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Evaluation of switch from satellite laboratory to central laboratory for testing of intraoperative parathyroid hormone

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ABSTRACT

Objectives: The aim of this study was to evaluate testing turnaround time (TAT) and incision to close time in parathyroid surgeries before and after switching intraoperative parathyroid hormone (PTH) testing from a near point of care location to a central clinical laboratory.
Design and Methods: This retrospective study covered a ten-year period. Both testing locations used the same Roche Diagnostics PTH immunoassay but on different analyzers. The predominant site for surgeries was the main operating rooms (ORs) in an adjacent building, with a limited number of parathyroid surgeries performed at a more distant ambulatory surgery center (ASC). Under ideal conditions, TAT for near point-of-care testing was 20 min, although multiple factors could increase TAT. Incision to close time from the electronic health record was used to define time of surgery.
Results: A total of 897 unique patients were identified for which 3031 orders for intraoperative PTH were placed (383 unique patients and 1244 orders after switch in testing site). The average total TAT times for testing (mean ± SD) in the central laboratory were 23.9 ± 16.0 min (median, 22 min) for all specimens, 22.8 ± 7.9 min (median, 21 min) for main OR specimens, and 26.4 ± 7.1 min (median, 25 min) for ASC specimens. Incision to close time for parathyroidectomies showed decreases in mean, median, and standard deviation following testing change.
Conclusions: Surgery time for parathyroidectomies may remain consistent or decrease if intraoperative PTH testing is moved from a near point of care to a central laboratory.

1. Introduction

The use of intraoperative parathyroid hormone monitoring (IOPTH) was first described about 30 years ago for patients undergoing surgery for primary hyperparathyroidism [1–3]. Due to its short half-life of less than 5 min, parathyroid hormone (PTH) was ideal for intraoperative monitoring as the blood concentration declines quickly after removal of the hyperfunctioning gland [2,4]. Along with Sestamibi scans, IOPTH provided information that supported minimally invasive approaches to parathyroid surgeries [5]. Since around 80% of patients with primary hyperparathyroidism have single gland disease, and IOPTH could predict multiple gland disease in most

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patients [6], this test allowed many patients to undergo less invasive surgery for primary hyperparathyroidism.

The capabilities and analytical times for PTH immunoassays have evolved considerably in the last three decades [7–9]. Early generation immunoradiometric assays (IRMA) required an overnight incubation with results taking up to 24 h [1,3]. Nowadays, a number of commercially available immunoassays targeting the "intact" PTH molecule (amino acids 1–84) can achieve analytical times of approximately 10–20 min, making intraoperative measurements feasible if specimens can be transported quickly for analysis [7,8, 10]. Lengthy TATs increase the amount of time that the patient is in the operating room (OR) and delay throughput [8,10].

However, there are practical challenges which hinder a rapid TAT [11–15]. When testing is performed in a location physically remote from the surgery, a delay in TAT arises due to the transport of samples from the OR, either via courier or a pneumatic tube system. Hospitals or medical centers with many ORs or with more than one set of ORs, such as a separate ambulatory surgery center (ASC), present additional logistical challenges for specimen transport. In addition to specimen transport time, delay in communication of results to the OR personnel may also occur. TAT has also been found to be affected by the level of experience of the surgeon and laboratory technician [13,14]. The actual analytical time needed for the assay to run, regardless of whether it is performed in a central laboratory or a point of care site near to or within the ORs, will also impact the overall TAT [8,12,16]. While near point of care or point of care testing can theoretically lead to shorter TATs, having separate instrumentation and testing personnel next to the OR may lead to suboptimal use of resources and time. For example, delay in TAT may occur due to miscommunication on surgery scheduling that leads to personnel and instrumentation not being ready for testing. For near-patient testing, processes also tend to be less automated, increasing chances of manual errors.

In the present study, our academic medical center moved intraoperative PTH testing from a satellite critical care laboratory located adjacent to the ORs ('near point of care') to the central (core) clinical laboratory. While this switch meant the testing site was now further from the ORs, there were distinct advantages. These included multiple instruments routinely available 24 h a day for testing and also no need to coordinate surgical schedule with personnel placement for intraoperative PTH measurements. Although the instrumentation used for the PTH analysis differed between the two sites, the underlying assay (vendor and electrochemiluminescence methodology) was the same. The type of personnel drawing the blood also did not change. Under ideal conditions, the near point of care location could achieve approximate 20 min TAT from specimen collection to result. However, this was very difficult to track routinely in actual cases due to manual steps throughout the process. The purpose of our study was to evaluate TAT and review practical issues brought about by the move of intraoperative plasma PTH testing from the near point of care location to the central laboratory, providing an opportunity to compare with other published literature on intraoperative PTH assay performance and turnaround time [11,13–15]. We were also able to compare incision to close time (a metric of length of procedure) for parathyroidectomies before and after switch in intraoperative PTH testing location.

