Audit of Turnaround Time for a Training Oral Histopathology Laboratory in Malaysia

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Abstract

Background. Turnaround time (TAT) is the benchmark to assess the performance of a laboratory, pathologists, and pathology services, but there are few articles on TAT of surgical pathology, particularly in relation to oral or head and neck specimens. This study investigates the TAT for oral histopathology reporting in an academic institution’s training laboratory and offers recommendations to achieve better overall quality of diagnostic services. Methods. This study examined data obtained from biopsy request forms for specimens received from the Oro-Maxillofacial Surgery Department of Hospital Tengku Ampuan Rahimah Klang in the Oral Pathology Diagnostic Laboratory of the Faculty of Dentistry, University of Malaya, over a period of 3 years between January 2012 and October 2014. Results. TAT for surgical and decalcified specimens were increased significantly compared to biopsies. Additional special handling did not influence TAT, but increased specimen volume resulted in greater TAT. Slide interpretation was the most time-consuming stage during histopathology reporting. Overall, mean TAT was acceptable for most specimens, but the TAT goals were less than satisfactory. Conclusion. A TAT goal appropriate for this laboratory may hence be established based on this study. Collective efforts to improve the TAT for various specimens are essential for better laboratory performance in the future.

Keywords

turnaround time, oral histopathology, biopsies, surgical specimens

Introduction

The first oral pathology diagnostic laboratory in Malaysia was established in 1967 as the “Stomatology Unit” in the Institute of Medical Research.¹ Oral pathology diagnostic services were made available in the Faculty of Dentistry, University of Malaya, from 1978.² In 2000, the University of Malaya became the only training center for budding oral pathologists in Malaysia by offering the Master of Clinical Dentistry (MClinDent) program in Oral Pathology and Oral Medicine. In keeping with the current developments in oral histopathological reporting, a continuous assessment of the practice is necessary to gauge the performance level as well as to address issues affecting the service. Therein lies the importance of a healthy turnaround time (TAT).

TAT was initially introduced in 1971 as the time interval between the printing of electrocardiogram to the placement of the printout in a patient’s chart.³ Numerous articles on medical services reporting TAT have been published ever since,³ and TAT is currently regarded as an invaluable key indicator of the performance and efficiency of medical services. TAT is evaluated as a component of quality assurance in surgical pathology⁴,⁵ as well as in ensuring patient satisfaction.⁶ In the past, different definitions of TAT have surfaced in different clinical domains, with variations between the clinician and the laboratory. From these, the laboratory TAT and clinician TAT were among the most commonly used definitions of TAT. Laboratory TAT referred to the time interval between the receipt of the specimen and the availability of the report, whereas the clinician TAT indicated the time interval between the physician’s request and the time the physician received the report.⁸,⁹ There is also the therapeutic TAT, described as
the overall quality of diagnostic services.

TAT has become the benchmark to assess the performance of a laboratory, pathologists, and pathology services. Shorter TAT is instrumental in maintaining efficient pathology services. In effect, clinicians are provided with an early diagnosis, and consequently, early intervention will reduce the need for lengthy hospitalization as well as the associated expenditures. Therefore, it is hardly surprising that there is no lack of research conducted on TAT. The bulk of available literature is generally skewed toward laboratory TAT, with greater emphasis on clinical pathology. In contrast, there is only a handful of articles on TAT of surgical pathology, often with no clear distinction for oral or head and neck specimens. The purpose of this study was to determine the TAT for oral histopathology reporting in an academic institution’s training laboratory and to offer recommendations on how to improve the TAT based on the existing facilities and human resources, and subsequently the overall quality of diagnostic services.

**Materials and Methods**

Samples considered for this study are all specimens (biopsies and surgical resections) received from the Oral-Maxillofacial Surgery Department of Hospital Tengku Ampuan Rahimah Klang (HTAR) in the Oral Pathology Diagnostic Laboratory of the Faculty of Dentistry, University of Malaya (UM), over a period of 3 years between January 2012 and October 2014. The samples comprised incisional biopsies, excisional biopsies, surgical specimens, and decalcified specimens. Frozen sections tied with diagnostic research and specimens that were referred for second opinion were excluded. Specimens sent for routine pathology review from other centers including the ones from patients treated at this tertiary center were also excluded.

