P1 Pathological Diagnosis of Thyroid Cancer Histopathological Image from Intraoperative Frozen Sections Based on Deep Transfer learning

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= Abstract =

Objective To explore the artificial intelligence (AI)-assisted diagnosis system of thyroid cancer based on deep transfer learning and evaluate its clinical application value. Methods The HE sections of 682 cases thyroid disease patients (including benign lesions, papillary carcinoma, follicular carcinoma, medullary carcinoma and undifferentiated carcinoma) in the Pathology Department of the Renmin Hospital of Wuhan University were collected, scanned into digital sections, divided into training sets and internal test sets according to the ratio of 8:2, and the training sets were labeled at the pixel level by pathologists. The thyroid cancer classification model was established using ResNet-50 image classification algorithm model. In the process of model training, the parameters of the breast cancer region recognition model are taken as the initial values, and the parameters of the thyroid cancer region recognition model are optimized through the transfer learning strategy. Then use the test set and 633 intraoperative frozen HE section images of thyroid disease in Jianli County Renmin Hospital, Jingzhou City, Hubei Province as the external test set to evaluate the performance of the established AI-assisted diagnostic model. Results In the internal test set, without the use of the breast cancer region recognition model transfer learning, the accuracy of the AI-assisted diagnosis model was 0.882, and the area under the Receiver operating characteristic (AUC) value was 0.938; However, in the use of the Transfer learning model, the accuracy of the AI-assisted diagnosis model for was 0.926, and the AUC value was 0.956. In the external test set, the accuracy of the zero learning model is 0.872, the AUC value is 0.915, and the accuracy of the Transfer learning model is 0.905, the AUC value is 0.930. Conclusion The AI-assisted diagnosis method for thyroid cancer established in this study has good accuracy and generalization. With the continuous development of pathological AI research, transfer learning can help improve the performance and generalization ability of the model, and improve the accuracy of the diagnostic model.

Keywords: Thyroid Cancer; Intraoperative Frozen Sections; Artificial Intelligence; Transfer Learning; Pathological Diagnosis.

P2 Deep Learning Prediction Model for Central Lymph Node Metastasis in Papillary Thyroid Microcarcinoma Based on Cytology

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= Abstract =

Controversy exists regarding whether patients with low-risk papillary thyroid microcarcinoma (PTMC) should undergo surgery or active surveillance; the inaccuracy of the preoperative clinical lymph node status assessment is one of the primary factors contributing to the controversy. Predicting the lymph node status of PTMC preoperatively with high accuracy is an imperative need. This study aims to predict lymph node status using a deep learning method for more precise triage of PTMC patients. We selected 208 liquid-based preparations as our research objects; all of these instances underwent lymph node dissection and, aside from lymph node status, were consistent with low-risk PTMC. We separated them into two groups according to whether the postoperative pathology showed central lymph node metastases. The deep learning model was expected to predict, based on the preoperative liquid-based preparation, whether PTMC was accompanied by central lymph node metastases. Our deep learning model attained a sensitivity, specificity, positive prediction value (PPV), negative prediction value (NPV), and accuracy of 78.9% (15/19), 73.9% (17/23), 71.4% (15/21), 81.0% (17/21) and 76.2% (32/42), respectively. The area under the receiver operating characteristic curve (AUC) value was 0.850. The predictive performance of the deep learning model was superior to that of the traditional clinical evaluation, and further analysis revealed the cell morphologies that played the key role in model prediction. Our study suggests that deep learning is a reliable strategy for predicting central lymph node metastases in thyroid micropapillary carcinoma, and its performance surpasses that of traditional clinical examination.

