Original Article

Audit of Quality Indicators of Cytology: An Institutional Study

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Abstract

Introduction: At present, clinical laboratories play a vital role in diagnosing and providing quality treatment. Various quality control (QC) and quality assurance (QA), including the pre-analytical and post-analytical variables, were taken into consideration for the internal quality indicators in the department of cytopathology of our institution. The aim of this study is to evaluate the importance of QC and QA parameters in the routine work of the cytopathology laboratory. **Materials and Methods:** This is a prospective cross-sectional study of 24 months duration. A total of 15,520 were evaluated for quality parameters. **Results:** A total of 15,520 cytology cases were evaluated. The cyto-histo correlation, non-conformities, TAT, Repeats and redo's, critical value, quality of staining and revised report rate were noted and identified with relevant statistical analysis. **Conclusion:** Routine QC and QA will ensure better diagnostic services and promote accreditation of laboratory activities.

Keywords: Audit, cytology, quality, turnaround time

Introduction

In the current scenario of evidence-based medicine, clinical laboratories play a very important role in diagnostic care, moreover so with increased awareness of consumer protection and greater demand for patient satisfaction.[1,2] While quality assurance (QA) encompasses all steps in the process, from specimen collection to transmission of reports to the clinician, quality control (QC) deals with the operational techniques in the daily workflow to ensure quality requirements.[3] QC is the operational techniques and activities that fulfil and verify the requirement of quality in an individual test or a process.[3] Continuous QC leads to continuous quality improvement (CQI) with respect to time, and performance and achievement of uniform quality.[4] CQI is a continuous process, unlike QA, which is a periodical assessment and focuses on accreditation.[5] QA is a systematic evaluation of QC results and quality practice parameters to assure that all systems are working in a manner appropriate to the excellence in health care delivery.[6] QA is a coordinated system to detect, control and prevent the occurrence of errors and finally enhance the clinician's ability to provide quality care to the patients.[7]

QA in a cytopathology laboratory is achieved by involving all the parties that contribute to cytopathology procedures.[8] QA measures start with the laboratory directors to the cyto-path-technologists at work. High-quality results are achieved when all the stakeholders work together by following the Standard operation procedures (SOP). Laboratory directors in a cytopathology laboratory are responsible for risk analysis and management. QA and QC practices in a cytopathology lab include the use of intra-laboratory and extra-departmental consultations, correlation of histopathology and cytological specimens and review of the diagnostic reports.[9]

The aim of this study is to undertake a comprehensive review of all the variables affecting the routine working of cytopathology laboratory, which includes local availability of man (qualified and efficient technologists and cytopathologists), material (availability of stains and equipment), and money (for regular maintenance of stains, equipment, personnel, and accreditation). The objective of the study was to identify the errors in the pre-analytical, analytical, and post-analytical phases and also suggest recommendations based on the relevant findings to maintain a satisfactory level of quality standards in routine practice.

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Materials and Methods

Study population

A hospital-based observational, retrospective and analytic study was undertaken to study the QA in the Department of Cytopathology of a tertiary care hospital located in south India for two years, from January 2019 to January 2021, on gynaecological and non-gynaecological samples. Ethical clearance was obtained from Institutional Ethics Committee (ETH/Med/2021/234 dated September 2021).

Patients selection

Inclusion criteria were all indoor and outdoor samples received in the cytopathology laboratory, including pleural fluids, ascitic fluids, cerebrospinal fluids, fine-needle aspiration cytology (FNAC) and guided fine-needle aspiration (FNA) samples. Exclusion criteria included samples without proper request, samples having mislabelling, fluid samples of more than 6 h preservation and samples without proper transportation such as inadequately capped, spillage or mishandling during transport. The sample size for the study, as per the statistics, was 1552.

Procedure

FNAC was done under strict aseptic precautions using a 22 or 23-gauge needle in a 10 ml syringe. Multiple smears were prepared from the aspirate, and those immediately fixed in 95% ethanol were stained using Haematoxylin and Eosin (H and E), and Papanicolaou stains and air dried smears were stained using Leishman–Giemsa and May Grunwald Giemsa stains. The fluid samples were centrifuged, and the sediment was used to make smears. The fixation of smears and staining patterns were similar to FNAC smears. The corresponding tissue samples subjected to histopathological examination were stained with H and Estains. All the cases were screened by two Pathologists. The final diagnosis of each case was determined by taking a biopsy as the gold standard.