The biopsy request form was modified to include data regarding the types of specimen as well as dates and times when

1. The specimen was taken at HTAR
2. The specimen was received in the UM laboratory from HTAR
3. The specimen was grossed by an Oral Pathology trainee under the supervision of a Consultant of Oral Maxillofacial Pathology
4. The slides were prepared by the medical laboratory technologist (MLT) for interpretation
5. The report was drafted by the consultant
6. The final report was typed by an MLT or trainee and signed by a consultant of oral maxillofacial pathology
7. The final report was dispatched to HTAR

Other relevant information extracted were specimen volume, number of blocks, processing procedures (paraffin embedding, hematoxylin and eosin stain, special stains, immunohistochemical stains), and reporting pathologists and/or postgraduate trainees. Specimen volume was calculated by the dimension of the specimens during macroscopic examination (length × width × height). All the oral pathologists, postgraduate trainees, and laboratory technicians involved were briefed on the form filling. Date and time for all the stages in specimen processing were recorded by the pathologist, MLT, or the clerk in a table on the back of the request forms. The final reports were usually collected by an attendant from HTAR whenever new specimens were delivered to the laboratory. For urgent cases, the specimens would be delivered to the laboratory on the same day of the surgery and the final reports would be faxed to HTAR as soon as they were available.

The TAT of a report was measured in working days, calculated from the time the specimen was received in the laboratory to the time the final report was released for the clinician. A working day referred to a calendar day of 24 hours beginning at 12 AM. Holidays and weekends were excluded in this calculation.

There was a total of 853 reports generated from 798 specimens, of which 785 reports satisfied all inclusion criteria. With the removal of 36 outliers, the final sample size amounted to 749 reports. The outliers were samples that fell beyond 2 standard deviations (SD) from the mean (mean ± 2SD) when examining the TAT for each category of specimens. All data were analyzed with SPSS version 12.0.

**Results**

The 749 reports analyzed were inclusive of 344 incisional biopsies (45.93%), 187 excisional biopsies (24.97%), 157 surgical specimens (20.96%), and 61 decalcified specimens (8.14%). The cases were almost evenly distributed in the 3 years (2012-2014) at 34.31%, 31.64%, and 34.05%, respectively (Table 1). Majority of the total reports are incisional or excisional biopsies, both of which do not clock significantly different mean TAT. Excisional and incisional biopsies have a mean TAT of 7.21 ± 0.26 days and 7.07 ± 0.21 days, respectively. On the other hand, mean TAT for surgical specimens (15.46 ± 0.80 days) was about twice the mean TAT for biopsies while mean TAT for decalcified specimens more than quadrupled at 40.07 ± 17.98 days. As a whole, types of specimen did influence the TAT significantly (Table 2). Of all cases, additional special handling was necessary for 81 specimens (10.81%): 42 required special stains, 32 required immunohistochemical stains, and 7 required both special stains and immunohistochemistry stains but no significant difference (P = .088) was noted between special handling and TAT (Table 3).
The overall mean TAT was 11.55 ± 11.83 days for all specimens. The largest interval was observed between slide preparation and the pathologist report, with a mean of 5.82 ± 5.40 days. Generally, all the reporting stages involving surgical specimens and decalcified specimens were more time consuming than biopsy specimens, especially in the interval between accessioning and grossing (Table 4).

For the years 2012, 2013, and 2014, TAT averaged at 11.33 ± 13.25, 12.67 ± 10.14, and 10.73 ± 11.72 days, respectively. Overall mean TAT for all the reporting stages were highest in 2013 (Table 5). Likewise, the number of paraffin blocks was also the highest in 2013. Surgical specimens contributed to the majority of the paraffin blocks every year (Table 1).

In Table 6, the specimen volume was categorized as <0.5 cm³, 0.5 cm³ to 2.0 cm³, and >2.0 cm³. A little over half of the reports (52.20%) had a specimen volume of <0.5 cm³, corresponding to a mean TAT of 7.31 ± 4.30 days. For specimen volume >2.0 cm³, mean TAT was significantly prolonged at 21.74 days. Specimen volume of <0.5 cm³ and 0.5 cm³ to 2.0 cm³ did not differ much from one another in terms of TAT.