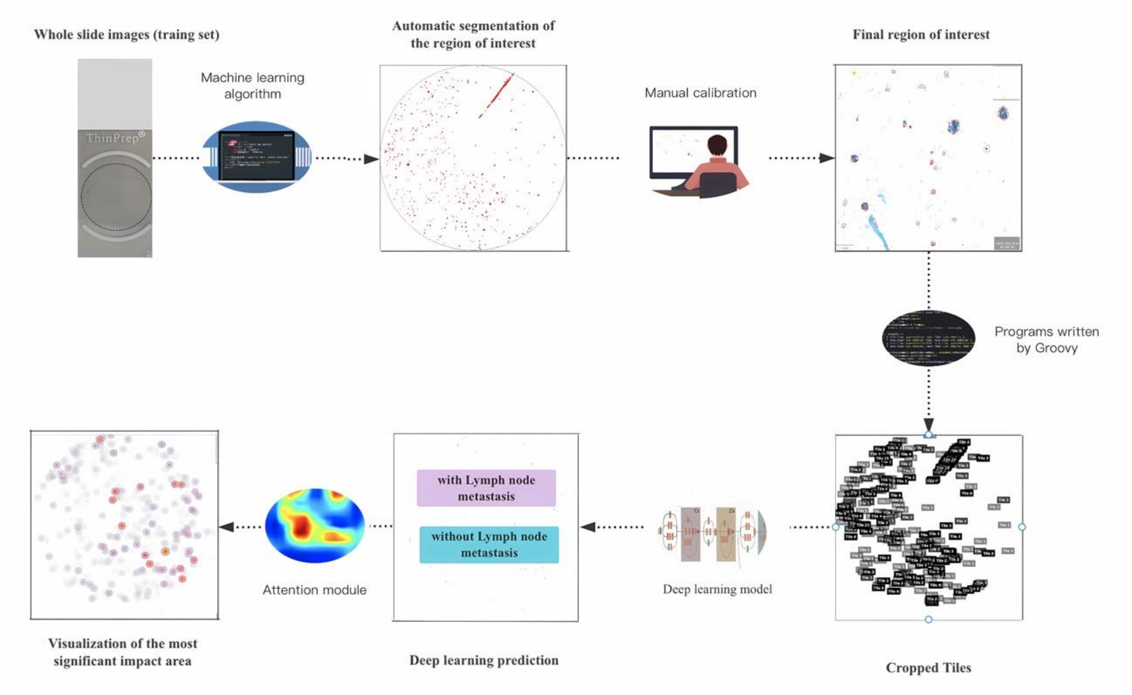

Figure 1. Pipeline of the deep learning framework presented in this study.

