RESEARCH ARTICLE

Editorial Process: Submission:07/04/2024 Acceptance:11/14/2024

Review of Quality Audit in a Radiation Oncology Department in a Tertiary Care Hospital– 2 Year-Results

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Abstract

Objectives: This study aimed to report the findings of comprehensive weekly quality audit of radiotherapy procedures conducted at our institute, assessing various domains including clinical notes, contour delineation, treatment planning, prescription accuracy, patient-specific quality assurance, and treatment set-up checks. **Material and Methods:** The audit protocol, based on the Peer Review Audit Tool (PRAT) from the Royal Australian and New Zealand College of Radiologists, evaluated six critical parameters: clinical decisions, contours, treatment prescriptions, plan evaluation, plan quality assurance, and daily treatment set-ups. Patients were assessed for changes categorized as no change, minor change, or major change. The audit panel comprised radiation oncologists, medical physicists, and therapists. The audit is conducted on a weekly basis, including patients who initiated treatment within the preceding week. **Results:** Between December 2020 to October 2023, 1831 cases were treated with radiotherapy in our institution and all of them were included in the quality audit. Overall, majority of patients exhibited no changes across various domains, with minor adjustments noted in a small percentage of cases. Notably, the clinical note check domain showed 99% adherence to standards, while contour delineation and treatment planning domains displayed minor adjustments in 2.7% and 1.7% of cases, respectively. Prescription accuracy and patient-specific quality assurance demonstrated high compliance, with minimal changes observed. Treatment set-up checks revealed minor variations in 0.3% and major changes in 0.2% of cases. **Conclusion:** This study underscores the importance of comprehensive quality audits in radiation oncology to ensure precision and consistency in treatment delivery. By identifying potential areas for improvement and maintaining high standards across all stages of the radiotherapy process, such audits play a crucial role in optimizing treatment outcomes and enhancing patient safety.

Keywords: Audit- quality- radiotherapy- cancer

Asian Pac J Cancer Prev, **25 (11)**, 4043-4049

Introduction

According to GLOBOCAN projections, it is anticipated that the number of cancer cases in India will surge to 2.08 million by 2040, signifying a substantial 57.5% increase compared to the year 2020. This upward trend is expected to persist in the coming decade. The overall prevalence of cancer is estimated to be 83 per 100,000 individuals, with a more pronounced prevalence observed in urban areas [1].

The number of functional radiotherapy units in India are below the limit recommended by the World Health Organization. Hence, the number of patients on radiotherapy per linear accelerator tends to be high in India, making it susceptible for errors [2].

Radiation treatment is a complex, multi-step process that necessitates the collaboration of numerous professionals such as radiation oncologists, physicists, dosimetrist, radiation therapists, and nurses. Radiotherapy involves a combination of manual and automated steps, heavily relies on complex datasets, their interpretation, and the exchange of information among staff and systems. Consequently, this complexity makes radiation treatment susceptible to a range of potential errors. The focus on quality assurance and auditing in the field of radiation oncology (RO) has undergone significant development over the past 3 decades with the publication of various guidelines for reporting of errors [3].

We present our findings of the weekly radiotherapy quality audit conducted at our institute from Dec 2020 till October 2023.

Materials and Methods

Our Radiation Oncology facility is equipped with 2

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linear accelerators namely the Varian ETHOS and Varian Tru-Beam and one HDR Brachytherapy unit (Varian Medical Systems, Palo Alto, USA). Three-dimensional and four-dimensional simulations are executed using computed tomography (CT), PET-CT, and magnetic resonance imaging, incorporating Picture Archiving and Communication Systems (PACS) and fusion software within Treatment Planning System (TPS) platforms. The radiation oncology workflow is seamlessly handled in a digital, paperless task management environment. The audit is conducted weekly and patients who started treatment in the last week are included in the audit.

Clinical information about the patients was obtained from the hospital information system. Information pertaining to contours, prescriptions, plan evaluation, plan quality, and treatment setup was gathered from Treatment Planning System software, such as Eclipse, Aria, or Ethos treatment planning system. The audit panel consisted of radiation oncologists, medical physicists, and therapists.

