph nodes; however, harvesting more nodes increases the likelihood of the detection of the metastases, which can improve patient survival. The number of nodes harvested is determined by patient factors, surgical technique, and most importantly, diligence of pathologic examination. A second search for nodes may be required if the primary search is inadequate, which may lengthen turn-around time. For these reasons, committed education and supervision of pathology residents for LND is extremely important. Few studies have been performed to assess the learning curve of residents' grossing skills.

Design: The average number of lymph nodes dissected per colorectal carcinoma case and the number of times a second search for lymph nodes was performed in all gastrointestinal (GI) resections was documented from July 2013- June 2014. A GI attending gave didactic sessions on types of surgical resections, colorectal cancer staging, and dissection techniques (including gross room demonstrations). LND was also supervised as needed. The average node yield per colorectal carcinoma case and the number of second searches in pre (July- December 2013) and post-education periods (January- June 2014) are compared.

Results: The average yields of lymph nodes per carcinoma case in the pre-education and post-education periods were 17.5 (11 cases) and 22.3 (20 cases), respectively. A second search for lymph nodes in all GI resection specimens in the pre-education and post-education periods were 7/71 (9.8%) and 3/79 (3.7%), respectively. There was one outlier case with a total of 257 lymph nodes which is not included in the statistics.

Period	Total GI resections	Total carcinoma resection	Average yield of nodes per carcinoma case	Second search for nodes
July- December 2013	71	11	17.5	7/71 (9.8%)
January- June 2014	79	21*	22.3	3/79 (3.7%)

*The outlier case of 257 lymph nodes is not included in the statistics

Conclusions: Proper training, instruction, and supervision of residents resulted in higher yields of lymph nodes, improved accuracy of staging, and minimized/avoided the need for a second search for lymph nodes. Our study confirms the impact of dedicated pathology resident education for improving patient care, grossing skills, and turn-around time.

507 Just-in-Time Teaching (JiTT) Applied To Pathology Residency Training

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Background: JiTT is an active teaching and learning strategy that combines web-based assignments with classroom learning. JiTT sessions can be limited to one-hour; each learning activity is an event by itself and it can be used in small groups composed of learners with heterogeneous backgrounds previously exposed to the material. Our goal is to demonstrate how JiTT can be applied to Pathology resident teaching.

Design: Subject: Breast Cytopathology.

Before the session:

a) Five days before: 12 digital images of three cases (benign, malignant, papillary lesion) shared with 14 Pathology residents. Also shared: textbook with designated sections for reading, downloadable via medical library.

b) Three days before: four open-ended questions emailed including what case was most difficult; answers due night before session.

The night before:

a) Answers reviewed by faculty and grouped by category.

b) 15-minute mini-lecture prepared addressing most confusing points.

During class:

a) 5 minutes: go over answers anonymously

b) 15 minute: mini-lecture using previously reviewed digital images

c) 15 minutes: class divided in two groups; multihead microscope review of corresponding glass slides

d) 15 minutes: Groups present cases and answer online questions.

e) 5 minutes: Closing presentation, most important points.

Three weeks after class:

Participating residents interviewed, asked for feedback and suggestions. Asked to recall three most important criteria learned from activity.

Results: Resident's perspective

Positive points:

a) web-based materials: flexibility to study in own time

b) study materials: can be kept as reference

c) 15-minute lecture: ideal duration

d) Repetition of same images (online, lecture and glass slides): helpful for learning

e) Groups: provide anonymity

Negative points:

a) Short time to answer questions in busy schedule

Recall:

All residents interviewed able to recall three important diagnostic criteria.

Suggestions:

Include active learning sessions such as JiTT in curriculum.

Faculty perspective

Positive points:

a) Student thinking made visible: major change in lecture

b) Residents better prepared: productive discussion

c) Main points reinforced

d) Pleasurable exchange

Negative points:

a) Increased preparation time, particularly night before lecture.

Conclusions: The main strengths of JiTT are the ability to make student thinking visible, help develop expert-like thinking processes, improve transfer of knowledge and promote reflective learning. We demonstrate how this learning strategy can be applied to Pathology residency teaching.

508 Three-Dimensional Printing (3D Printing) of Anatomical Pathology Specimens in Undergraduate Medical Education – An Irish Experience

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Background: Three-dimensional printing, an evolving new technology recently applied in medicine, can be utilized in teaching pathology to undergraduate medical students. The aim is to demonstrate pathology entities to undergraduate medical students with an emphasis on gross morphology and clinicopathological correlation of surgically excised tumors.