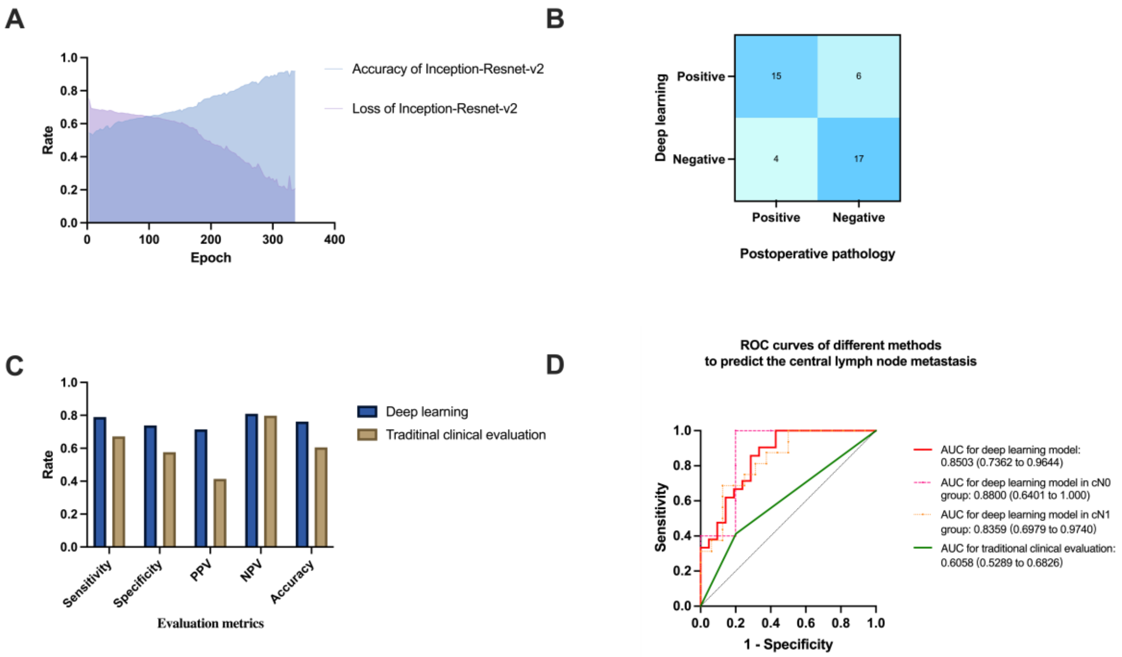

Figure 2. Lymph node status prediction by deep learning model. (A) Accuracy and cross-entropy loss curve in the training set. (B) Confusion matrix of the deep learning model in the test set. (C) Evaluation matrix of deep learning and traditional clinical evaluation in predicting CLNM in PTMC. (D) The receiver operating characteristic (ROC) curves for predicting CLNM of PTMC of deep learning and traditional clinical evaluation.

P3 Exploring the selection of digital pathology scanners in the implementation of digital intelligent pathology within the field of digital pathology

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= Abstract =

Background:

To analyze and discuss the actual application of digital pathology scanners from six different manufacturers in the Pathology Department of Ruijin Hospital, affiliated with Shanghai Jiao Tong University School of Medicine. We aim to present our experience with the challenges encountered and enhance the comprehension of digital pathology scanners in different regions of China.This will enable us to meet the diverse demands of clinical practice, education, and research, while expediting the digitization and intelligent development of pathology in China.

Design:

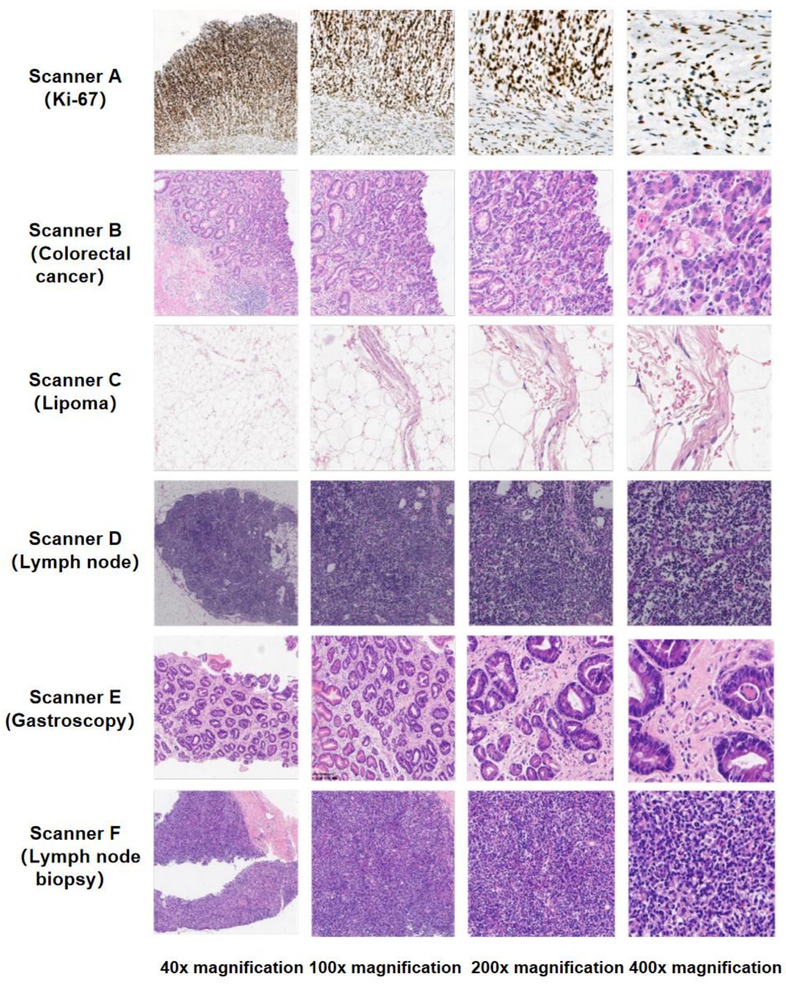
We collected various types of pathology slides and evaluated the mechanical performance and image quality of scanners from different manufacturers by practically applying them in work scenarios.Additionally, using gastric biopsy specimens as an example, we developed a preliminary artificial intelligence model for identifying the benign and malignant nature of gastric biopsies. This model was trained on Whole Slide Images (WSI) generated by one of the scanners. To validate the model, the same batch of physical glass slides were used and scanned by the remaining scanners to generate WSIs.