The departmental audit protocol has been formulated on the basis of the Peer Review Audit Tool (PRAT), from the Royal Australian and New Zealand College of Radiologists [4]. We scrutinized six critical parameters, which encompassed the quality of clinical decisions, contours, treatment prescriptions, plan evaluation, plan quality assurance, and daily treatment set-ups. Each parameter had predefined definitions for minor and major changes. We assessed all patients across these parameters, categorizing their outcomes as either no change, minor change, or major change (Table 1).

To ensure the accuracy of data, the audit was conducted in a multidisciplinary manner with the presence of multiple Radiation oncology consultants, residents, Medical physicists, radiation therapists

Results

Overall

In the assessment of 1831 patients, the overall results indicate that the majority exhibited no changes across various domains. 1812 patients showing no change in the clinical note check domain (98.97%) and minor changes were observed in 19 cases (1.03%). In the contour check, 1769 patients exhibited no change (96.57%), while 50 patients (2.73%) showed minor changes and 12 patients (0.65%) exhibited major changes. Regarding patient plan check domain, 1791 patients demonstrated no changes (97.74%), while 31 patients (1.69%) had minor changes and 9 patients (0.49%) displayed major changes. In the prescription check, 1820 patients had no changes (99.34%), while 4 patients (0.22%) required minor changes and 7 patients (0.38%) had major changes. Within the patient specific QA domain, 1829 patients exhibited no change (99.89%), with no minor changes observed, while 2 patients (0.11%) exhibited major changes. Lastly, in the treatment set-up check, 1821 patients showed no changes (99.34%), while 6 patients (0.33%) required minor changes and 4 patients (0.22%) required major changes (Table 2).

Intent wise

In the assessment of 377 patients undergoing curative radical treatment, across various domains, the following results were obtained. In the clinical note check domain, 374 patients remained unchanged (99.2%), with only 3 patients (0.8%) exhibiting minor changes and no major changes observed. For the contour check, 359 patients showed no changes (95.2%), while 16 patients (4.3%) experienced minor changes and 2 patients (0.5%) displayed major changes. Regarding the patient plan check domain, 368 patients demonstrated no alterations (97.6%), while 8 patients (2.1%) had minor changes and 1 patient (0.3%) exhibited a major change. In the prescription check, 375 patients had no changes (99.5%), while 2 patients (0.5%) experienced major changes with no minor changes observed. Within the patient specific QA domain, all 377 patients remained unchanged (100%) with no minor or major changes. Finally, in the treatment set-up check, 373 patients showed no changes (98.9%), while 1 patient (0.3%) required minor changes and 3 patients (0.8%) displayed major changes.

In the assessment of 976 patients undergoing curative adjuvant treatment, the majority exhibited no changes across various domains. Within the clinical note check domain, 970 patients showed no change (99.4%), with only 6 patients (0.6%) showing minor changes and no major changes observed. Similarly, in the contour check, 939 patients displayed no changes (96.2%), while 28 patients (2.9%) experienced minor changes and 9 patients (0.9%) exhibited major changes. Concerning the patient plan check domain, 951 patients demonstrated no changes (97.5%), with 18 patients (1.8%) experiencing minor changes and 7 patients (0.7%) displaying major changes. In the prescription check, 970 patients had no changes (99.4%), while 3 patients (0.3%) required minor changes and 3 patients (0.3%) exhibited major changes. Within the patient specific QA domain, 974 patients showed no change (99.8%), while 2 patients (0.2%) displayed major changes, with no minor changes observed. Finally, in the treatment set-up check, 971 patients showed no changes (99.6%), with 4 patients (0.3%) experiencing minor changes and 1 patient (0.1%) displaying a major change.

The number of patients that underwent curative neoadjuvant treatment was 79. In the clinical note check domain, 78 patients remained unchanged (98.7%), with only 1 patient (1.3%) showing a minor change and no major changes observed. Similarly, in the contour check, 78 patients exhibited no changes (98.7%), while 1 patient (1.3%) displayed a major change with no minor changes observed. Regarding the patient plan check domain, 78 patients demonstrated no changes (98.7%), with 1 patient (1.3%) requiring a minor change and no major changes observed. In the prescription check, all 79 patients required no changes (100%). Within the patient specific QA domain, all 79 patients required no change (100%), with no minor or major changes observed. Finally, in the treatment set-up check, 78 patients showed no changes (98.7%), with 1 patient (1.3%) requiring a minor change and no major changes observed.