Clinical parameters

The following parameters were studied; quality of staining, critical value, cytology histology correlation, revised report rate, turnaround time (TAT), redo's cases, repetition, non-conformities and participation in the EQAS programme. Root cause analysis was done for pre-analytical, analytical and post-analytical factors affecting QC.

The quality of staining was monitored to ensure 'crisp' staining to appreciate the finer details of the cytology smears. Orange green (OG) and Eosin (EA) stain lose their strength more rapidly; hence was replaced weekly. Similarly, various grades of alcohol were also replaced weekly. Xylene was replaced when it became tinted with cytoplasmic stain. The haematoxylin stain had constant staining characteristics and did not require frequent changes. For the assessment of haematoxylin staining, blue colour was considered satisfactory, violet as insufficient bluing, grey as borderline and brown for unsatisfactory bluing. For unsatisfactory staining, root cause analysis was performed.

Critical values are defined as the reports for which the delay in reporting could lead to an alteration in the patient management system leading to serious adverse consequences on clinical decision-making, operational efficiency and patient safety. The cases which were diagnosed as malignant were included in the critical value. For the cerebrospinal fluid, the critical value is >20 cells/mm^3. Critical values are to be informed within 30 min after the generation of reports. Root cause analysis of the delayed critical values was done.

The cytological cases were correlated with the available histopathology reports. Cytology histology correlation is the per cent of patients with correlating cytology and biopsy reports.

The revised report was calculated based on the formula; total revised rate in month/total number of reports ×100. TAT is defined as the time duration between the specimens received in the laboratory till their reporting. TAT for FNAC and other body fluids was 2 days, and for cerebrospinal fluid, 20 min. Redos are the cases where the entire procedure was redone due to a variety of reasons. Repeat cases are those where the procedure was repeated due to inconclusive results. Non-conformities are the cases where no official reports were generated. The root cause analysis was done for all the parameters.

Statistical analysis

The data were entered in a Microsoft Excel sheet and analysed using SPSS software version 22. For the evaluation of internal QC, sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) for fluid cytology and FNA cytology was obtained after comparison with respective available histopathology reports.

Results

In the present study, the total sample size was 15,522. Out of which, 0.9% (153/15522) were unsatisfactory gynaecological samples, and 2.37% (369/15522) were unsatisfactory non-gynaecological samples. Further, of these 15000 satisfactory samples, 46% (7000/15000) were gynaecological samples, 34% (5110/15000) were FNACs, 15% (2264/15000) were fluids and 4.17% (626/15000) were miscellaneous samples like BAL, urine, sputum.

In the present study, regarding the quality of staining, out of 15,522 smears, only 20 non-gynaecological samples showed unsatisfactory staining. Root cause analysis showed that lack of competence of staff (n = 01, 5%), lack of compliance to standardised (n = 12, 60%), use of stain beyond the expiry date (n = 04, 20%) and Miscellaneous factors (n = 03, 15%) were the causes for unsatisfactory staining [Table 1].

In the present study, out of a total of 7000 non-gynaecological samples, 15.7% (1100/7000) were critical values. In our institute, we have the practice of reporting critical values within 30 min of the generation of reports. About 96% (1056/1100) of all the critical values were communicated within 30 min to the concerned clinicians. 44 cases (4%) of the cases were missed because of varied reasons as equipment failure

(*n* = 24, 54.5%), lack of adequate staff (*n* = 8, 18.1%), logistical reasons (stationary items) (n = 7, 15.9%) and connectivity issues with number of limited printers (*n* = 5, 11.3%) [Table 2].

Based on the route cause analysis, some of the remedial actions were taken, which included (a) appointment of a biomedical engineer to immediately attend to any equipment failure. (b) Mandatorily, all the machines were covered under an annual maintenance contract. (c) Adequate provisions were made to arrange for sufficient stationary items and printers, and also (d) more report dispatch counters with trained staff were opened for smooth and early dispersal of reports. Wherever feasible, efforts were made to communicate the critical reports to the clinicians using personal SMS and WhatsApp services to avoid patient inconvenience and delay in patient management.