2. Materials and methods

This is a retrospective study performed at an 811-bed tertiary/quaternary care academic medical center. The hospital has endocrinology and endocrine surgery services available in both the outpatient and inpatient settings. The electronic health record (EHR) for the institution is Epic (Epic, Inc., Madison, WI). Providers can order laboratory tests and medications within the EHR. The clinical laboratories use Epic Beaker Clinical Pathology as the laboratory information system (LIS), with instrument interfaces to Beaker utilizing middleware software (Instrument Manager) from Data Innovations (Burlington, VT) [17,18].

The data in the study were collected as part of a retrospective study approved by the Institutional Review Board (protocol # 201903764) covering the time frame from May 1, 2009 to February 21, 2019. The study was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki). Epic Reporting Workbench (RWB), an EHR data reporting tool, was used to retrieve laboratory results for PTH measurements [19]. The RWB searches captured all PTH orders within the retrospective time frame. During this time period, there were three plasma PTH orders available in the EHR: (1) Parathyroid hormone ("PTH", intended for all non-surgical orders in the ambulatory, emergency department, or inpatient settings), (2) "intraoperative PTH – baseline", and (3) "intraoperative PTH".

Prior to August 1, 2014, intraoperative PTH measurements were performed on a Roche Diagnostics e411 analyzer in a "Critical Care Laboratory" located adjacent to the main ORs and surgical pathology specimen grossing room. The Critical Care Laboratory was staffed 24 h a day, 365 days of the year by one or more medical laboratory scientists who also performed other tasks such as blood gas analysis and temporary storage of tissue bank materials for surgeries. Specimens were typically hand-delivered by OR personnel to a door that opened into the Critical Care Laboratory. The e411 analyzer had a 9 min analytical time for PTH. The instrument was not used for any analysis other than intraoperative PTH and was turned off when there were no known parathyroid surgeries scheduled. The standard practice was to have the instrument on, calibrated, and two levels of quality control run prior to parathyroid surgeries. All orders from the ORs used paper, with the medical laboratory scientist placing the order using laboratory-initiated order workflow. The instrument was not interfaced to the LIS, and thus the results were manually entered by the medical laboratory scientist into the LIS. In addition to entering the results to the LIS, the medical laboratory scientist routinely called the OR where the surgery was being performed to verbally report results as they were available. The call to the OR was a critical piece because OR staff did not routinely access laboratory results via the EHR prior to August 2014.

Due to the manual processes, detailed TAT data across many procedures were not available for intraoperative PTH measurements in the Critical Care Laboratory. In particular, no data were electronically or otherwise reliably captured for time of collection or time of arrival in the Critical Care Laboratory. Nevertheless, time and benchmarking studies of the procedure over multiple years indicated under ideal conditions that near point of care testing could yield a TAT of 20 min from time of collection to result called to the OR. It was not clear, however, how close actual TATs were to this ideal, as tracking each step in the process during routine operations would be a

manual event.

Starting in August 2014, the Critical Care Laboratory relocated to the central clinical laboratory located in an adjacent building and one floor above the main ORs. Prior to this move, laboratory leadership communicated with and met with the surgeons who performed the vast majority of parathyroidectomies. The agreed-upon process was as follows. Orders from the OR would be placed electronically in the EHR. Within the ORs, only the intraoperative PTH orders (and not the routine PTH orders) were to be used, with effort put in to standardize electronic order sets. The specimens were to be hand-delivered to the central clinical laboratory, with the person delivering the specimen to indicate that the specimen was for intraoperative PTH measurement. The laboratory now did not require advance notice that a surgery was being performed and did not see pending intraoperative PTH orders.

For the intraoperative PTH specimens, the clinical laboratory did not utilize the pre-analytical instrumentation (Roche 8100) and, instead, immediately centrifuged the specimen off-line, transferred plasma to new labelled container, and front-loaded one of two cobas e602 analyzers that run the PTH assay. The e602 analyzer also has a 9 min analytical time for PTH. This took priority over other samples in the queue. The reagents used on both the e411 and e602 analyzers are essentially the same. There were no significant analytical issues with this analyzer switch. Calibration and two levels of quality control (QC) were performed on a routine schedule for testing in the central laboratory. The instrument used for near point of care intraoperative PTH testing was calibrated and had QC performed only on days of parathyroid surgeries, timed so that testing would be available prior to scheduled surgeries. Two levels of QC were used in both testing locations.