Out of 749 specimens, 88 cases (11.75%) were seen by the consultant pathologist only, while the rest were attended by both a postgraduate trainee and a consultant pathologist. Biopsy specimens recorded slightly better, if insignificant, mean TAT for cases seen solely by the pathologist. However, surgical specimens and decalcified specimens both had better mean TAT when seen by both (Table 7).

Summary of the laboratory’s TAT goals for various specimen types are presented in Tables 8 and 9.

**Discussion**

The overall mean TAT for oral biopsy specimens in this study of 7.15 days represented an improvement from a previous study published by Siar and Tan in 2000. Their article reported an overall mean TAT of 13.93 days over the span of 20 years. There was drastic reduction of TAT to just 7.21 days in 1998, made possible by the availability of accession dates due to improved documentation. However, even though the study was conducted in the same laboratory setting, direct comparison was impracticable due to different calculation methods. Furthermore, surgical specimens were yet to be submitted to this laboratory in the duration of their study. The optimal TAT for oral biopsy was adjudged to be 7 to 10 days. The Royal College of Pathologists (RCPath) in their guidelines for handling of specimens in relation to non-neoplastic lesions of the head and neck recommended that 80% of the cases must be reported within 7 calendar days and 90% within 10 calendar days with the exception of cases...
Table 4. Breakdown of Turnaround Time for All Specimens by Types of Specimen and Reporting Stages.

<table>
<thead>
<tr>
<th>Reporting Stages</th>
<th>Days, Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessioning and grossing</td>
<td>EB</td>
</tr>
<tr>
<td>Accessioning and grossing</td>
<td>0.26 (0.69)</td>
</tr>
<tr>
<td>Processing</td>
<td>1.62 (0.83)</td>
</tr>
<tr>
<td>Slides examination</td>
<td>4.81 (3.37)</td>
</tr>
<tr>
<td>Pathologist report</td>
<td>0.43 (0.80)</td>
</tr>
<tr>
<td>TAT</td>
<td>7.21 (3.60)</td>
</tr>
</tbody>
</table>

Abbreviations: TAT, turnaround time; SD, standard deviation; EB, excisional biopsy; IB, incisional biopsy; SS, surgical specimen; DE, decalcified specimen.

Table 5. Breakdown of Turnaround Time for All Specimens by Types of Specimen and Reporting Stages in 2012, 2013, and 2014.

<table>
<thead>
<tr>
<th></th>
<th>Days, Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EB</td>
</tr>
<tr>
<td>Accessioning</td>
<td>0.50</td>
</tr>
<tr>
<td>and grossing</td>
<td>(0.52)</td>
</tr>
<tr>
<td>Processing</td>
<td>1.41</td>
</tr>
<tr>
<td>Slides</td>
<td>4.76</td>
</tr>
<tr>
<td>examination</td>
<td>(0.65)</td>
</tr>
<tr>
<td>Pathologist</td>
<td>0.48</td>
</tr>
<tr>
<td>report</td>
<td>(0.56)</td>
</tr>
<tr>
<td>TAT</td>
<td>7.01</td>
</tr>
</tbody>
</table>

Table 6. Turnaround Time According to Specimen Volume.

<table>
<thead>
<tr>
<th>Specimen Volume (cm³)</th>
<th>Total (n)</th>
<th>Mean TAT (SD)</th>
<th>P (df)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;0.5</td>
<td>387</td>
<td>7.31 (4.30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5-2.0</td>
<td>150</td>
<td>8.08 (6.63)</td>
<td>155.524 (2746)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&gt;2.0</td>
<td>212</td>
<td>21.74 (16.88)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: TAT, turnaround time; SD, standard deviation; EB, excisional biopsy; IB, incisional biopsy; SS, surgical specimen; DE, decalcified specimen.