The number of patients requiring palliative treatment was 399. Within the clinical note check domain, 390

Table 1. Peer Review Audit Tool (PRAT) Criteria

	Clinical Note Check	Contour Check	Patient Plan Check	Treatment Prescription Check	Patient Specific QA Check	Treatment Set-Up Check
No Change						
Minor Change	Sequence of events, Incomplete personal history (Allergy, family etc), Examination findings and staging.	Minor change in PTV or OAR, without significant clinical impact on patient	Replan for Dose exceeding or space for further reduction of dosage to Noncritical organs such as Parotid, Oral cavity, 50% Isodose distribution, change in treatment technique IMRT/ RA/3DCRT, Reduction in low volume dose spill and achieving conformity. Change in plan due to incorrect gantry angle or collision	Minor change in prescription without significant clinical impact		Minor set up variation without clinical impact
Major Change	Incomplete HPR report, Important investigations (Imaging, Biopsy, PET scan etc), Incomplete previous treatment details, Incomplete management plan.	Major change in PTV or OAR, with a significant clinical impact on patient	Replan for dose exceeding Critical OAR, Inadequate coverage of PTV. Unacceptable doses to OAR due to inappropriate technique.	Change in dose and fractionation, Bolus or No bolus use, Depth of prescription. Daily versus alternate day schedule.	< 95% Gamma index QA pass for IMRT, VMAT Point dose variation >5 % for SRS / SBRT	Inadequate PTV coverage on more than 3 days. Change of immobilization device, Incorrect positioning

patients required no changes (97.7%), with 9 patients (2.3%) showing minor changes and no major changes observed. Similarly, in the contour check, 393 patients exhibited no changes (98.5%), while 6 patients (1.5%) experienced minor changes with no major changes observed. Regarding the patient plan check domain, 394 patients demonstrated no changes (98.7%), with 4 patients (1.0%) requiring minor changes and 1 patient (0.3%) requiring a major change. In the prescription check, 396 patients had no changes (99.2%), while 1 patient (0.3%) required minor changes and 2 patients (0.5%) exhibited major changes. Within the patient specific QA domain, all 399 patients required no changes (100%), with no minor or major changes observed. Finally, in the treatment set-up check, all 399 patients showed no changes (100%), with no minor or major changes observed (Table 3).

Site wise

In the evaluation of 473 patients diagnosed with breast cancer, for the clinical note check 470 (99.3%) showed no change, with 3 (0.7%) experiencing minor changes and none undergoing major changes. In the Contour Check, 460 (97.3%) remained unchanged, while 10(2.1%) had minor changes and 3 (0.6%) had major changes. Regarding the patient plan check, 462 (97.7%) remained stable, with 9 (1.9%) experiencing minor changes and 2 (0.4%) experiencing major changes. Similarly, the prescription check showed 468 (99%) with no change, 2(0.4%) with minor changes, and 3 (0.6%) with major changes. In the patient specific QA domain, 473 (100%) showed no change, and there were no minor or major changes. Lastly, the treatment set-up check displayed 473 (100%) with no change, and no minor or major changes were observed.

In the assessment of 279 patients diagnosed with oral cavity cancer, with clinical note check, 277 (99.3%) had no changes, 2 (0.7%) exhibited minor change, none had major change. As far as contour check is concerned, no change was noted in 266 (97.3%) patients, 8 (2.1%) patients had minor changes, major change was noted in 5 (0.6%). In patient plan Check, 270 (96.8%) patients had no change, 4 (1.4%) patients exhibited minor change, major change was noted in 5 (1.8%) patients. In prescription check, 278 (99.6%) had no change, minor change was seen in 1 (0.4%) and major change was seen in none. All patients had patient specific QA passed with 279(100%). Treatment set up check was perfect in 275(98.6%) and 4 (1.4%) patients had no changes.