In the present study, 13.8% (972/7000) of the total sample size was available for cytology histology correlation. Our study revealed 93.3% (907/972) concordance for cytology reports. 7% (65/972) of cases were found discordant with their biopsy report. The causes for discordance was Low cellularity (*n* = 27, 41.5%), haemorrhagic background (*n* = 20, 30.7%), inadequate smears (*n* = 18, 27.6%) and non-representative areas (*n* = 10, 15.3%) [Table 3].

Based on the route cause analysis, some of the remedial actions were taken, which include (a) efforts were made to improve the aspiration techniques, (b) encouraging the use of guided aspiration in case of very tiny, deep-seated lesions and vascular lesions and (c) improve the smearing and staining techniques, respectively.

In the present study, the revised report is 3% (210/7000) of the total cases studied. The causes for revised report was indeterminate cytology report (*n* = 120, 57.1%), ancillary studies as showing new findings (*n* = 50, 23.8%), new clinical features/complications (*n* = 15, 7.1%), new clinical information on treatment and prognosis (n = 15, 7.1%) and clinician request for review (*n* = 10, 4.7%) [Table 4].

Based on the route cause analysis, some of the remedial actions were taken, which include, (a) Malignant cases are reported by a cytopathologist, (b) clinical correlation is always encouraged before attaining a conclusive opinion, (c) weekly clinicopathology meetings are organised to appreciate clinic-pathological views and (d) relevant radiological biochemical and serological investigations are advised and subsequently reviewed before a final opinion is reached.

In the present study, 2.08% (146/7000) cases were reported outside TAT. The causes were procedural delays regarding registration and bill payment (*n* = 50, 34.2%), transcription of errors (*n* = 40, 27.3%), lack of adequate staff at report dispatch counter and limited availability of printers (*n* = 36, 24.6%) and requirement of additional clinical information (*n* = 20, 13.6%) [Table 5].

Based on the route cause analysis, some of the remedial actions were taken, which include (a) installation of laboratory information system software, (b) Barcoding of samples specimens (c) steps to prevent erroneous data entry and transcription errors initiated with proper training of the support staff involving with the typing and dispatch of reports.

Table 1: Root cause analysis of failure to maintain good staining quality

Factors affecting staining quality	Number of cases, *n* (%)
Lack of competence of staffs	1 (5)
Lack of compliance to standardised	12 (60)
Use of stain beyond expiry date	4 (20)
Miscellaneous factors	3 (15)
Total	20 (100)

Table 2: Analysis of delayed critical values

Route cause analysis	Number of cases, *n* (%)
Equipment failure	24 (54.5)
Lack of adequate staff	8 (18.1)
Logistical reasons (stationary items)	7 (15.9)
Connectivity issues with number of limited printers	5 (11.3)
Total	44

Table 3: Analysis of discordant correlation

Route cause analysis	Number of cases, *n* (%)
Low cellularity	27 (41.5)
Haemorrhagic background	20 (30.7)
Inadequate smears	18 (27.6)
Non-representative areas	10 (15.3)
Total	65

Table 4: Analysis of revised reports

Route cause analysis	Number of cases, *n* (%)
Indeterminate cytology report	120 (57.1)
Ancillary studies as showing new findings	50 (23.8)
New clinical features/complications	15 (7.1)
New clinical information on treatment and prognosis	15 (7.1)
Clinician request for review	10 (4.7)
Total	210

In the present study, a total of 2.87% (147/5110) FNACs underwent the RE-DO procedure. The causes were erroneous data and transcription error (*n* = 50, 34%), improper guided procedure (*n* = 40, 27.2%), using trainee technology students (*n* = 25, 17%) and broken slides/drying artefacts (*n* = 32, 21.7%) [Table 6].

Based on the route cause analysis, some of the remedial actions were taken, which include (a) steps to prevent erroneous data entry and transcription errors initiated with proper training of the support staff involved in the typing and dispatch of reports. (b) Efforts have been made to improve guided

procedures with judicious and appropriate use of high and radiological interventions such as magnetic resonance imaging and computed tomography scans. (c) Efforts have been made to improve the training of the students with proper 'hands-on demonstration'. (d) Safety measures have been initiated to prevent the breakage of slides and the occurrence of drying artefacts with adequate fixation and proper staining.