Results:

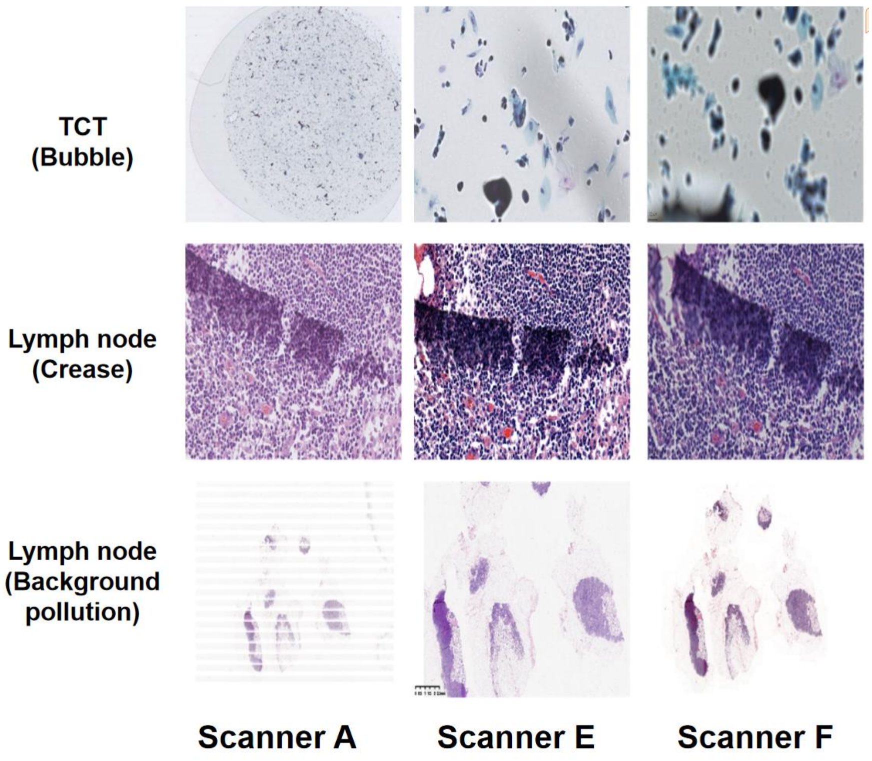
The WSI images generated by the digital pathology scanners were in line with the routine practice of examining slides under a microscope. Nevertheless, there were variations in mechanical performance and image quality among different scanners, and the specifications provided by manufacturers were inadequate for a comprehensive evaluation of their performance.The algorithm model, which relied on WSI images generated by a single scanner, obtained an impressive AUC score of 0.88 on the test set produced by that particular scanner. However, when the model was validated on WSIs generated by the other scanners using the same batch of physical glass slides for testing, noticeable declines in performance were observed, highlighting significant discrepancies.

Conclusions:

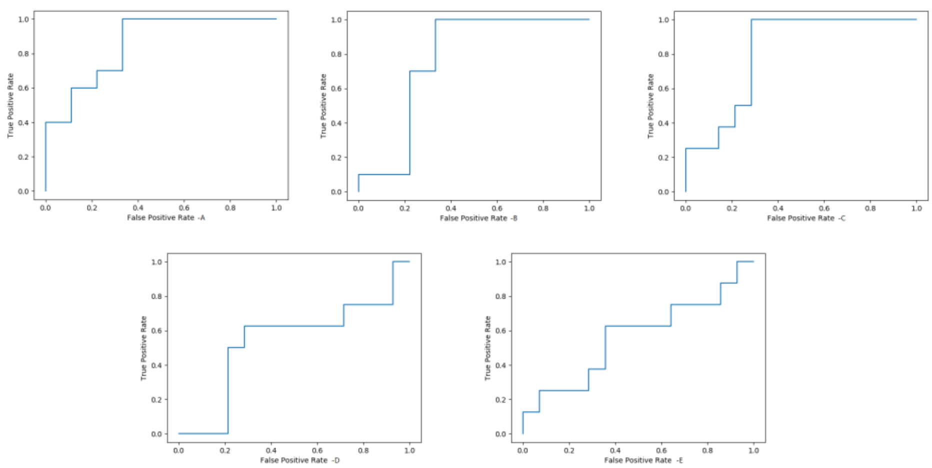
It is imperative to establish guidelines and standards for the selection of suitable scanners in the implementation of digital intelligent pathology. Pathology departments should evaluate scanner performance based on their current digital workflow status and opt for digital pathology scanners that align with the department's developmental needs. Moreover, enhancing quality control requirements for physical slides can significantly improve scanning efficiency and the quality of Whole Slide Images (WSIs). In order to effectively strategize the implementation of digital intelligent pathology, expedite the integration of digital pathology and artificial intelligence into clinical practice and translational medicine, it is crucial to establish pertinent standards for WSIs. These standards will facilitate the advancement of computational pathology and cater to the diverse needs of next-generation diagnostic pathology.



