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Rapid on-site evaluation using telecytology: A major cancer center experience

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Abstract

Background: Rapid on-site evaluation (ROSE) with cytology preparations plays a critical role in minimally invasive procedures. The time spent by a pathologist performing ROSE is unpredictable and could be used for more cost-effective activities. The solution encountered by several institutions to address this issue is the use of telecytology (TC). This study analyzes the experience of using telecytology for ROSE in a major cancer center over a period of over 2 years.

Methods: A retrospective analysis of all remote TC evaluations for adequacy on fine needle aspiration (FNA) and touch preparations (TP) of core biopsies (CB) performed at a major cancer center was performed. The preliminary adequacy assessment was then compared to the adequacy assessment at final diagnosis.

Results: A total of 12 949 adequacy assessments were analyzed. The most common sites biopsied in our institution were lymph node, lung, and liver. There were 7725 adequacy assessments for CB (59.7%), while adequacy assessment for FNA specimens represented 40.3% (n = 5224) of the total number of specimens evaluated by ROSE. Perfect concordance between initial adequacy assessment and the adequacy assessment at final cytologic diagnosis was 93% (12 049/12 949). The final diagnosis adequacy upgrade rate was 6.7% (n = 863), and the adequacy downgrade (a specimen considered adequate on-site that was determined to be nondiagnostic on final examination) was 0.3% (n = 37).

Conclusions: TC can be easily implemented with the current technologies available. It is cost-effective and allows for better patient care with a more efficient use of the pathologist's time and laboratory resources.

Keywords

adequacy; cytology; telecytology; telepathology; validation

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CONFLICT OF INTEREST

N/A.

1 | INTRODUCTION

The current trend in healthcare relies increasingly on minimally invasive procedures to obtain material for diagnosis, instead of surgical resections. It is in this setting that rapid on-site evaluation (ROSE) with cytology preparations plays an important role. Several authors have shown ROSE to improve patient care by reducing the number of repeat procedures.[1–5] This reduction in repeat procedures decreases potential side effects from the procedures, such as lower rates of infection, hemorrhage, and pneumothorax in lung biopsies. ROSE with cytology preparations is also useful in core biopsies (CB) as it minimizes the loss of material that could have been lost if the specimen was submitted to frozen section. Additionally, it decreases the psychological stress inflicted on the patients when a procedure does not yield the intended material or the burden on the patient and family by eliminating unnecessary hospital commutes. Furthermore, increasingly complex oncologic specimens often require immediate feedback for clinical management and ancillary study triage highlighting the importance of ROSE in modern patient care.

ROSE of fine needle aspirations biopsies (FNAB) and touch preparations (TP) from CBs are traditionally performed by pathologists or cytotechnologists (CT) that have to go to the site where the procedure is being performed. The personnel stay on-site until the diagnostic material is obtained or the specimen is considered adequate. The time spent performing ROSE can extend to hours if the lesion is in a location of difficult access and these procedures are very operator dependent. Unfortunately, the wait time of the pathologist is not reimbursable and it can significantly impact the workflow and revenues of cytology services as other reimbursable activities are not performed. Conversely, if a pathologist is not directly involved in the process, the whole ROSE activity cannot be performed, albeit some institutions in the U.S. charge the technical component, even though this matter remains controversial. The process can be quite time consuming and not cost-effective.[6]

The solution encountered by several institutions to address this issue is the use of telecytology (TC). In this model, CTs and fellows go on-site to prepare the smears or TPs while the cytopathologist stays in the laboratory/office and the slide images are sent through TC. This model is much more cost and time-effective as the cost per minute of a CT or fellow is lower than of a pathologist, who can then engage in other academic or other reimbursable activities during the procedure downtime. Additionally, a pathologist can support multiple sites simultaneously, further enhancing the cost effectiveness of the process. This study analyzes the experience of using telecytology for ROSE in a major cancer center over a period of 2 years. It describes the adequacy and discrepancy rates as well as some difficult cases.