In the present study, 3.01% (154/5110) FNACs underwent repetition. The causes were inadequate material (n = 74, 48%), inconsistent cyto-clinical correlation (n = 35, 22.7%), additional material for ancillary studies (n = 17, 11%), using trainee technology students (n = 15, 9.7%) and uncooperative patients (n = 13, 8.4%) [Table 7].

Based on the route cause analysis, some of the remedial actions were taken, which include (a) efforts have been made to improve the cytology procedure with proper hands-on training of the trainees, (b) prior informed consent was obtained from the patients, and the procedure was explained to them to allay any apprehensions, (c) coordination with the clinical departments is encouraged and (d) ancillary studies were done wherever feasible as a pre-procedure workup.

In the total duration of the present study, 2.85% of total cases were reported as NCs. The most common causes of NC were; improper labelling of the sample, incomplete registration, inadequate clinical history and insufficient samples.

Randomly selected 200 samples (100 fluids and 100 FNAC) were crosschecked with respective cell block and histopathology as internal QC, and the following prediction accuracy measures were calculated. A simple randomisation technique was adopted for this purpose. For fluid cytology, sensitivity was 78%, specificity 89%, PPV 62% and NPV 87% (95% confidence interval [CI]). For FNAC, sensitivity was 98%, specificity 94%, PPV 95% and NPV 98% (95% CI).

Table 5: Analysis of turn around time

Route cause analysis	Number of cases, *n* (%)
Procedural delays regarding registration and bill payment	50 (34.2)
Transcription of errors	40 (27.3)
Lack of adequate staff at report dispatch counter and also limited availability of printers	36 (24.6)
Requirement of additional clinical information	20 (13.6)
Total	146

Table 6: Analysis of redo's

Route cause analysis	Number of cases, *n* (%)
Erroneous data and transcription error	50 (34)
Improper guided procedure	40 (27.2)
Using trainee technology students	25 (17)
Broken slides, drying artifacts	32 (21.7)
Total	147

Table 7: Analysis of repeats

Route cause analysis	Number of cases, *n* (%)
Inadequate material	74 (48)
Inconsistent cyto-clinical correlation	35 (22.7)
Additional material for ancillary studies	17 (11)
Using trainee technology students	15 (9.7)
Uncooperative patients	13 (8.4)
Total	154

Discussion

The history of cytopathology has had many twists and turns as the days progressed. The era of the 1920s was considered a landmark year for diagnostic cytology. Aspiration and exfoliative cytology was first introduced in the 1920s, and subsequently, imprint smears began in the year 1830s. The first person to show cancer cells under the microscope was Johannes Muller, who made it possible by cutting the scraped surface of a surgically excised tumour.[1] Breast tissue aspiration was introduced by Paget, and by the end of the 1890s, urine cytology findings were included in the routine diagnosis of bladder cancer as well.[10]

By the 1950s, cytology reports became an integral part of laboratory services, and by the 1960s, cytology was considered a new speciality within Pathology. In 1961, Leopold Koss published a textbook on diagnostic cytology.[10] Of late, the new and improved imaging techniques have led to rapid advances in aspiration cytology.[10]

Quality is characteristic of entities that bear upon their ability to satisfy stated or implied needs. QC is the operational techniques and activities that fulfil and verify the requirement of quality in an individual test or a process.[1] Unlike, Biochemistry and Hematology, where numerical data are readily available, diagnostic cytology reports involve skills of interpretation, explanations, evaluations of probability along with clinical judgments.[11] This is because cytopathology is an art of analysing and interpreting the shapes, sizes and architectural patterns of cells and is also considered a science by which the images are placed in a specific clinical background to arrive at an accurate diagnosis.[12]

Assessment and implementation of QC in cytopathology remain a challenge as its services are entirely qualitative rather than quantitative. Inherent qualities such as the lack of objective numerical data, descriptive reports, the subjectivity of individual reports and bias and non-uniformity of reporting patterns make assessment and implementation of QC challenging in cytopathology.[13] Hence, the perfect coordination between technical and managerial activities accompanied by qualified and competent cytopathologists is required for the implementation of efficient, effective, error-free and accurate diagnostic reports [Figure 1].[13]