In 114 patients treated for Gynaecological Cancers,

Table 2. Overall Changes

Clinical note check			Contour check			Patient plan check		
No change	Minor change	Major change	No change	Minor change	Major change	No change	Minor change	Major change
1812	19	0	1769	50	12	1791	31	9
-98.97%	-1.03%	0%	-96.57%	-2.73%	-0.65%	-97.74%	-1.69%	-0.49%
Prescription check			Patient specific QA check			Treatment setup check		
No change	Minor change	Major change	No change	Minor change	Major change	No change	Minor change	Major change
1820	4	7	1829	0	2	1821	6	4
-99.34%	-0.22%	-0.38%	-99.89%	0%	-0.11%	-99.34%	-0.33%	-0.22%

Table 3. Intent Wise

INTENT	Patients (N)	Clinical note check			Contour check			Plan evaluation check			Prescription check			Patient specific QA check			Treatment set up check		
		No change	Minor change	Major change	No change	Minor change	Major change	No change	Minor change	Major change	No change	Minor change	Major change	No change	Minor change	Major change	No change	Minor change	Major change
Curative radical	377	374 (99.2%)	3 (0.8%)	0	359 (95.2%)	16 (4.3%)	2 (0.5%)	368 (97.6%)	8 (2.1%)	1 (0.3%)	375 (99.5%)	0	2 (0.5%)	377 (100%)	0	0	373 (98.9%)	1 (0.3%)	3 (0.8%)
Curative adjuvant	976	970 (99.4%)	6 (0.6%)	0	939 (96.2%)	28 (2.9%)	9 (0.9%)	951 (97.5%)	18 (1.8%)	7 (0.7%)	970 (99.4%)	3 (0.3%)	3 (0.3%)	974 (99.8%)	0	2 (0.2%)	971 (99.6%)	4 (0.3%)	1 90.1%)
Curative neoadjuvant	79	78 (98.7%)	1 (1.3%)	0	60 (98.4%)	0	1 (1.3%)	78 (98.7%)	1 (1.3%)	0	79 (100%)	0	0	79 (100%)	0	0	78 (98.7%)	1 (1.3%)	0
Palliative	399	390 (97.7%)	9 92.3%)	0	393 (98.5%)	6 91.5%)	0	394 (98.7%)	4 (1%)	1 (0.3%)	396 (99.2%)	1 (0.3)	2 (0.5%)	399 (100%)	0	0	399 (100%)	0	0

clinical note check had no change in all patients 114 (100%). Contour check domain had 104 (91.2%), 9 (7.9%), 1 (90.9%) patients with no change, minor change and major change respectively. With respect to patient plan check, 112 (98.2%) of patients had No change, 2 (1.8%) patients showed minor change and there was no major change reported. In prescription check, 112 (98.2%) patients had No change, 2 (1.8%) patients showed major change. Patient specific QA reported no change and major change in 113 (99.1%) and 1(0.9%) patients respectively. There was no change reported in 111 (97.4%) for treatment set-up check. Major change was noted in 2 (2.6%) patients.

In the evaluation of 52 patients diagnosed with prostate cancers, no change was noted in all patients 52 (100%). In contour check, no change was reported in 51 (98.1%) and major change in 1 (1.9%) patient while none had a minor change. In patient plan check, 50 (96.2%) patients had no change, 2 (3.8%) with minor change and none with major change. In prescription check, no change was seen in all patients 52 (100%). Patient Specific QA had no change in 51 (98.1%) and major change in 1 (1.9%) patient. With respect to treatment set-up, no change was noted in 51 (98.1%) of patients, minor change in 1 (1.9%) patients and major change in none.

In 81 patients treated with Anorectal Cancers, with respect to clinical note check, no change was seen in 80 (98.8%), minor change was noted in 1 (1.2%) and no patient had a major change. In contour check domain, while 79 patients (97.5%) remain unchanged, both minor and major change was reported in 1 (1.2%) patient each. Similarly, in patient plan check, no change was reported in 80 (98.8%), minor change was seen in 1 (1.2%), and no patient had a major change. In prescription check and patient specific QA domain, all patients analysed had no change. Treatment Set-up Check exhibited no change in 80 (98.8%), and minor change in 1 (1.2%) patient.

In the evaluation of 99 patients diagnosed with primary CNS neoplasms, for the clinical note check domain, 96 (96.9 %) showed no change, with 3 (3.03%) experiencing minor changes and none had major changes. In the contour check, 98 (98.9%) remained unchanged, while 1 (1.01%) had minor changes and none had major changes. Regarding the patient plan check, 95 (96%) remained stable, with 4 (4.04%) experiencing minor changes and none experiencing major changes. Similarly, with respect to the prescription check, patient specific QA check and set up check all patients 99 (100%) had no change, none with minor and major changes.