2 | MATERIALS AND METHODS

A retrospective analysis of all remote TC evaluations for cellular content and adequacy on fine needle aspiration (FNAs) and TPs of CBs performed at Memorial Sloan Kettering Cancer Center (MSK) for a period of 26 months was performed. The data was obtained for internal Quality Assurance purposes; therefore, Institutional Review Board review was not required. Patient age and sex data were collected along with the number of cases at each

satellite site. Cellular content and adequacy were determined based on the correlation with clinical-radiological findings. The preliminary adequacy assessment was then compared to the adequacy assessment at final cytology diagnosis that included all preparations, including monolayer preparations and cell block preparations from needle rinses, and/or CB diagnosis in case of ROSE of TPs. Concordance is defined as correlation between the preliminary adequacy assessment and the adequacy assessment at final cytologic diagnosis. An adequacy upgrade occurs when the preliminary adequacy assessment is considered inadequate but the adequacy assessment at final diagnosis is determined to be diagnostic. An adequacy downgrade occurs when the preliminary adequacy assessment is deemed adequate but the adequacy assessment at final cytologic diagnosis is determined to be nondiagnostic.

2.1 | Technical description

The iMedHD2 system by Remote Medical Technologies (RMT; Melville, New York) was used to send the images. The RMT architecture is based on a spoke and hub networked client-server concept. The system is coupled with Optronics® (Goleta, California) or Lumenera® HD2 (Ottawa, Ontario, Canada) HD video cameras that generate video at 60 frames per second (fps). The systems were either stationary or installed in mobile carts (Figure 1). The captured digital HD images are sent to 28 inches ultra high definition LED Samsung™ U28D590D (Seoul, South Korea) monitors or Apple® mini iPads (Cupertino, California, USA) for remote viewing. The live image stream is broadcast at 1920 × 1080 and is contained behind MSK's institutional firewall. Remote viewing is web-based and uses 1 Gigabit per second intranet connection speeds.

2.2 | Process workflow

The CT is informed when a biopsy procedure is about to begin and alerts the cytopathology attending, who proceeds to access the on-site camera through the web browser. The CT prepares slides on-site and selects the appropriate region of interest. She/He then communicates with the attending cytopathologist through a hands-free Vocera™ (San Jose, California) device. ROSE for adequacy is performed with TC assistance. The material was considered adequate if lesional tissue was identified or the radiologic findings were compatible with the radiological and clinical suspicion. Collection of additional material for ancillary studies was obtained if deemed necessary by the pathologist.

3 | RESULTS

A total of 12 949 adequacy assessments were performed during the observed period. The vast majority of procedures were performed in interventional radiology and ultrasound suites. TPs from interventional radiology comprised most of the cytologic evaluations. The most common sites biopsied in our institution were lymph node, lung and liver. There were 7725 adequacy assessments for CB (59.7%), while adequacy assessment for FNA specimens represented 40.3% (n = 5224) of the total number id specimens evaluated by ROSE. Our study shows that TC-assisted preliminary adequacy assessment was highly concordant with the final cytopathologist-rendered adequacy assessment. Perfect concordance or accuracy was at 93.0% (12 049/12 949). The adequacy upgrade rate (a specimen considered nondiagnostic on site that was determined to be adequate on final examination) was 6.7% (n

= 863), and the adequacy downgrade (a specimen considered adequate on site that was determined to be nondiagnostic on final examination) was only 0.3% (n = 37). The discrepancy rate was higher in the FNA ROSE specimens (8.7%, 455 cases) as compared to the TP ROSE specimens (5.7%, n = 445). Both adequacy upgrade and downgrade rates were higher in FNA specimens (8.3% and 0.4%, respectively) in comparison to TP ROSE (5.5% and 0.2%, respectively)

The most common cases with discrepancies between the adequacy assessments at initial assessment and final cytologic diagnosis were cases from well differentiated neoplasms from the liver and kidney (Figure 2) and mesenchymal lesions. Bronchial cells in thick smears also represented challenges in endobronchial ultrasound guided biopsies as they could be mistaken for lymphocytes if present in thick parts of the smears.

4 | DISCUSSION

TC represents a potential solution for the increased need of cytology services for ROSE in many institutions. It has benefited from technological improvements that occurred in the past few years. Cameras and monitors with increased image resolution, improved software available for image transmission, enhanced communication platforms, and faster internet speed have allowed the implementation of optimized ROSE processes using TC. The use of TC allows one pathologist to support multiple sites concurrently without the need for a pathologist to be physically present at each site to provide ROSE. High definition images can be sent to the pathologist by technical or medical trainee staff with cytology experience, thus decreasing the number of pathologists required for this activity.