There was a separate standard TAT for specimens of oral mucosal malignancies in which 80% of diagnostic biopsies were to be reported within 7 calendar days of the procedure. The British Association of Head and Neck Pathologists (BAHNO), one of the consulted stakeholders in the publication of the data set for histopathology reporting of mucosal malignancies in the oral cavity by RCPACpath, set a minimum interval between biopsy to report issue at 90% within 7 calendar days. The mean TAT in this study met the recommended TAT for biopsy specimens, but the cumulative completion percentage was sorely lacking. Only 60% of biopsies were reported within 7 days. However, while no distinction between neoplastic or nonneoplastic lesion was made in this study, an oral report or a faxed report customarily preceded the final written report in all urgent cases.
salivary gland tumors, and soft tissue tumors. These were usually large specimens, often with considerable specimen volume and produced higher average of blocks per report, which in turn led to a less desirable TAT. This was reflected by the increased overall mean TAT for 2013, when a substantial increase in paraffin blocks were recorded. Larger specimens often necessitate longer grossing time, especially since all soft tissue specimens were processed in its entirety as opposed to representative sections in this laboratory. Extra processing effort and additional evaluation by the pathologist would also be required. The use of special handling techniques by way of overnight fixation, recuts or levels, re-embedding of poorly oriented specimens, re-grossing, special histochemical staining, and immunohistochemical staining reportedly further prolongs the TAT.20 This study only examined the impact of special stains and immunohistochemical staining to TAT, the results of which were insignificant. Generally, immunohistochemistry or special stains would require an additional 2 days, inclusive of the day of request, provided the request was made at least half an hour prior to the closure of the laboratory. Since surgical specimens often included parts that required decalcification, the combined TAT would naturally be worse as the most worrying TAT in this study revolved around decalcified specimens. RCPath’s standard TAT for resection specimens was 80% of all cases within 10 calendar days of the specimen being taken.18 BAHNO’s minimum standard was 80% by 14 calendar days or 21 calendar days in cases where decalcification was required.19

### Table 7. Comparison of TAT Between Cases Seen by Consultant Pathologists Only and Those Seen by Postgraduate Student (PG) With Consultant Pathologist.

<table>
<thead>
<tr>
<th>Type of Specimens</th>
<th>Pathologist Only, Mean TAT (SD)</th>
<th>Pathologist and PG, Mean TAT (SD)</th>
<th>Mean Difference (95% CI)</th>
<th>t (df)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decalcified specimen</td>
<td>17 47.47 (17.69)</td>
<td>44 37.20 (17.45)</td>
<td>10.266 (0.257, 20.275)</td>
<td>2.052</td>
<td>.045</td>
</tr>
<tr>
<td>Excisional biopsy</td>
<td>22 6.91 (3.58)</td>
<td>165 7.25 (3.61)</td>
<td>−0.339 (−1.954, 1.275)</td>
<td>−0.415</td>
<td>.679</td>
</tr>
<tr>
<td>Incisional biopsy</td>
<td>34 6.56 (3.51)</td>
<td>310 7.12 (3.83)</td>
<td>−0.564 (−1.9915, 0.787)</td>
<td>−0.821</td>
<td>.687</td>
</tr>
<tr>
<td>Surgical specimens</td>
<td>15 16.20 (9.44)</td>
<td>142 15.38 (10.02)</td>
<td>0.820 (−4.525, 6.165)</td>
<td>0.303</td>
<td>.762</td>
</tr>
<tr>
<td>Total</td>
<td>88 4.66 (3.58)</td>
<td>661 4.66 (3.58)</td>
<td></td>
<td>1.00</td>
<td>.315</td>
</tr>
</tbody>
</table>

Abbreviations: TAT, turnaround time; SD, standard deviation; df, degrees of freedom; CI, confidence interval.

*Equal variance assumed (Levene’s test P value = .960).
*Equal variance assumed (Levene’s test P value = .697).
*Equal variance assumed (Levene’s test P value = .581).
*Equal variance assumed (Levene’s test P value = .987).
*Level of significance was set at .05.

### Table 8. Turnaround Time for Different Types of Specimen at Different Checkpoints.

<table>
<thead>
<tr>
<th>Type of Specimen and TAT</th>
<th>IB, n (%)</th>
<th>EB, n (%)</th>
<th>SS, n (%)</th>
<th>DE, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤7 days</td>
<td>217 (63.1)</td>
<td>117 (62.6)</td>
<td>46 (29.3)</td>
<td>1 (1.6)</td>
</tr>
<tr>
<td>&gt;7 days</td>
<td>127 (36.9)</td>
<td>70 (37.4)</td>
<td>111 (70.7)</td>
<td>60 (98.4)</td>
</tr>
<tr>
<td>≤14 days</td>
<td>325 (94.5)</td>
<td>175 (93.6)</td>
<td>85 (54.1)</td>
<td>2 (3.3)</td>
</tr>
<tr>
<td>&gt;14 days</td>
<td>19 (5.5)</td>
<td>12 (6.4)</td>
<td>72 (45.9)</td>
<td>59 (96.7)</td>
</tr>
<tr>
<td>≤21 days</td>
<td>344 (100.0)</td>
<td>187 (100.0)</td>
<td>113 (72.0)</td>
<td>13 (21.3)</td>
</tr>
<tr>
<td>&gt;21 days</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>44 (28.0)</td>
<td>48 (78.7)</td>
</tr>
<tr>
<td>Total</td>
<td>344</td>
<td>187</td>
<td>157</td>
<td>61</td>
</tr>
</tbody>
</table>