In contrast to the workflow in the Critical Care Laboratory, intraoperative PTH results from the central laboratory could auto-verify (barring any flags or errors preventing this) and thereafter immediately appear in the LIS and then EHR. By this time period, the ORs were routinely using the EHR to accommodate workflow changes brought on by the institutional change to Epic Beaker Clinical Pathology and, in 2015, Epic Beaker Anatomic Pathology as the LIS [18,20]. The change to the Epic Beaker LIS made paper requisitions and subsequent laboratory-initiated ordering much less efficient than with the previous LIS. Consequently, the ORs utilized workflows that allowed EHR orders to print out LIS barcoded labels that could be applied to specimens for laboratory analysis. The "collection time" was the time documented by the person collecting the blood sample. Depending on workflow, this could be scan of patient wristband and tube barcode prior to collection or manual time entry by person performing the phlebotomy. Blood draws were performed by staff within the OR, often anesthesiologist or nurse anesthetist. The "receipt time" was when the specimen was delivered to the central laboratory, at which point it would be promptly scanned to officially document and time stamp specimen arrival. The "verified" time is when the PTH result appeared in the LIS and then immediately thereafter in the EHR. Table 1 summarizes differences in procedure between the former and current methods for intraoperative PTH.

The medical center maintains main ORs which are located in the same building as surgical pathology and the former Critical Care Laboratory. The central clinical laboratory is located one floor above the ORs in an adjacent building. The main OR comprises 37 operating rooms. The distance of the main OR from the central clinical laboratory is approximately 158 steps or 1 min 20 s while walking briskly. A separate ASC is located three buildings distant and two floors down from the central clinical laboratory, with all the buildings physically connected by walkways. During the retrospective analysis period, only a single surgeon scheduled parathyroidectomy surgeries in the ASC; these were generally cases involving relatively healthy patients who had imaging studies showing evidence of single parathyroid gland disease. The ASC is made up of 12 operating rooms. The distance from ASC to the central clinical laboratory is approximately 593 steps or 4 min 45 s while walking briskly.

In terms of surgery protocols, there was not a standardized procedure for intraoperative PTH monitoring across surgeons at our institution. However, there was a common practice in having the blood tube delivered by hand as a STAT specimen to the location of testing. Delivery by pneumatic tube system was discouraged, although this occurred in rare cases. Multiglandular disease was determined by the final surgical pathology report identifying the removal of more than one abnormal gland. Our institution is a regional referral center for endocrine surgeries, and thus both simple and complex parathyroid procedures, including re-do surgeries, are performed at our institution.

3. Results

3.1. Overall demographics and patterns of testing

Over the ten-year retrospective period, a total of 897 unique patients had 3031 orders for intraoperative PTH. These included 514 unique patients (375 female, 139 male) with 1787 orders for intraoperative PTH performed as near point of care. After the switch in testing location to the central laboratory, intraoperative PTH was performed on a total of 383 unique patients (282 female, 101 male)

Table 1
Differences encountered with switch from satellite to central laboratory for intraoperative parathyroid hormone testing.

Variable	Satellite Laboratory ('Near Point of Care')	Central Laboratory
Intraoperative PTH ordered electronically by clinical team	No	Yes
Laboratory information system label applied by clinical team	No	Yes
Time stamp on each step of specimen handling and transport	No	Yes
Manual centrifugation of specimen	Yes	Yes
Courier transport of specimen	Yes	Yes
Clinical team phoned of results	Yes	No
Total turnaround time goal of approximately 20 min	Yes	Yes