There are several platforms available in the market that can be used to share microscopic images, including static image transmission, live image transmission, and scanned digital images. Each of these platforms offers different advantages and disadvantages over others. A workflow based on static image transmission platform is simple and cheaper than the other platforms, but it might not be suited for large volume settings and it does allow the full review of the slide. The use of scanned digital images for ROSE suffers from current technological limitations such as the speed of scanning of cytology preparations. Currently, in our opinion, live imaging streaming represents the most time and cost effective platform. It allows the pathologist to review the whole slide.[7,8] Live image transmissions can be performed with different types of equipment. There are low-cost mobile applications like Apple's FaceTime that has also been evaluated as TC options.[9,10] Although popular, this application has limitations when used for TC such as quality of the image when changing magnifications and potential network connection issues. Also, the required level of security mandated by most institutions makes it difficult to use such application for clinical purposes.[11] The selection of live image streaming as the platform for TC should be based on the workflow of each individual laboratory and should take in the consideration the resources available, both human and technical, as well as image quality, user-friendliness, reliability, and security of the equipment.[11]

This study represents the largest evaluation of TC to date (n = 12 949). As a comparison, other larger assessments of digitized scanned slides from other institutions may have a

sample size of up to 600 cases.[12] The workflow implemented for this activity was designed to minimize the efforts of the personnel on-site. Communicating with the pathologist and making sure the images transmitted were in focus was the only additional effort required of the on-site personnel. The pathologist would access the images transmitted by the equipment when notified by the personnel on-site. There was no notable increase in time of screening and the feedback from the clinicians was very positive. It allowed direct pathologist to clinician communication, including live discussion of the case. Our study also demonstrated that the use of telecytology did not impact the accuracy of ROSE. The concordance or accuracy in our study was 93%. This was similar to our prior TC studies, suggesting that the learning curve for the implementation of ROSE did not impact accuracy. Also, these results are comparable to previous reports, which have demonstrated an 80% to 95% concordance rate for TC and 66.7% to 97% for conventional on-site methods.[13–19] A slightly higher concordance obtained from TP might be a result of a more aggressive sampling of the specimen leading to the increased amount of diagnostic material available or degree of experience of the clinician performing CB.

The adequacy upgrade rate in which lesions initially designated as nondiagnostic became diagnostic on the evaluation of the entire specimen was 6.7% in our study. Adequacy upgrades in our setting are expected because not all diagnostic material may be available at the time of adequacy assessment. At MSK, most specimens are accompanied by a needle rinse that is prepared later in the cytology laboratory and, sometimes, a cell block is also prepared. The diagnostic material might be present in these additional preparations or only in the CB if a touch preparation was performed. Furthermore, many of the upgraded cases were lesions associated with marked fibrosis or hypocellular specimens. The diagnostic cells in these specimens with extensive fibrosis are only seen when the entire specimen, including the core biopsy and/or needle rinse material is evaluated. It also explains why FNAs have a lower accuracy, as FNAs of these lesions are frequently hypocellular.

The adequacy downgrade rate in which lesions initially considered adequate were later deemed inadequate was noted in only 0.3% of cases and it was most common among FNA cases. The leading cause of downgraded cases is the misinterpretation of benign cells as malignant cells. Examples of such cases include misinterpretation of reactive hepatocytes containing bilirubin pigment as melanoma cells in a patient with a prior diagnosis of metastatic melanoma and renal tubular cells misinterpreted as oncocytoma cells. The impact of an adequacy downgrade at final cytologic diagnosis is an early termination before the diagnostic cells were collected. Conversely, an adequacy upgrade at final cytologic diagnosis implies that the lesion was sampled but might suggest that unnecessary passes were performed. It is important to emphasize the discrepancy rates will depend on the skill level of the CTs or fellow present onsite. Their role is critical to show the pathologist the cells of interest. The skill level of the CTs in our institution contributed to our results and similar adequacy downgrades may not be replicated in every institution. In our institution, the CTs are trained in this process for 3 months before they participate in ROSE independently.