Discussion

The significance of maintaining comprehensive records cannot be overstated, serving as a tangible testament to the care provided and offering a crucial defence in the face of complaints or claims. The collaborative nature of clinical oncology, involving multiple clinicians, underscores the essential role of accurate clinical documentation for the sake of continuity in patient care. In the unfortunate event of a complaint or claim, medical and nursing records become focal points of scrutiny, examined closely by a spectrum of professionals, from experts and administrators

to lawyers and the courts. Furthermore, patients' right of access to their own medical records emphasizes the transparency and trust inherent in sound record-keeping practices. Studies consistently illuminate the correlation between the quality of practitioners' record-keeping and the standards of their professional practice. This connection underscores the importance of adopting a meticulous and disciplined approach to documentation, as it not only aids in maintaining high standards of care but also serves as a foundational component in defending the integrity of healthcare practices [5,6]. Electronic medical records (EMR) have become ubiquitous, and computer-based radiation oncology information systems (ROIS) now serve as central hubs for coordinating core aspects of radiotherapy care. The ROIS, acting as a comprehensive repository, manages technical information, clinical notations, scheduled patient visits, treatment records, and workflow coordination. It plays a pivotal role in treatment delivery, housing records of treatment intent, types of radiotherapy, schedules, technical aspects of treatment plans, and image-based target localization [7]. As we delve into the discussion of clinical note checking, the audit results illuminate the commendable state of our record-keeping practices. Notably, the observation of 1812 (99%) of clinical notes exhibiting no changes, with only 19 (1%) reflecting minor adjustments and no major alterations.

Among these 19 cases, 12 required a clinical note update due to incompleteness, and 7 needed an update due to pending clinical investigations.

Delineation of contours is a crucial step in treatment planning, as it entails outlining the tumor or areas susceptible to microscopic disease, along with nearby organs at risk (OARs). Despite the emergence of consensus guidelines designed to standardize contour delineation and mitigate variation among providers, numerous studies conducted on the peer review process highlight that a considerable portion of modifications to treatment plans involves changes to contours. This underscores the ongoing challenge of achieving consistency in contour delineation and its impact on the quality of plans and patient outcomes [8]. Rooney and colleagues conducted weekly chart rounds for patients undergoing radical radiation therapy for lung cancer. Their peer review process led to alterations in 27% of the analysed patients, with 63.6% of these changes attributed to adjustments in target volume delineation [9]. In a separate study, Ballo et al organized a bi-weekly peer-review conference for nonpalliative cases. The examination revealed recommended changes in 12.2% of the cases, with 69.1% of those changes involving modifications to the target [10]. Cox and colleague's investigation focused on external beam radiation therapy cases subject to prospective daily contouring rounds. Before initiating treatment planning, modifications were necessary for 36% of the plans. The primary reasons for delays were incomplete contours and the need for target adjustments [11]. More recently, Mitchell et al implemented a prospective peer-review process, holding chart rounds 3 to 4 days weekly. Their findings showed that 10% of cases had recommendations for changes in contours [12]. These findings collectively emphasize the significant role of target delineation errors as a prominent cause for alterations in both retrospective and prospective peer reviews. Surucu and colleagues conducted a study on the effects of transitioning to prospective contouring and planning rounds as a form of peer review. The results revealed that following the implementation of this approach, alterations to contours or doses were necessary in nearly 5% of the presentations [13]. In our study, in the contour check domain, in 1769 cases (96.6%), no changes were reported, while 50 cases (2.7%) indicated minor adjustments, and 12 cases (0.7%) reported major changes. Among the 50 minor changes, 35 cases required a modification in the PTV, 11 cases needed the incorporation of additional target volumes, and in 4 cases, OARs were either not contoured or exhibited missing slices. Among the 12 major changes, 8 cases warranted PTV modification, while in 4 cases, additional target volumes had to be incorporated in the PTV.