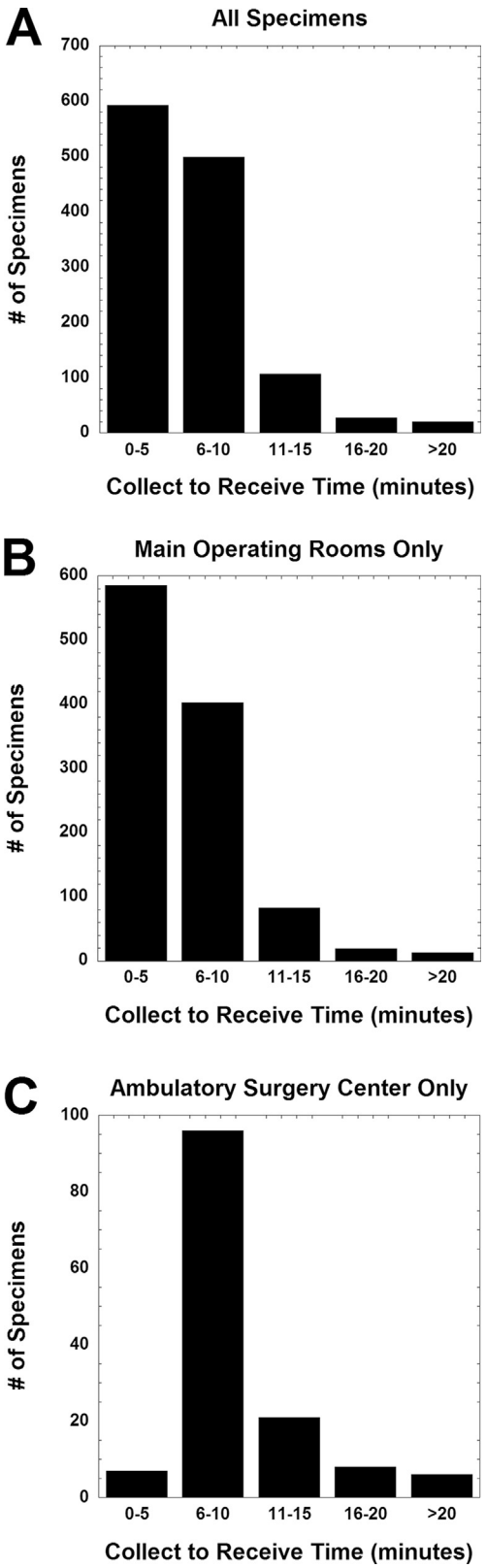

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Fig. 1. Collected to received time for specimens submitted for intraoperative PTH testing. (A) The histogram shows the time taken from specimen collection to receipt in the central laboratory for the total number of specimens (n = 1238) submitted for intraoperative PTH testing in the five-year retrospective analysis timeframe. This data includes specimens collected in both the main operating rooms (ORs) and the ambulatory surgery center (ASC). (B) The histogram shows the data restricted to specimens collected in the main OR (n = 1103). (C) The histogram shows the data restricted to specimens collected in the ASC (n = 135).

with 1244 total measurements. Only 0.56% of specimens (11 for near point of care and 7 in central laboratory) exceeded the package insert hemolysis threshold (H index of 250) for the PTH assay. No specimens exceeded the limits for icterus (I index of 65), lipemia (L index of 1500), or upper limit of the analytical measurement range (5000 pg/mL) in the assay package insert.

TAT metrics for the intraoperative PTH testing were only available following the switch to central laboratory (383 unique patients and 1244 total measurements) so this section through section 3.4 will focus on the central laboratory testing data. For comparison in the same timeframe, regular (non-operative) PTH was ordered on 11,419 unique patients (4740 male; 6679 female) with 20,436 total