Although properly trained CTs have the ability to perform adequacy assessments independently,[20,21] there are several reasons why the participation of a pathologist is critical. The increased complexity of cases requiring a multitude of ancillary studies requires

advanced knowledge to triage the specimen appropriately for the proper testing. For instance, a possible hematopoietic lesion might require material to be sent for flow cytometry studies[22] and a possible diagnosis of lung carcinoma might require additional immunohistochemical and molecular studies.[23–31] Additionally, ROSE billing in the absence of a pathologist in the process is still controversial in the United States. Most institutions do not bill for ROSE in which there is no direct participation of the pathologist, while others bill only for the technical component. The College of American Pathologists' position is that 88172 CPT code should not be used to report the assistance of a technologist during FNA as 88172 is a physician service code.[32] The CPT code 88333 for the evaluation of TP is a pathology consultation code, although a technical component modifier component can be used. Therefore, the use of telecytology for ROSE is justified both from the point view of an improved patient care as well as from a financial perspective. The investment for the implementation of TC can be recovered through the revenue generated when the pathologist is directly involved in ROSE.

In summary, TC can be easily implemented with the current technologies available. It requires some upfront investment that is offset by additional revenue and time savings obtained from the activity. More importantly, it allows a better patient care throughout the institution with a more efficient and cost effective use of the pathologist time and laboratory resources. The discrepancy rate of adequacy assessment using TC is similar to adequacy assessments performed on-site.

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REFERENCES

[1]. de Koster EJ, Kist JW, Vriens MR, Borel Rinkes IH, Valk GD, de Keizer B. Thyroid ultrasound-guided fine-needle aspiration: the positive influence of on-site adequacy assessment and number of needle passes on diagnostic cytology rate. Acta Cytol. 2016;60:39–45. [PubMed: 26982029]

[2]. Ecka RS, Sharma M. Rapid on-site evaluation of EUS-FNA by cytopathologist: an experience of a tertiary hospital. Diagn Cytopathol. 2013;41:1075–1080. [PubMed: 24166808]

[3]. Ganguly A, Giles TE, Smith PA, White FE, Nixon PP. The benefits of on-site cytology with ultrasound-guided fine needle aspiration in a one-stop neck lump clinic. Ann R Coll Surg Engl. 2010;92:660–664. [PubMed: 20663278]

[4]. Kern I, Gabric S, Triller N, Pozek I. Telecytology for rapid assessment of cytological specimens. J Telemed Telecare. 2012;18:86–89. [PubMed: 22186066]

[5]. Khurana KK, Graber B, Wang D, Roy A. Telecytopathology for onsite adequacy evaluation decreases the nondiagnostic rate in endoscopic ultrasound-guided fine-needle aspiration of pancreatic lesions. Telemed J E Health. 2014;20:822–827. [PubMed: 25093731]

[6]. Dhillon I, Pitman MB, Demay RM, Archuletta P, Shidham VB. Compensation crisis related to the onsite adequacy evaluation during FNA procedures-Urgent proactive input from cytopathology community is critical to establish appropriate reimbursement for CPT code 88172 (or its new counterpart if introduced in the future). Cytojournal. 2010;7:23. [PubMed: 21082041]

[7]. Bott MJ, James B, Collins BT, et al. A prospective clinical trial of telecytopathology for rapid interpretation of specimens obtained during endobronchial ultrasound-fine needle aspiration. Ann Thorac Surg. 2015;100:201–205. discussion 205–206. [PubMed: 26002445]

[8]. Buxbaum JL, Eloubeidi MA, Lane CJ, et al. Dynamic telecytology compares favorably to rapid onsite evaluation of endoscopic ultrasound fine needle aspirates. Dig Dis Sci. 2012;57:3092–3097. [PubMed: 22729624]

[9]. Agarwal S, Zhao L, Zhang R, Hassell L. FaceTime validation study: low-cost streaming video for cytology adequacy assessment. Cancer Cytopathol. 2016;124:213–220. [PubMed: 26491941]

[10]. Dudas R, VandenBussche C, Baras A, Ali SZ, Olson MT. Inexpensive telecytology solutions that use the Raspberry Pi and the iPhone. J Am Soc Cytopathol. 3:49–55. [PubMed: 31051730]

[11]. Sirintrapun SJ, Rudomina D, Mazzella A, Feratovic R, Lin O. Successful secure high-definition streaming telecytology for remote cytologic evaluation. J Pathol Inform. 2017;8:33. [PubMed: 28966833]

[12]. Li X, Gong E, McNutt MA, et al. Assessment of diagnostic accuracy and feasibility of dynamic telepathology in China. Hum Pathol. 2008;39:236–242. [PubMed: 17950781]

[13]. Briscoe D, Adair CF, Thompson LD, et al. Telecytologic diagnosis of breast fine needle aspiration biopsies. Intraobserver concordance. Acta Cytol. 2000;44:175–180. [PubMed: 10740603]