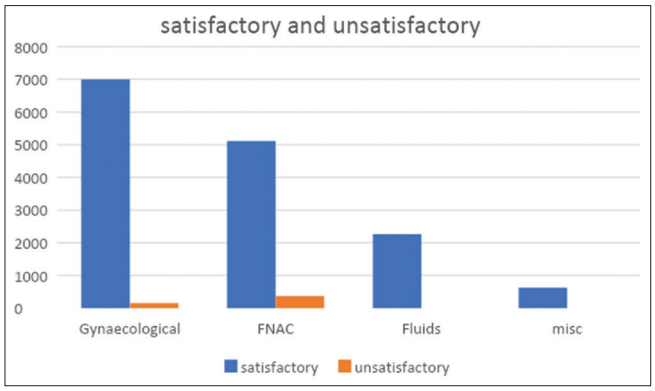

Figure 1: Graphical representation of satisfactory and unsatisfactory cases. FNAC: Fine needle aspiration cytology.

QC is conventionally applicable to three phases of operation (1) the pre-analytical phase, (2) the analytical phase and (3) the post-analytical phase. The pre-analytical phase is related to sample collection, transport, accession and processing.[13] Patient or specimen identification is one of the most important aspects, and it begins with specimen labelling and accessioning.[14] SOP for sample accession, identification, processing and rejection should be well documented and displayed in the laboratory and also the technical staff should be fully aware of its contents.[15] All the laboratory equipment, including microscopes, should be of acceptable quality and should have periodic calibration. The cytology smears should undergo the phases of fixation, dehydration and clearing of sufficient duration to ensure complete processing as mentioned in the respective SOPs.[16]

The analytical phase is related to actually carrying out the test (manual/automated). QC of analytical aspects of cytopathology is very difficult because of the subjectivity of the reports. (a) Interdepartmental discussions, (b) blinded random case review, (c) comparison of other reports, (d) Hierarchical form of reporting, (e) review by experts and participation in continued medical education programmes are some of the steps which will help in the improvement of the quality of cytology reports.[17]

The post-analytical part consists of the transmission of results, storage/disposal of samples, maintenance of test data, etc. Report generation within the stipulated TAT and without any transcription errors, along with dispatch to the right persons, is a good quality indicator of post-analytical cytopathology laboratory services.[18] Patient safety issues such as reporting of critical values to the clinicians are also an important aspect of post-analytical quality maintenance.[18]

According to the study, failure to maintain TAT is predominantly due to equipment breakdown, followed by the extra time needed for obtaining additional clinical information and logistical delays due to sample collection and transportation. Similar to the study done by Gupta *et al*.[6] and Mehrotra *et al*.,[19] samples rejection due to incomplete requisition forms with incorrect identification details constitutes the maximum cause for rejection of cytology samples. Similar to the study conducted by Plebani[20] the post-analytical errors constitute wrong data entries, transcription mistakes and wrong validation of the data. Identical findings were also observed by Jones *et al*.,[21] emphasising cyto-histopathological correlation and also confirmation of the accuracy of cytological diagnosis by histopathological examination is considered an acceptable reference standard. In the present study, the cytology reports were randomly correlated with histopathology reports and the findings were statistically analysed.

With regard to fluid cytology, the sensitivity, specificity, and NPV were 70%, 100% and 37% (CI: 27–54), respectively, in a study by Haridas *et al*.[22] This is identical to our study as well. Our study highlights the need for the laboratory services to undergo accreditation as it helps in maintaining QA and also improving standard laboratory practices along with the attainment of satisfactory professional competency. Hence the study lays emphasis on following ISO: 9001-2015, standards which are universally regarded as optimal and achievable. In this regard, identical observations were noted by Mallick[23] in their study to ensure quality performance, every laboratory should have some form of quality management system for all the procedures performed under its scope of activity. QA, CQI and QC are integral components of a required 'quality system'.

Conclusion

It is mandatory to maintain optimum quality standards in all aspects of laboratory services as the reports generated by the various laboratories directly affect patient treatment and welfare. 'Quality' is a continuous journey, not a 'destination', and the journey towards quality begins with the identification and collection of the right sample, processing it in the right manner and dispatching the correct report at the right time.

Hence, we feel that every diagnostic laboratory should incorporate a 'Quality management system' to ensure regular high-quality, error-free, efficient and effective laboratory operations which can fulfil accreditation standards as accreditation ensures CQI with active involvement of the stakeholders.