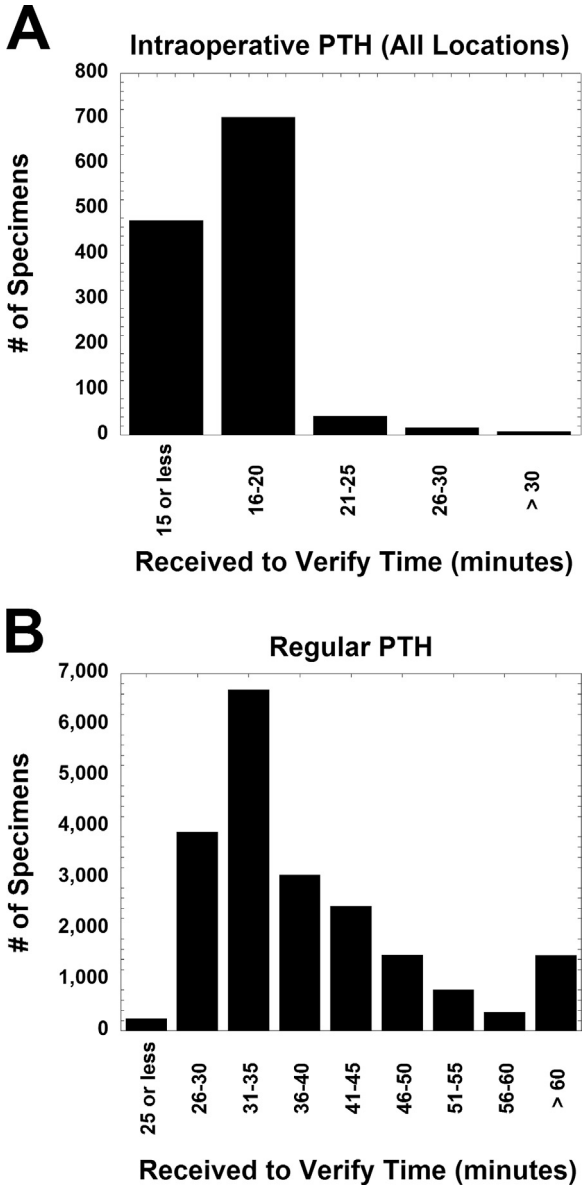

Fig. 2. Received to verified time for specimens submitted for intraoperative and regular (non-operative) PTH testing. (A) The histogram shows the time taken from receipt in central laboratory to the final verification in the electronic health record for specimens submitted for intraoperative PTH testing (n = 1238). (B) The histogram shows the received in central laboratory to final verification time for specimens submitted for regular (non-operative) PTH testing (n = 20,436).

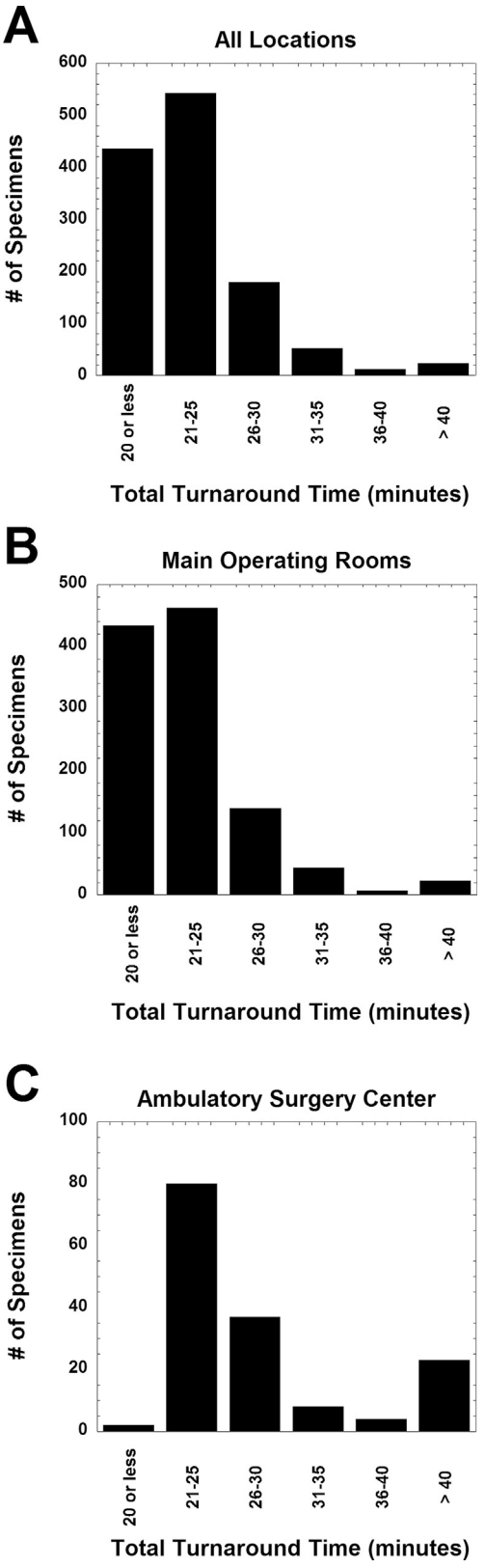

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Fig. 3. Total turnaround time in specimens submitted for intraoperative PTH testing. (A) The histogram shows the time from specimen collection to final verification for all specimens submitted for intraoperative PTH testing (n = 1238). (B) The histogram shows the data restricted to specimens collected in the main OR (n = 1103). (C) The histogram shows the data restricted to specimens collected in the ASC (n = 135).

measurements. Of the intraoperative PTH orders, 1103 were collected in the main OR, while 135 samples (10.9% of total) were collected in the ASC. Six orders for intraoperative PTH were placed when the patient was not in the OR but in another location such as recovery rooms or perioperative suites. These 6 samples were excluded from analysis, leaving a total of 1238 measurements ordered from OR locations (main OR and ASC). For intraoperative PTH-baseline, the average number of measurements per patient (mean ± SD) was 1.1 ± 0.3 (indicating a small proportion of patients with more than 1 baseline order), while the average for subsequent intraoperative PTH measurements (mean ± SD) was 2.3 ± 1.2.