[14]. Cai G, Teot LA, Khalbuss WE, et al. Cytologic evaluation of image-guided fine needle aspiration biopsies via robotic microscopy: A validation study. J Pathol Inform. 2010;1:4. [PubMed: 20805959]

[15]. Galvez J, Howell L, Costa MJ, Davis R. Diagnostic concordance of telecytology and conventional cytology for evaluating breast aspirates. Acta Cytol. 1998;42:663–667. [PubMed: 9622684]

[16]. Heimann A, Maini G, Hwang S, Shroyer KR, Singh M. Use of telecytology for the immediate assessment of CT guided and endoscopic FNA cytology: diagnostic accuracy, advantages, and pitfalls. Diagn Cytopathol. 2012;40:575–581. [PubMed: 22707323]

[17]. Khurana KK, Rong R, Wang D, Roy A. Dynamic telecytopathology for on-site preliminary diagnosis of endoscopic ultrasound-guided fine needle aspiration of pancreatic masses. J Telemed Telecare. 2012;18:253–259. [PubMed: 22302762]

[18]. Raab SS, Zaleski MS, Thomas PA, Niemann TH, Isacson C, Jensen CS. Telecytology: diagnostic accuracy in cervical-vaginal smears. Am J Clin Pathol. 1996;105:599–603. [PubMed: 8623769]

[19]. Kim B, Chhieng DC, Jhala N, et al. Dynamic telecytopathology has equivalent efficacy with on site rapid cytology diagnoses for pancreatic carcinoma. Cancer Cytopathol. 2006;108:357–358.

[20]. Breeze J, Poller DN, Gibson D, et al. Rapid on-site assessment of specimens by biomedical scientists improves the quality of head and neck fine needle aspiration cytology. Cytopathology. 2014;25: 316–321. [PubMed: 24138590]

[21]. Collins JA, Novak A, Ali SZ, Olson MT. Cytotechnologists and onsite evaluation of adequacy. Korean J Pathol. 2013;47:405–410. [PubMed: 24255627]

[22]. da Cunha Santos G, Boerner SL, Geddie WR. Maximizing the yield of lymph node cytology: Lessons learned from rapid onsite evaluation of image- and endoscopic-guided biopsies of hilar and mediastinal lymph nodes. Cancer Cytopathol. 2011;119:361–366. [PubMed: 21717590]

[23]. de Biase D, Visani M, Malapelle U, et al. Next-generation sequencing of lung cancer EGFR exons 18–21 allows effective molecular diagnosis of small routine samples (cytology and biopsy). PLoS One. 2013;8:e83607.

[24]. Heymann JJ, Bulman WA, Maxfield RA, et al. Molecular testing guidelines for lung adenocarcinoma: Utility of cell blocks and concordance between fine-needle aspiration cytology and histology samples. Cytojournal. 2014;11:12. [PubMed: 24987443]

[25]. Li W, Zhang Z, Guo L, et al. Assessment of cytology based molecular analysis to guide targeted therapy in advanced non-small-cell lung cancer. Oncotarget. 2016;7:8332–8340. [PubMed: 26789109]

[26]. Qiu T, Guo H, Zhao H, Wang L, Zhang Z. Next-generation sequencing for molecular diagnosis of lung adenocarcinoma specimens obtained by fine needle aspiration cytology. Sci Rep. 2015;5:11317. [PubMed: 26066407]

[27]. Rekhtman N, Brandt SM, Sigel CS, et al. Suitability of thoracic cytology for new therapeutic paradigms in non-small cell lung carcinoma: high accuracy of tumor subtyping and feasibility of EGFR and KRAS molecular testing. J Thorac Oncol. 2011;6:451–458. [PubMed: 21266922]

[28]. Russell PA, Rogers TM, Solomon B, et al. Correlation between molecular analysis, diagnosis according to the 2015 WHO classification of unresected lung tumours and TTF1 expression in small biopsies and cytology specimens from 344 non-small cell lung carcinoma patients. Pathology. 2017;49:604–610. [PubMed: 28811082]

[29]. Schmitt F, Machado JC. Ancillary studies, including immunohistochemistry and molecular studies, in lung cytology. Surg Pathol Clin. 2014;7:35–46. [PubMed: 26839267]

[30]. Travis WD, Rekhtman N. Pathological diagnosis and classification of lung cancer in small biopsies and cytology: strategic management of tissue for molecular testing. Semin Respir Crit Care Med. 2011;32: 022–031.