A high-quality treatment plan is designed to attain the goals of the clinical prescription, skilfully managing the interplay between a heightened target dose to maximize tumor control and maintaining organ-at-risk doses at levels that are suitably low to prevent excessive toxicity. This approach ensures the delicate equilibrium necessary for achieving optimal treatment outcomes. The American College of Radiology advises that every radiation therapy plan should undergo an independent double check and receive the signature of a radiation oncologist within one week of the initiation of treatment [14]. Qureshi et al. evaluated and reported on the frequency of changes in radiation therapy treatment plans following peer review in a simulation review meeting conducted once a week. Among the 116 plans assessed, 26 (22.4%) were recommended for changes. Minor adjustments were suggested for 15 treatment plans (12.9%), major changes for 10 plans (8.6%), and only one plan was identified for a missing contour [15]. The outcomes of our study revealed significant trends in the plan evaluation domain. In 1791 cases (97.8%), no changes were reported, while 31 cases (1.7%) indicated minor changes, and 9 cases (0.5%) reported major changes. Among the 31 minor changes, in 6 cases, the OAR doses had to be revised, 17 cases were recommended for improved target coverage. In 8 cases, a change in technique was warranted. The change of technique usually involved a change in photon energy, a change from DIBH to Free breathing, inclusion of bolus, or the use of a mono-isocentric technique. Among the 9 major changes, 8 cases warranted a change in the plan due to target coverage, while 1 case required a change in the plan because OAR dose constraints were not achieved.

Common errors in the administration of radiation therapy include instances where patients receive an inaccurate radiation dose, the treatment targets the wrong site, or there is an inadvertent administration of treatment to the wrong patient [16]. According to data from the Pennsylvania Department of Environmental Protection, Bureau of Radiation Protection, which documented 37 Medical Accelerator Events between 2004 and 2009, 46% of errors involved treating the incorrect site, 27% treated the wrong patient, 21% were errors in the incorrect dosage, and 3% each were attributed to underestimated medical procedure duration and inattention to detail [17].

In our treatment prescription check domain, our audit procedures have shown that

in 1820 cases (99.4%), no changes were reported, while 4 cases (0.2%) indicated minor changes, and 7 cases (0.4%) reported major changes. These changes typically occurred due to incompletely filled prescriptions, the addition of fractions, or modifications to the planned dose.

Ensuring precision in delivering the planned radiation dose is imperative in contemporary cancer treatments, particularly with the emergence of sophisticated treatment delivery options involving advanced technology like medical linear accelerators [18]. As part of our audit process, we conduct a portal dosimetry QA assessment to guarantee the accuracy and reliability of the radiation dose delivery. In the patient-specific QA check domain, our meticulous procedures reveal that 1829 (99.9%) reported no changes, with only 2 (0.1%) indicating major changes. These results underscore the effectiveness of our quality assurance measures. Both the instances of major changes involved a patient specific QA not being performed on time.

Ensuring precise patient positioning and accurate beam placement is essential for achieving the desired treatment outcomes. Despite efforts, variations and errors in patient setup can occur during the course of treatment. To address this, Image-guided Radiotherapy (IGRT) is employed, correcting for any changes in patient position and target localization before each treatment session [19]. In our institution, we utilize kv-Cone Beam CT for this purpose. As part of our quality audit, a retrospective review of pre-treatment CBCT images is conducted during audits to identify setup errors, variations, and to assess physiological changes such as weight loss compared to planning CT images. In the treatment set-up check domain, our meticulous procedures show that in 1821 cases (99.5%), no changes were reported, while 6 cases (0.3%) indicated minor changes, and 4 cases (0.2%) reported major changes. Among the 6 minor changes, 1 case had issues with bladder filling, 1 had issues with rectal filling, and 4 had issues with patient positioning. Among the 4 major changes, 1 patient had issues with bladder filling, and the remaining 3 had issues with patient positioning.

In conclusion, radiation therapy is an exceptionally precise cancer treatment modality. Evaluating the quality of all components in the radiation treatment process is essential to optimize treatment results. A comprehensive quality audit, spanning every facet of radiation therapy, fosters consistency in patient care regardless of their background. This, in turn, minimizes errors and resource wastage. Performing quality audits in each department is imperative as it reinforces the accuracy of treatment plans for patients. This precision is particularly crucial in the realm of radiation oncology, where precise delineation and delivery play a pivotal role in maximizing treatment outcomes.

Author Contribution Statement

All authors provided substantial contributions to conception, design, analysis and interpretation of research data.

Acknowledgements

Acknowledgements to Department of Onco-sciences, Reliance foundation hospital.

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