3.2. Collect to received time

Fig. 1 shows the 'collected to received time' taken from collection to the receipt time. The graphs show a similar distribution for

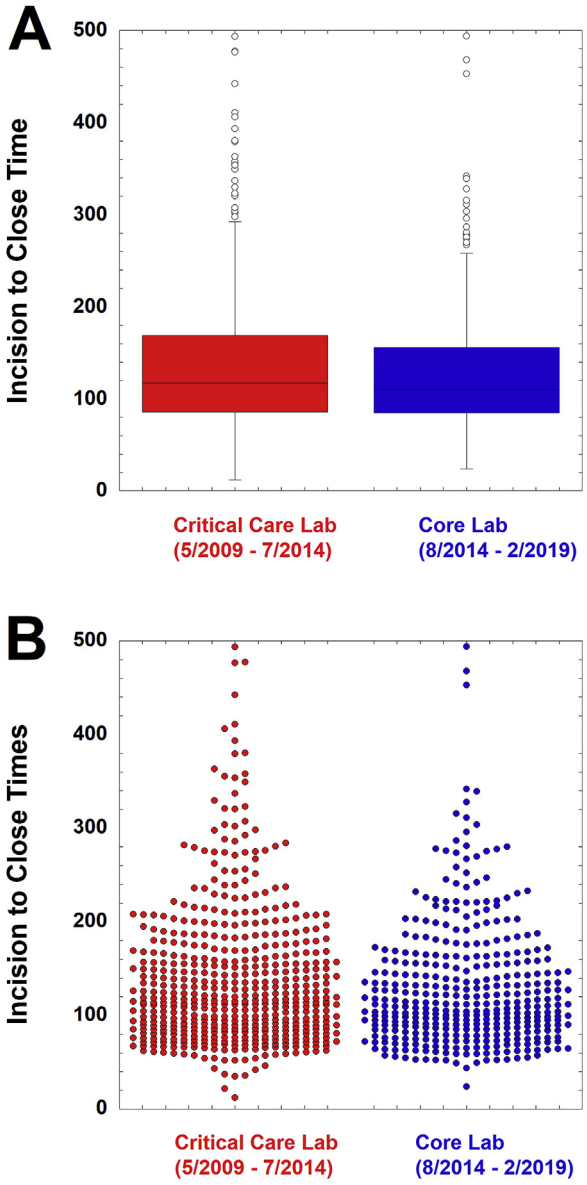

Fig. 4. Incision to close times for parathyroidectomies performed before and after switch from near point of care to central laboratory intraoperative PTH testing. The data is shown in both box plot (A) and dot plot (B) (n = 514 for near point of care; n = 383 for central laboratory).

overall data and the main OR (reflecting that the main OR comprises nearly 90% of specimens), while that of the ASC location has overall longer times. Fig. 1A shows the data for all intraoperative specimens, while Fig. 1B and C shows the data separately for the main ORs and ASC, respectively. The average collect to receive times (mean ± SD) were 7.6 ± 16.2 min (median, 6 min) for all specimens, 6.5 ± 7.6 min (median, 5 min) for main OR only, and 9.7 ± 6.6 (median, 8 min) for ASC only. As evidenced by the average values and Fig. 1B and C, the collect to receive time was longer for the ASC relative to the main ORs, an expected finding given the longer physical distance from ASC to the central laboratory as compared to the main ORs (593 vs. 158 steps). Overall, 592 out of 1244 (48%) specimens had a collect to receive time of less than or equal to 5 min. There were a small number of samples where collect to receive time was much higher than the average. In particular, collect to receive time was greater than 20 min for 20 specimens overall (1.6% of total), with 14 specimens from the main OR (1.4% of total) and 6 specimens from the ASC (4.3% of total). Some of the factors related to these delays are discussed in section 3.4.

3.3. Received to verified time

Fig. 2 shows the period of time from which all the specimens were received by the laboratory to the time results were verified in the LIS and then available in the EHR ('received to verified time'). Fig. 2A shows the data for all intraoperative specimens, while Fig. 2B shows the data for regular (non-operative) PTH testing. The average received to verified times (mean ± SD) were 16.4 ± 2.7 min (median, 16 min) and 47.1 ± 57.2 min (median, 35 min) for intraoperative and regular (non-operative) PTH orders, respectively. As noted by the average values and the data in Fig. 2A and B, the received to verified time was longer for the regular (non-operative) specimens, an expected finding given the longer time spent on the Roche 8100 pre-analytical system (routine, non-priority workflow) prior to analysis on the e602 instrument.

3.4. Total turnaround time

The total TAT for specimens submitted for intraoperative PTH testing is displayed in the histograms in Fig. 3. Fig. 3A shows the total TAT for all locations. Fig. 3B shows the data for main OR, while Fig. 3C shows the TAT for the ASC. The average total TAT (mean ± SD) were 23.9 ± 16.0 min (median, 22 min) for all specimens, 22.8 ± 7.9 min (median, 21 min) for main OR only, and 26.4 ± 7.1 min (median, 25 min) for ASC only.