Abbreviations: TAT, turnaround time; IB, incisional biopsy; EB, excisional biopsy; SS, surgical specimen; DE, decalcified specimen.

Note: Bold figures indicate the recommended TAT for that particular type of specimen.

### Table 9. Cumulative Percentile of Turnaround Time for Various Types of Specimen.

<table>
<thead>
<tr>
<th>Percentile Rank</th>
<th>IB</th>
<th>EB</th>
<th>SS</th>
<th>DE</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>16.2</td>
<td>3</td>
</tr>
<tr>
<td>20%</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>20.4</td>
<td>4</td>
</tr>
<tr>
<td>30%</td>
<td>5</td>
<td>5</td>
<td>8</td>
<td>28.6</td>
<td>5</td>
</tr>
<tr>
<td>40%</td>
<td>5</td>
<td>6</td>
<td>10</td>
<td>37</td>
<td>6</td>
</tr>
<tr>
<td>50%</td>
<td>6</td>
<td>6</td>
<td>12</td>
<td>40</td>
<td>7</td>
</tr>
<tr>
<td>60%</td>
<td>7</td>
<td>7</td>
<td>17</td>
<td>43.2</td>
<td>9</td>
</tr>
<tr>
<td>70%</td>
<td>9</td>
<td>9</td>
<td>20.6</td>
<td>48</td>
<td>11</td>
</tr>
<tr>
<td>80%</td>
<td>10</td>
<td>10</td>
<td>24.4</td>
<td>59.6</td>
<td>15</td>
</tr>
<tr>
<td>90%</td>
<td>13</td>
<td>12</td>
<td>30</td>
<td>66</td>
<td>25</td>
</tr>
<tr>
<td>100%</td>
<td>18</td>
<td>18</td>
<td>43</td>
<td>76</td>
<td>76</td>
</tr>
</tbody>
</table>

Abbreviations: TAT, turnaround time; IB, incisional biopsy; EB, excisional biopsy; SS, surgical specimen; DE, decalcified specimen.
Mean TAT for surgical specimens in this study was marginally short of BAHNO’s minimum standard, but mean TAT for decalcification specimens almost doubled the standard TAT. Only 54.1% of surgical specimens were reported within 14 days, but decalcification specimens reported within 21 days was less than half. Hence, it was imperative to review the protocol for reporting decalcified specimens.

Decalcification involves removing inorganic calcium from the organic collagen matrix, calcified cartilage, and surrounding tissues in bone to obtain satisfactory paraffin sections using decalcifying agents like acids and chelating agents. Factors influencing the decalcification rate are concentration and volume of the active reagent, age of patients, type of bone, and size of specimen. This laboratory has continually made efforts over the years to shorten the decalcification process interval. There was a switch of decalcifying agent from 10% formic acid (weak organic acid) in the earliest days to 8% hydrochloric acid (strong inorganic acid) in the mid-1990s. At the time of writing, the more efficient but costlier RDO Rapid Decalifier was the decalciying agent of choice. The EXAKT 300, a cutting-grinding machine for hard tissue and other material not suitable to be sectioned by routine methods, was routinely used to section bony margins for faster reporting since the 1990s. However, the exceedingly long interval between accessioning and grossing was a cause for concern.