（Figure 1）Subjective evaluation of the images: The images that received positive subjective evaluations are consistent with the standard practices of examining microscopic slides. After scanning tissues of different sizes, textures, and types, the whole slide imaging (WSI) displays magnified images with high resolution and clarity in the image viewing software.



（Figure 2）Subjective evaluation of the images: Different scanner manufacturers have specific quality requirements for the slides. However, when the slides have various flaws, all scanners face challenges in achieving accurate focus, leading to scanning failures. Some scanners exhibit higher sensitivity than others, which may cause background-contaminated slides to display uneven color stripes in the whole slide imaging (WSI).



(Table 1) The algorithm test results (AUC) were compared among different scanners, with the graph's horizontal axis representing the false positive rate and the vertical axis representing the true positive rate.

P4 Application of Fine-grained Vision Transformer Adapter in Cytopathology

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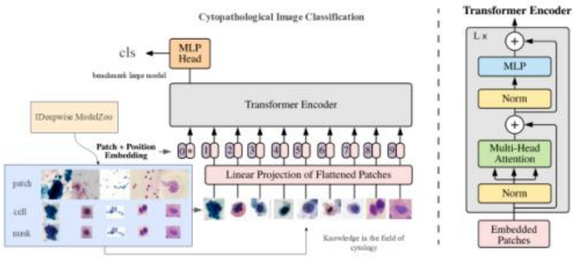
= Abstract =

Background: Given that identifying different pathological cells relies on specific classification models, this limits the development of large-scale benchmark models in cellular pathology. Therefore, we propose a classification model suitable for various cytologies.**Methods:** Firstly, we use a pre-trained model, the Segment Anything Model (SAM), to create a large-scale cytopathology image dataset comprising masks under more than 10,000,000 unique modalities.Subsequently, we employ multiple independent pre-trained models from the iDeepWise deep learning model library to pre-annotate all masked areas. Doctors manually annotate 1% of the data to determine the cell types. We then develop a new fine-grained visual Transformer adapter that implements cellular pathology knowledge for positional embedding. This approach enables the creation of a multi-task classification model without any additional or pre-defined tasks and applied to cellular pathology image classification. During model training, we use 1% of the annotated data to correct model training parameters, thereby avoiding bias in the model's training iteration direction. At the encoder stage, we employ an attentional convolutional network to capture the variety of features in the fine-grained details. **Results:** Ultimately, we obtained a cytopathology fine-grained vision transformer adapter applicable to various cytologies learning and classification task, including cervical cells, urine cells, peritoneal cells, sputum cells, and thyroid cells. Empirical evaluations on major benchmark datasets showed that our method outperforms not only in achieving leading-level performance but also surpasses a series of cutting-edge pathological cell image classification methods, such as ResNet-50, VIT, and Swin-Transformer. **Conclusion:** Our fine-grained vision transformer adapter model can be used as a benchmark large model in cytopathology.