3.5. Impact on incision to close times

To assess whether the changes in intraoperative PTH may have impacted length of parathyroidectomies, we analyzed incision to close time. Data from the EHR [19] were available for 514 parathyroidectomy surgeries performed when the intraoperative PTH was near point of care and 383 surgeries after the switch in testing to the central laboratory. Incision to close time decreased significantly from near point of care to central laboratory intraoperative PTH testing ($P = 0.037$, Kruskal-Wallis non-parametric test), with decreases in both average and median times (Table 3). This trend was seen even for the small number of parathyroidectomies performed in the more distantly located ASC (Table 3). Fig. 4 shows box plots and dot plots of the incision to close times for all parathyroidectomies.

4. Discussion

Intraoperative PTH analysis presents a challenge for both the clinical laboratory and OR personnel [12–15]. Intraoperative PTH helps assess efficacy of the surgery and allows conclusion of minimally invasive surgery when levels drop according to criteria or show need for further surgical exploration [21,22]. Intraoperative PTH measurement may, for example, suggest inadequate resection or likely presence of ectopic parathyroid tissue.

In order to have a fast TAT for intraoperative PTH testing, a point of care test may seem ideal to meet TAT goals [7,13,16,23]. However, this is not always practical. In addition, truly compact, portable, and easy to operate point of care devices for measurement of PTH have not been available on the market in recent years. Having dedicated instrumentation near the OR may lead to inefficient use of testing personnel, especially as surgery schedules can change unpredictably, leading to staff and/or instrumentation being unavailable for testing. This can occur if there is miscommunication that a surgery is taking place. Both the instrumentation and laboratory technicians can be readily available if testing is performed in a central laboratory. In our study, two separate instruments in the core laboratory (routinely used for a variety of immunoassays) can perform intraoperative PTH, leading to redundancy in event of instrument failure [13–15]. Furthermore, processes for near-patient testing may not be as automated as those for centralized testing, leading to more opportunities for manual errors such as mislabeling and incorrect entry of results into the EHR.

We investigated reasons for delayed TAT for intraoperative PTH. The most common factors identified included misordering of regular PTH instead of the intraoperative PTH order, specimen transport by pneumatic tube instead of courier, or specimen drop-off by personnel who did not identify the specimen as intraoperative PTH. These incidences generally occurred with OR and anesthesia teams that infrequently performed parathyroidectomies, especially if not using electronic order sets approved for these surgeries. For three cases where regular PTH was mistakenly ordered, by the time the OR team called the laboratory about delayed TAT, the specimens were already on the automated line and could not be pulled for rapid processing. Ongoing education has been helpful in reducing these rare events that delay TAT. Table 2 provides a summary of key preanalytical, analytical, and postanalytical challenges in intraoperative PTH testing.

When testing is done in a central laboratory, there are a number of important preanalytical factors [11,13–15]. These include time

spent in delivery of the specimen to the laboratory (e.g., courier, pneumatic tube) and ensuring that when these samples are received in the laboratory, they are appropriately labelled and handled as intraoperative specimens that require a quick TAT. Specimen transport is influenced by physical distance between the OR and clinical laboratory and, if relevant, functionality of pneumatic tube system. Additional preanalytical considerations include ordering of the correct test (e.g., intraoperative PTH compared to routine PTH order) and handoff of specimen to the clinical laboratory identifying specimen as an intraoperative PTH order. Analytical measurement time is influenced by whether the assay is suited to intraoperative PTH by a short analytical time, with the fastest assays currently marketed being about 9–10 min. A key postanalytical variable is how the results are transmitted to the OR such as by phone or viewing results in the EHR and how quickly OR personnel obtain results for decision-making.

Our TAT data is comparable with other studies that had a reported overall TAT when testing is performed in the central laboratory of approximately 15–27 min [1,12,13,24]. A recent study by Leung et al. compared TAT for intraoperative PTH testing performed in the central laboratory (with samples transported by pneumatic tube system from the ORs to the clinical laboratory across the street in a different building) as compared to analysis by an instrument placed in the OR suite [12]. In the Leung et al. study, analysis in the OR site had an average TAT 7 min faster than central laboratory (20 min vs 27 min), accounted for mainly by extra preanalytical time involved in the pneumatic tube transport to the central laboratory, including packing and unpacking specimens.

Our current results are similar to Leung et al. in that our TAT for near point of care was also 20 min under ideal conditions. However, the incision to close time for length of parathyroidectomies in our study before and after implementation of central laboratory processing strongly suggest that this ideal TAT is not actually achieved routinely and also shows higher variability that impacts overall length of procedure. Our overall average total TAT for samples sent from main OR (average, 22.8 min; median, 21 min) was shorter than the central laboratory in the Leung et al. study likely due to less preanalytical time by direct courier transport to central laboratory compared to transport by pneumatic tube.