At present, there is only one functional cut-up or grossing station in the laboratory. The grossing procedure for small to medium-sized specimens is conducted daily during late afternoons with larger surgical specimens reserved for another time. Specimens are only received during working hours, and the laboratory is closed on weekends and public holidays. Since weekends and holidays were excluded in our TAT estimation, the impact on TAT should theoretically be nonexistent or minimal. Due to logistic considerations, HTAR sent the specimens in batches once or twice a week. With only one grossing station available, grossing of the surgical specimens would take time, especially with several specimens arriving simultaneously. In addition, decalcification could only proceed after the grossing of surgical specimen was completed, which in itself was equally time consuming. This batching led to delays in the TAT. It would also explain the paradoxically lowest overall mean TAT for decalcified specimen in 2013. Besides having the lowest count of decalcified specimens, the specimens were probably spaced apart in terms of arrival dates.

Reporting stages seemingly more delayed were the processing of grossed specimens till the staining of slides and the examining of ready slides till drafting of report. The former was dependent on staffing and facilities, and the latter on trainee pathologists and available signing pathologists. This laboratory was staffed by 5 MLTs whose responsibilities ran the gamut from clerical duties to routine or research-related specimen processing. Additional academic and administrative duties are part and parcel of being in a teaching institution. Loss of qualified technical staff is thereby disruptive to the service. This was reflected by the poorer laboratory performance in 2013 when 2 senior MLTs abruptly retired due to health reasons and the eventual replacements needed time to absorb workload.

All cases were overseen and signed off by 2 oral pathology consultants who also shouldered various responsibilities. In fact, one of them was appointed dean of the faculty in the interim, a position with demanding commitments. The Royal College of Pathologists recommended a distribution of workload unit by specimen through a modified point system but the system was not applicable in this scenario. A mismatch of staffing and workload was evident, and may be factored in the general suboptimal TAT. In our practice, a senior postgraduate trainee (resident equivalent) would see the cases first and prepare the initial draft of the report. The consultant pathologist on duty would then review the case and make revisions to the draft if necessary. If special handling was necessary, trainees were expected to confer with the consultant pathologist and make the necessary requests. With the trainees’ involvement, some insignificant delay to the TAT of specimens was inevitable and this was reflected in the mean TAT for biopsy specimens. However, the learning process would be invaluable to the trainees. On a closer look, this setup was actually advantageous especially for large surgical specimens and decalcified specimens, evidenced by the improved mean TAT when seen first by postgraduate trainees. This was likely because postgraduate trainees were tasked directly with grossing duties, and not bogged down by other responsibilities.

Interpretation of slides is by and large a relatively objective process, but benefits from the experience of the signing oral pathologist. Routine cases would probably receive concordant diagnoses among different pathologist within an acceptable TAT. The bigger concern would be difficult cases, not analyzed separately in this study. Consultations of any form, requests for unavailable molecular studies, or immunohistochemical markers may be further sources of delay. Currently, ancillary molecular investigations are not provided by this laboratory. If the need arises, a referral or request to the general pathology department will be forwarded, and therefore a prolonged TAT is a given. The Association of Directors of Surgical Pathology allowed additional time for special handling of specimens such as those requiring prolonged fixation, decalcification, submission of additional tissue, recuts, immunostains, and intradepartmental consultations. Other incriminating factors discussed elsewhere were larger...
institutional size, greater surgical pathology volume, delayed slide availability, increased number of surgical pathologists and integration of pathology trainees, and diagnosis of malignancy.\textsuperscript{16,23}

The present study was conducted in view of implementing a standard operating procedure in the Oral Pathology Diagnostic Laboratory, University of Malaya. Several recommendations to improve the overall TAT are proposed below.

1. \textit{Accessioning and screening of cases}. Introduction of a computerized patient identification system or request form to reduce the incidence of incorrect labelling and avoid time wastage.\textsuperscript{13} After the initial triage for urgent cases, routine cases are attended to. Complex cases to follow, and duly categorized by level of difficulty.\textsuperscript{17}

2. \textit{Grossing/cut-up/trimming}. Gross examination of specimens to commence in the mornings instead of evenings. Small specimens to be done first and larger or complex specimens that are incompletely grossed can be resumed with in the afternoon. This will ensure all specimens are fully grossed by the end of the day. A set up with 2 grossing stations will also alleviate the matter of specimen stacking. Hard tissue to be cut into block size to aid decalcification.\textsuperscript{2}