Method	Cervical cells	Urinary cells	Peritoneal cells	Sputum cells	Thyroid cells
Resnet-50	92.34	92.8	94.42	94.34	91.74
VIT	94.87	94.1	95.81	95.46	93.78
Swin-Transformer	97.22	96.5	97.35	94.61	95.04
Our Model	96.59	98.6	98.83	95.87	96.57

P5　Vision Transformer による肺細胞診標本の良悪性鑑別と注目領域の可視化

Automated Classification and Visualization of Lung Cytological Specimen Using Vision Transformer

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人工知能を用いた画像分類アルゴリズムのひとつに畳み込みニューラルネットワーク(Convolutional neural network, CNN)があり、細胞診標本の分類にも優れた分類性能が得られることが確かめられている。我々もこれまでにパパニコロウ染色やギムザ染色標本を対象とした肺細胞診標本の良悪性鑑別や組織型分類に取り組んできた。近年、自動翻訳や ChatGPT 等の自然言語処理の処理能力が著しく向上しており、これらの技術では CNN ではなく、Attention 機構を導入した Transformer と呼ばれる技術を利用している。Transformer は自然言語だけではなく画像処理へ応用可能であり、Vision Transformer などの画像処理モデルも提案されている。本発表では Vision Transformer を用いて肺細胞診標本の自動鑑別処理と分類根拠の可視化を試みた結果を報告する。

P7 Validation of Galen Prostate and Galen Breast AI solutions in a Japanese cohort

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Background

Prostate and breast cancer incidence rates have been on the rise in Japan, emphasizing the need for precise histopathological diagnosis to determine patient prognosis and guide treatment decisions. This study aimed to validate the performance and clinical utility of two artificial intelligence (AI) solutions in the detection of prostate and breast cancer in real world clinical routine use in a in a Japanese cohort, also assessing their grading capabilities.

Design

The research entailed a retrospective examination of 200 consecutive prostate and breast core needle biopsy cases (741 WSIs for prostate cases and 678 WSIs for breast cases) obtained from a Japanese institution. All slides were scanned previously with the Philips Ultrafast Scanner (Philips Digital Pathology Solution, Netherlands) at 40x magnification. The digitized slides were blindly processed by the AI solutions. Alerts were triggered in case of discrepancies between the AI results and the ground truth (GT), which was based on the original sign-out reports, prompting a second review by independent subspecialist pathologists.

Results

The AI solutions showed accurate cancer detection, with AUCs of 0.988 (95%CI: [0.975;1]) and 0.997 (95% CI: [0.992;1]) for the Galen Prostate and Galen Breast, respectively. Additionally, the AI showed high accuracy for the detection of DCIS with an AUC of 0.996 (95% CI: [0.987;1]). Galen Prostate was able to detect a higher Gleason score in 4 adenocarcinoma cases and detect a previously unreported cancer. Overall, 5 cases had their diagnoses revised based on the AI system's alerts, corresponding to a revision rate of 5% among the 100 prostate needle biopsies analysed. The AI solutions successfully identified relevant pathological features, such as perineural invasions and lymphovascular invasions.

Conclusions

These findings demonstrated high accuracy of these AI solutions irrespective of the geographical origin and different lab pre-analytics, with the potential to enhance the precision and efficiency of prostate and breast cancer diagnosis in Japan. Furthermore, this validation paves the way for broader adoption of AI as decision support tools within the Asian population, potentially leading to improved patient outcomes and decreased healthcare costs.

P8　成田記念病院での WSI 運用実績

WSI at Narita Memorial Hospital

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＝抄録＝
成田記念病院はベット数 284 床、年間病理診断件数 3000 弱の中規模病院である。1 枚用 WSI (Whole Slide Imaging)スキャナを設置し 2 年が経過したので、運用実績について紹介したい。
小・中規模施設で WSI 導入を検討している方の運用のきっかけになれば、と考える。
一般的には WSI 導入により病理医不在時の迅速診断や遠隔診断が可能になるとされているが、当院では主に、①院内カンファレンス、②他病理医へのコンサルテーション、③他院からのガラス内容の保管、④希少例/学会発表用症例のコレクション/蓄積、⑤大学との共同研究用として運用している。
特に②他院コンサルテーションについてはとても重宝しており病理医（私）の業務および精神的負担軽減に役立っている。
今後は、技師の協力下、病理医不在時の迅速診断にも対応可能か検討したい。これらのデジタル化が進めば病理医の働き方改革「Work Style Innovation (WSI) 」にも役立つと考える。