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Conflicts of interest

There are no conflicts of interest.

References

1. Marchevsky AM, Wick MR. Evidence-based medicine, medical decision analysis, and pathology. Hum Pathol 2004;35:1179-88.
2. Jones BA, Valenstein PN, Steindel SJ. Gynecologic cytology turnaround time. A College of American Pathologists Q-Probes Study of 371laboratories. Arch Pathol Lab Med 1999;123:682-6.
3. Icho N. The automation trend in cytology. Lab Med 2000;31:218-21.
4. Branca M, Longatto-Filho A. Recommendations on quality control and quality assurance in cervical cytology. Acta Cytol 2015;59:361-9.
5. GuptaV, Negi G, Harsh M, Chandra H, Agarwal A, ShrivastavV. Utility of sample rejection rate as a quality indicator in developing countries. J Nat Accred Board Hosp Healthc Provid 2015;2:30-51.

6. Aggarwal A, Aeran H, Rathee M. Quality management in healthcare: The pivotal desideratum. J Oral Biol Craniofacial Res 2019;9:180-2.
7. Lippi G, Chance JJ, Church S, Dazzi P, Fontana R, Giavarina D, *et al*. Preanalytical quality improvement: From dream to reality. Clin Chem Lab Med 2011;49:1113-26.
8. Barisoni L, Lafata KJ, Hewitt SM, Madabhushi A, Balis UG. Digital pathology and computational image analysis in nephropathology. Nat Rev Nephrol 2020;16:669-85.
9. Agarwal A, Sharma R, Gupta S, Finelli R, Parekh N, Selvam MKP, *et al.* Standardized laboratory procedures, quality control and quality assurance are key requirements for accurate semen analysis in the evaluation of infertile male. World J Mens Health 2022;40:52-65.
10. Hajdu SI, Ehya H. Foundation of diagnostic cytology. Ann Clin Lab Sci 2008;38:296-9.
11. Bishop JW, Marshall CJ, Bentz JS. New technologies in gynecologic cytology. J Reprod Med 2000;45:701-19.
12. Branca M, Longatto-Filho A. Recommendations on quality control and quality assurance in cervical cytology. Acta Cytol 2015;59:361-9.
13. Nakhleh RE. What is quality in surgical pathology? J Clin Pathol 2006;59:669-72.
14. Rao S, Masilamani S, Sundaram S, Duvuru P, Swaminathan R. Quality measures in pre-analytical phase of tissue processing: Understanding its value in histopathology. J Clin Diagn Res 2016;10:EC07-11.
15. Hollensead SC, Lockwood WB, Elin RJ. Errors in pathology and laboratory medicine: Consequences and prevention. J Surg Oncol 2004;88:161-81.
16. Adyanthaya S, Jose M. Quality and safety aspects in histopathology laboratory. J Oral Maxillofac Pathol 2013;17:402-7.
17. Iyengar JN. Quality control in the histopathology laboratory: An overview with stress on the need for a structured national external quality assessment scheme. Indian J Pathol Microbiol 2009;52:1-5.
18. Walz SE, Darcy TP. Patient safety & post-analytical error. Clin Lab Med 2013;33:183-94.
19. Mehrotra A, Srivastava K, Bais P. An evaluation of laboratory specimen rejection rate in a north Indian setting-a cross-sectional study. IOSR J Dental Med Sci 2013;7:35-9.
20. Plebani M. The detection and prevention of errors in laboratory medicine. Ann Clin Biochem 2010;47:101-10.
21. Jones BA, Valenstein PN, Steindel SJ. Gynecologic cytology turnaround time. A College of American Pathologists Q-Probes Study of 371 laboratories. Arch Pathol Lab Med 1999;123:682-6.
22. Haridas N, Suraj KP, Rajagopal TP, James PT, Chetambath R. Medical thoracoscopy vs. closed pleural biopsy in pleural effusions: A randomized controlled study. J Clin Diagn Res 2014;8:MC01-4.
23. Mallick D. Evaluation of Quality Assurance in the Cytopathology Laboratory of a Tertiary Care Hospital in Eastern India. Available from: https://www.jcrsmed.org/article.asp?issn=2455-3069;year=2021;volume=7;issue=1;spage=24;epage=28;aulast=Mallick. [Last accessed on 2022 Aug 15].