Prior to our switch to the central laboratory for intraoperative PTH testing, we evaluated use of the pneumatic tube for transport. Under optimal conditions, pneumatic tube transit time from the main OR to central laboratory could be as fast as 3 min. However, variability in system load led to times as long as 8 or 9 min, especially during times of peak activity. There is also time spent in packing and unpacking the tube container. Overall, one key positive of our study was consistent TAT across 5 years, with very few cases of extended TAT due to problems. The issues that have arisen (e.g., misordering of regular PTH instead of the intraoperative order, an uncommon occurrence that we detected only 3 times in the dataset) have been addressed by ongoing education. For example, communication between surgery and anesthesia prior to starting parathyroidectomy cases emphasizes timing of blood draws for intraoperative PTH and reinforces not to transport these specimens by the pneumatic tube system. Autoverification of intraoperative PTH results by the core laboratory eliminates variability in having the laboratory technician call the OR with the intraoperative PTH results. Operating room staff can know that results will appear in the EHR. This consistency allows the surgical services to more reliably predict the time course of parathyroidectomies.

There are some limitations to our study. The analysis was performed at a single medical center. We did not have detailed robust data of the TAT when the testing was located in a near point of care area, with processes basically all manual. However, we were able to compare length of surgeries before and after switch. There were also multiple differences involved in the switch from near point of care to central laboratory for intraoperative PTH testing which may have impacted overall TAT. For example, these included access of results by the EHR compared to phone call. Human nature may have also led to prolonged TAT as personnel may have gradually became less aware of the urgency of intraoperative PTH testing over time which required intermittent remediation.

Table 2
Factors and variables that impact turnaround time for intraoperative parathyroid hormone testing.

Factors	Key Variables
Preanalytical factors	
Ordering of correct PTH (e.g., avoiding order of routine PTH for intraoperative orders)	• Education of clinical team • Use of approved order sets with correct orders • Detection of wrong order by laboratory personnel or informatics rules
Transport method	• Functionality of the pneumatic tube system (if considered as option) • Time comparison of transport options • Availability of staff to transport specimens
Specimen identified as “intraoperative”	• Courier identifies specimen as intraoperative PTH order in handoff to laboratory staff • Careful review of barcodes by laboratory staff
Availability of instrumentation ready for analysis	• Redundancy of instrumentation • Hours that instruments are routinely available
Analytical factors	
Analytical time	• Analytical capability of instrument and method • Frequency of reruns due to errors or other issues
Postanalytical factors	
Reporting of results	• Manual verification or autoverification of results • Use of electronic health record by operating room to access test results or other means such as phone call to the operating room

Table 3
Operating room times for parathyroidectomy surgeries before and after switch from satellite to central laboratory for intraoperative parathyroid hormone testing.

Variable	Satellite Laboratory ('Near Point of Care') May 2009–July 2014	Central Laboratory August 2014–February 2019
Incision to close times (all operations)		
Number of surgeries	514	383
Average	138.5 min	129.0 min
Standard deviation	75.1 min	66.8 min
Median	117.1 min	110.0 min
Incision to close times (ASC only)		
Number of surgeries	17	28
Average	138.9 min	119.4 min
Standard deviation	76.0 min	64.3 min
Median	111.4 min	98.6 min

5. Conclusions

The timely analysis and reporting of intraoperative PTH results presents a challenge for the surgeons, OR staff, and the clinical laboratory. The results of this study show that a switch in testing for intraoperative PTH to a central laboratory, although theoretically slower than point of care testing, may in practice lead to more consistent TAT.

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CRediT authorship contribution statement

Denise Jacob: Conceptualization, Investigation, Formal analysis, Visualization, Writing - original draft. **Geeta Lal:** Investigation, Formal analysis, Writing - review & editing. **Dena R. Voss:** Conceptualization, Investigation. **Tami Bebber:** Conceptualization, Investigation. **Scott R. Davis:** Conceptualization, Investigation, Formal analysis, Visualization. **Jeff Kulhavy:** Conceptualization, Investigation. **Sonia L. Sugg:** Investigation, Formal analysis, Writing - review & editing. **Anna E. Merrill:** Conceptualization, Investigation, Formal analysis, Writing - review & editing. **Matthew D. Krasowski:** Conceptualization, Writing - review & editing.

Declaration of competing interest

None of the authors have any conflict to report.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.plabm.2020.e00176.

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