Design: Multi-colored 3D prints of anatomical pathology specimens including pancreaticoduodenectomy (Whipple's operation), radical nephrectomy, hemicolectomy, orchiectomy, esophagectomy, and skin ellipses were generated following creating three-dimensional computer aided design with Autodesk®123D®software (Pirrarn-3D) in a 3D printing service (3D Creation Lab, Stoke on Trent, UK). In addition, three-dimensional prints were created of preserved anatomic pathology specimens in the pathology museum of University College Cork. Three-dimensional models were demonstrated to medical students during small group teaching sessions comprising 10 medical students per group. To assess the utility of 3D printing in teaching, a questionnaire was devised to assess student feedback on the new teaching technique.

Results: The three-dimensionally printed models clearly demonstrated the gross morphological appearance and pathological stage of each tumor. Students responded with a positive feedback on understanding the gross anatomy of anatomic pathology specimens utilizing 3D printed anatomic pathology specimens. Students suggested augmenting the quality of colors and texture of the 3D prints.

Conclusions: Initial trial of three-dimensional printing of anatomical pathology specimens has been successful in small group based teaching setting. Three-dimensional prints can be implemented in other teaching settings, and potentially augment the use of preserved human tissue at pathology museums. Three-dimensional prints of anatomic pathology specimens can thus become an adjuvant in the teaching of undergraduate pathology curriculum.

509 Evolution in Characteristics of Resident Graduates From a Large Academic Pathology Training Program, 1994-2013

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Background: The field of pathology has changed dramatically over the recent decades and has become more complex with emphasis toward subspecialization. These changes potentially influence resident training as programs and trainees search for the best skill sets to acquire in the evolving field. Over the last 20 years, our institution's residency education was modified profoundly to emphasize subspecialty practice. Furthermore, efforts were made to screen and recruit candidates who desired such training. In this study, we examine the characteristics of our program's resident graduates over a 20 year time period to search for trends that reflect the changes in the field and may help chart the course of our specialty in years to come.

Design: The study was approved by the Institutional Review Board. For each trainee who graduated from our pathology residency program (1994-2013), the following parameters were evaluated: highest academic degree, type of training, number of publications during residency, enrollment in fellowships, and type of career position. The data collected were divided into 2 time periods. Fisher's Exact test and two-tailed t-test were used for statistical analysis.

Results: For statistical comparisons, the first half of the study period (1994-2003) was compared to the second half (2004-2013). Statistically significant differences were found in the type of pathology training - APCP vs AP or CP training ($p=0.035$), average number of total and first author publications per resident during residency ($p<0.001$), percent of residents who enrolled in fellowship(s) ($p<0.001$), and type of career position - academic position vs all other types combined ($p=0.034$). In the second half, more trainees selected focused (AP or CP only) training, authored more publications, pursued fellowship training, and were employed in an academic pathology practice.

Conclusions: This study shows significant changes in the characteristics of our pathology resident graduates over a recent 20-year time period. These trends in our pathology resident graduates appear to mirror the recent subspecialization emphasis in pathology.

510 RESIDENT 2.0: Web 2.0 Tools in Pathology Residency Training

Daniel Rosen. Baylor College of Medicine, Houston, TX; Michael E. DeBakey V.A. Medical Hospital, Houston, TX.

Background: Residency training is a very demanding work environment. Besides the daily clinical work, residents have to fulfill program requirements for graduation such as scholarly activities, teaching and research participation. The work schedule can interfere with education leading to poor conference attendance. Moreover, given the intense demand of the work environment residents may be susceptible to developing burnout and as a consequence decreased productivity, increase stress and decreased job satisfaction. New theories of learning and the new interactive technologies have begun to enable the pedagogical changes from a *teaching-centered* to a *learning-centered* environment. We present Web 2.0 tools that can help resident training, improve participation and provide objective measures applicable to the ACGME outcomes-based milestone accreditation system.

Design: We applied the Teaching-Centered and Learning-Centered Approach described by Buckley *et al* and the conceptual model developed for collaborative learning in distance education by Exte *et al.* The taxonomy wheel developed by Carrignton *et al* was used to describe Web 2.0 tool implementation. The online activities were applied to multiple resident activities such as conferences, lecture schedule, journal clubs, research, portfolio, and publications.