3. \textit{Tissue processing}. One cycle of the automated tissue processor takes about 16 hours. The machine is started in the evening so that the process is completed by morning. Ideally, smaller specimens could be processed in 1.5 hours, medium specimens in 3.5 hours, and the remainder specimens of any size could be processed overnight.\textsuperscript{13} However, the ensuing multiple processes and extended working hours would place extra demands on the already stretched personnel. Procuring additional tissue processor is only cost-effective in laboratories with high specimen load. Rapid manual tissue processing is an option when the number of tissue blocks is limited but the process is tedious and requires constant attention.\textsuperscript{24} The use of microwave technology in histopathology, specifically for tissue fixation and processing, has gained much momentum in the past 3 decades.\textsuperscript{25} Various studies have demonstrated comparable overall quality of tissue sections prepared by microwave processing and the traditional processing methods.\textsuperscript{26-29} Microwave tissue processing allows small biopsy specimens to be processed in 15 minutes and larger biopsy specimens in 60 minutes.\textsuperscript{27} Shorter processing time substantially reduces TAT. Environmental advantages and lower reagent costs are further bonuses.\textsuperscript{28} Microwave processing is widely accepted in immunohistochemical staining but has yet to catch on in routine tissue processing. Leong suggested that the laboratory staff’s reluctance to embrace the altered work pattern associated with microwave processing was partly the reason.\textsuperscript{30} Perhaps a gradual increase in batched runs would be more acceptable.

4. \textit{Slides preparation}. Slide number written directly on to the frosted glass end of the slides is more efficient than hand-written adhesive white labels.\textsuperscript{13} Slide labelling with a slide etcher may be considered as it was found to be error-free, more legible, 2.3 times faster than manual labelling, and does not require human intervention.\textsuperscript{31} Automated hematoxylin and eosin staining and automated coverslipping are effective in reducing TAT as well. Automated hematoxylin and eosin staining eliminates the need for the technician’s intervention in differentiation steps and the time spent per slide was found to be 50% less than manual staining.\textsuperscript{31} Automated coverslipping is 3 times more productive than manual coverslipping when using glass cover and 11 times more when using film.\textsuperscript{31}

5. \textit{Reporting}. Time lost due to typing errors can be minimized through the introduction of computerized reports with online correction of errors and authorization by pathologists.\textsuperscript{17} At present, assigning the trainees to type the reports would not only free up the MLTs but also hasten the report completion time. Alternatively, implementation of voice-recognition technology (VRT) in reporting surgical pathology is an attractive option. Although initially it requires motivation and specific training, pathologists will be able to sign-out cases anytime, preventing transcriptions bottleneck, and overcome the matter of unavailability of in-house transcriptionists beyond regular working hours. VRT has been successfully employed in clinical practice since 1980, especially in radiology.\textsuperscript{32-36} VRT implementations have also purportedly improved report TAT, reduced transcription costs, and decreased errors in surgical pathology.\textsuperscript{37,39} Therefore, VRT may be considered an inexpensive alternative to manual transcriptions where there is a shortage of transcription services.\textsuperscript{40}

A change of work ethos might be just as important to spark an improvement in TATs. Recall appointments in the clinic are usually scheduled to allow a 2-week histopathology turnaround. Therefore, there are arguments against the necessity of rushing the reports since it bears no impact on the clinical course.\textsuperscript{13} However, in an era gearing toward patient-centered service, diagnostic accuracy complemented by promptness is always welcomed.
There were several limitations in this study. These data were derived from specimens sent by HTAR only, which were reported by 2 oral pathologists. In the duration of the study, the Oral Pathology Diagnostic Laboratory also received specimens from other sources, distributed among all available pathologists. Thus, the findings in this study may not represent the laboratory’s true functional potential. Furthermore, the period between accessioning and result does not always adequately reflect laboratory performance. Pre- and post-laboratory processes should be taken into account for the clinician TAT. TAT for malignant specimens were also not analyzed separately.

Conclusion
There has been no established acceptable TAT goals for this institution to meet the laboratory’s capability and the institution’s need for timely patient care. The laboratory TAT for oral biopsies and surgical specimens in the current study may fall short of recommended standards, but the present audit serves as a platform to jumpstart changes. Teamwork, effective long-term planning, and smart investments are essential positive initiatives. Adequate staffing is also a crucial consideration. With the implementation of all or some of the recommended changes, an acceptable TAT for this laboratory is projected in the near future.

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