[31]. Wistuba II. Molecular testing of non-small cell lung carcinoma biopsy and cytology specimens. Am Soc Clin Oncol Educ Book. 2012; 459–464. [PubMed: 24451780]

[32]. C. G. Cracking the code: advice for CPT dilemmas. CAP Today. 1999;1999:84–90.

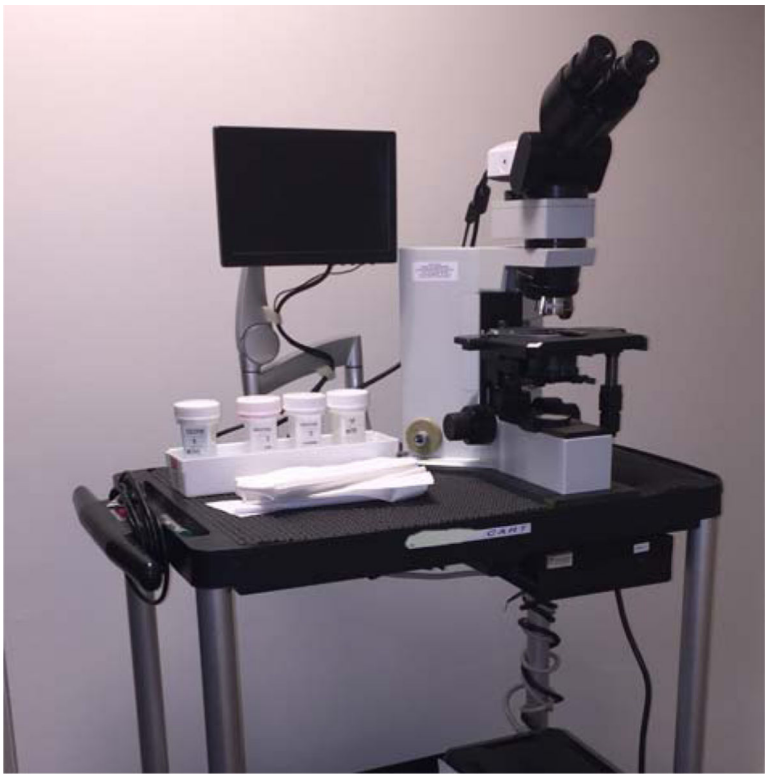

FIGURE 1.
RMT® equipment used for telecytology with live image transmission installed in a mobile cart

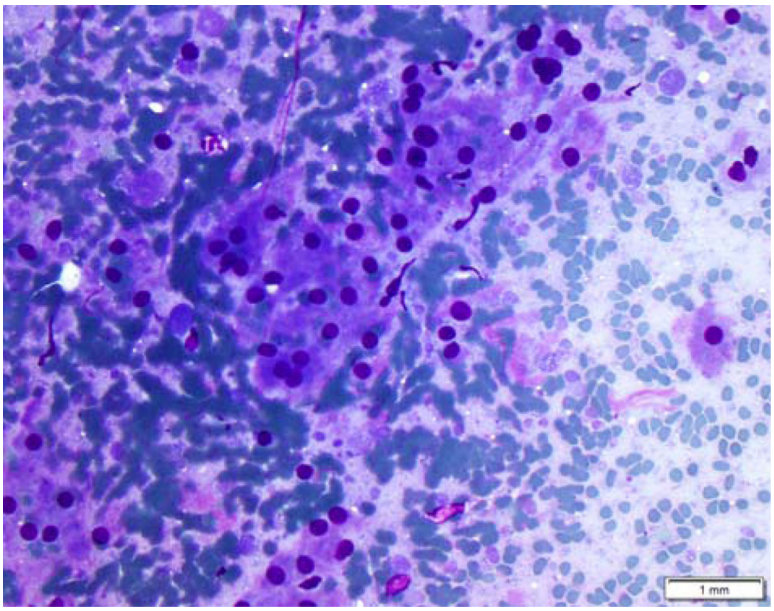

FIGURE 2.

Modified Giemsa stained slide from a kidney biopsy showing cells with bland nuclear features and abundant granular cytoplasm. The differential diagnoses include benign renal tubular cells and neoplasm with oncocytic features