Results: The taxonomy wheel groups web 2.0 resources according to: creation/collaboration (ie:voicethread, prezi), evaluation (ie:surveymonkey, easypolls), analysis (ie:google analytics, 10x10), application (ie:evernote, go2web20), understanding (ie:footnote, facebook), and remembering (ie:zoho, visuwords). Time pressure or lack of structure and design for the use of Web 2.0 tools in conjunction with the curriculum may have a negative impact on this model. Trainees are implicated heavily in terms of knowledge creation. Some Web 2.0 tools are easier to implement in some resident activities such as journal clubs, lecture schedule and didactic conferences.

Conclusions: WEB 2.0 tools provide flexibility of design, ease of use, and significant learning opportunities. These resources facilitate the transition to a learning centered

system and provide objective outcome measures applicable to the new ACGME accreditation system. For this approach to be successful correct web tools selection is critical to facilitate student contribution, participation and confidence.

511 Assessing Resident Frozen Section Diagnostic Skills for Endometrial Cancer

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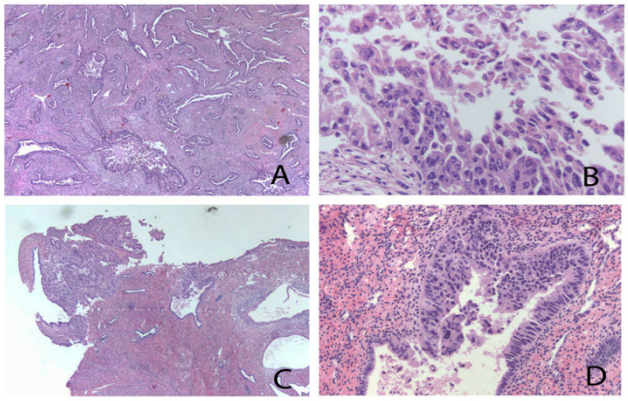
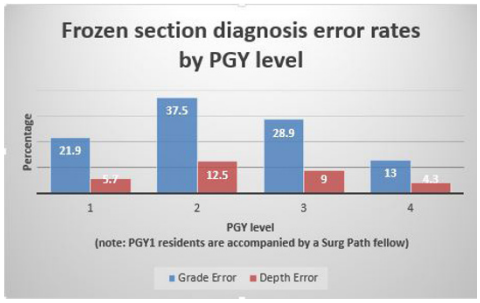
Background: The development of frozen section diagnostic skills is a critical part of pathology residency training. Our study aims to assess trainee performance on endometrial cancer frozen sections and to identify common errors while providing recommendations for improvement.

Design: Twenty-two residents at our institute (ranging from PGY1 to PGY5) performed a total of 260 endometrial cancer frozen sections from 2011 to 2014. Their independent frozen section diagnoses, including tumor type, grade, and myometrial invasion, were compared with the final pathology reports.

Results: Endometrial cancer type and grade were accurately diagnosed by residents on frozen sections in 194 of 260 cases (75%). The misdiagnosed cases resulted from undercalling endometrioid tumor grade in 43 cases (17%), overcalling in 6 (2%), and missing Type II tumor component in 17 (6%), including 7 serous carcinoma, 5 clear cell carcinoma, and 5 carcinosarcoma. (Shown in figure 1, A/B clear cell carcinoma; C/D Serous carcinoma both misdiagnosed as Grade 1 Endometrioid carcinoma on frozen section.)



The depth of myometrial invasion was accurately reported in 240 cases (92%) while undercalled in 20 cases (8%). No errors were made in the gross inspection of cervical involvement of the tumor. Frozen section error rate decreased with years of training (PGY1 accompanied with PGY5 24; PGY2 44%; PGY3 37%; and PGY4 17%). Overall, resident frozen section errors would have led to 24 (9%) of patients receiving sub-optimal staging procedures.



Conclusions: Our trainees demonstrated moderate performance on endometrial cancer frozen sections with an overall accuracy of 75%. Their frozen section skills gradually developed throughout the residency. Additional training should be devoted to training residents to recognize high grade components and type II tumor on frozen section.

512 Teaching Strategy for Colonic Polyps

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Background: Pathology residents often find distinguishing between types of colon polyps challenging, particularly serrated lesions. In this study, the accuracy and interobserver reproducibility of resident colon polyp diagnoses, including hyperplasitc polyp (HP), colonic adenoma (CA), sessile serrated polyp (SSP), sessile serrated polyp with adenomatous change (SSPA), traditional serrated adenoma (TSA) and prolapse polyp (PP), was measured before and after a 1 hour lecture on colon polyp diagnosis to assess the effectiveness of this teaching strategy.

Design: Two sets of 40 colon polyps were compiled for which there was independent diagnostic agreement between 2 GI pathologists. 13 pathology residents of all levels of training were given the first set and asked to make a diagnosis from the following 6 options: HP, CA, SSP, SSPA, TSA, and PP. Residents then attended a 1 hour lecture focusing on key diagnostic features for each of the 6 diagnoses. Following the lecture, residents were given the second set of polyps to diagnose. Accuracy of diagnosis when compared to the expert diagnosis and interobserver variability using kappa statistics were measured before and after the lecture.

Results:

Table 1. Accuracy of diagnosis before and after lecture

Expert Diagnosis	Pre-lecture % Correct	Post-lecture % Correct
Overall	68	69
HP	89	64
CA	80	81
SSP	63	81
SSPA	44	57
TSA	46	52
PP	82	74
HP and PP	85	67
CA, SSP, SSPA and TSA	60	70

Table 2. Interobserver reproducibility before and after lecture

	Pre-lecture Interobserver Reproducibility (κ)	Post-lecture Interobserver Reproducibility (κ)
Overall	0.46	0.51
HP	0.44	0.39
CA	0.57	0.61
SSP	0.42	0.46
SSPA	0.37	0.52
TSA	0.17	0.41
PP	0.66	0.46
HP and PP	0.44	0.33
CA, SSP, SSPA and TSA	0.56	0.68

Conclusions: There was little change in the overall accuracy of diagnosis and only slightly improved interobserver reproducibility following the lecture. However, when grouping premalignant lesions (CA, SSP, SSPA, and TSA) there was more significant improvement. These results suggest a lecture format may not be the best teaching strategy for this diagnostic challenge, but may have some benefit in the diagnosis of actionable entities. A computerized teaching module with a quiz format is currently being explored.

Endocrine Pathology

513 Low Frequency of TERT Promoter Mutation in a Series of 529 FNAs

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Background: The preoperative diagnosis of thyroid nodules mainly depends upon fine needle aspiration (FNA) cytology. However, 20% to 30% of cases cannot be ruled out for cancer. New approaches to diagnosis of cancer in FNA thyroid nodules are based on molecular analysis. Promoter mutations in the gene for telomerase reverse transcriptase (*TERT*) have been recently identified in thyroid cancers and shown to be important in their pathogenesis. *TERT* (C228T) was prevalent in poorly/undifferentiated thyroid cancer, as well as *BRAF* V600E mutation-positive PTC.

Design: We collected 529 thyroid FNAs from June 2013 to June 2014. Cytological diagnoses were performed according with the SIAPEC-IAP guidelines. 93 patients underwent thyroidectomy. Clinical history and thyroid ultrasound reports were matched to thyroid FNA cytology and surgical pathology report. Molecular testing for *BRAF*, *Ras* (*NRas* cod 61, *HRas* cod 61 and *KRas* cod 12/13) and *TERT* promoter mutations was performed.

Results: Of 529 thyroid FNA 23 (4.3%) were inadequate (TIR1), 368 (68.9%) were benign nodules, 92 (17.4%) indeterminate lesions (TIR3) of which 64 (12.1%) TIR3A and 28 (5.3%) TIR3B. 8 were (1.5%) suspicious nodules, and 39 (7.4%) were malignant cases. *BRAF* mutations were found in 1 TIR1 (4.3%); 1 TIR2 (0.3%); 1 (10.1%) TIR3B; 2 TIR4 (25%) and 22 TIR5 (56.4%). *Ras* mutation was found in 1 (4.3%) inadequate sample, in 19 (5.2%) benign nodules, in 11 (12%) indeterminate lesions and in 2 (25%) suspicious cases. No *Ras* mutations were found in malignant nodules. One (12.5%) case of TIR4 and 2 (5.1%) of TIR5 were *TERT* promoter mutated. Comparing with histological diagnoses we found that *BRAF* V600E mutation was present only in papillary thyroid carcinomas (PTC). *Ras* alterations were found in 3 follicular variant PTC (FVPTC), one follicular carcinomas (FTC) and 2 microfollicular adenomas. *TERT* C228T mutation was found in one anaplastic thyroid cancer which was also positive for *Ras* mutation and two classical PTCs both of them *BRAF* V600E. Overall frequency of *TERT* promoter mutation was 0,75% (4 out of 529).

Conclusions: We confirmed that *TERT* promoter mutations were associated with poor prognosis PTCs and anaplastic cancer. Undoubtedly, it will provide prognostic and therapeutic implications. The frequency of *TERT* promoter mutation in our series is very