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CRITICAL ANALYSIS OF RADIOMICS IN RADIATION ONCOLOGY

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ABSTRACT

Radiomics could be a phenomenon in radiation oncology that provides an incredible way to move treatment forward through quantitative investigation of therapeutic pictures. This basic assessment provides an understanding of the utilization of radiology for individualized treatment arranging and result expectations. Synthesize methods, results, and conclusions of significant considerations to assess the current field of radiomics in radiation oncology. Imperatively, the discoveries highlight the relationship between radiographic marks and clinical results and uncover the potential to advance clinical procedures. In any case, challenges stay, particularly regarding repeatability and planning. Tending to these issues is fundamental to the fruitful assessment of radionics in radiation oncology. Proposals for future inquiries address these

confinements to progress the integration of radiology into schedule hone and advance understanding improvement.

INTRODUCTION

Radiation oncology is at the cutting edge of cancer treatment, endeavoring to convey tall radiation measurements to cancer cells while saving sound tissue. Customarily, treatment arranging was based overwhelmingly on clinical and anatomical criteria. However, later progresses in restorative imaging and innovation were introduced within the time of radionics and presented changes in radiographic imaging to move the setting of clinical outcomes (Nardone et.al.2021).

The Development of Radiomics

- Advances in Restorative Imaging

The Advancement of Radiomics Restorative imaging innovations such as computed tomography (CT), magnetic resonance imaging (MRI) and positron emission tomography (PET) give tall determination. The substance of picture capture has never been seen before (Lohmann et.al.2021).

- Computer innovation

At the same time, innovation was created that gives complex calculations for picture investigation and extraction. These advancements shaped the premise for the presentation of radiomics in radiation oncology (Liu et.al.2020).

Understanding Radiomics

- Quantitative Information Extraction

Radiomics requires extracting quantitative information from restorative pictures through a subjective examination. This permits point-by-point characterization of tumor phenotypes and microenvironment (Gregucci et.at.2022).

- Image includes examination

Radiomics provides for the examination of various picture highlights, intensity, texture, and spatial connections covering pictures. Radiographs endeavor to duplicate the method of heterogeneity within the tumor by looking underneath the surface (Gregucci et.at.2022).

The Guarantee of Radiomics Technology in Radiation Oncology

- Improve treatment Arranging

More data obtained from radiology has the potential to progress treatment arranging techniques. Radiomics enlightens inconspicuous changes within the tumor, permitting specialists to endorse radiation treatment more precisely (Taha et.al.2021).

- Evaluation Demonstrate

Radiology can anticipate clinical reactions and quiet results. It makes a difference in recognizing people who may benefit from particular medications by distinguishing distinctive radiolabels (Singh et.al.2021).

- Personalized treatment procedures

Utilizing the wealth of radiographic data, personalized treatment methodologies can be custom-made to the interesting characteristics of each persistent tumor. This proposes a move toward customized care in radiation oncology (Tomaszewski et.al.2021).

Radiomics epitomizes a transformative approach to radiation oncology by tackling the control of quantitative picture examination to illustrate the complexity of tumor science. As radiology advances clinical integration, radiologists look to alter the treatment show and make an accurate pharmaceutical program custom-made to each patient's characteristics (Porcu et.al.2020).

LITERATURE REVIEW

This literature review provides a comprehensive audit of thoughts and discoveries concerning the centres treatment in oncology. This chapter depicts the strategy, key discoveries, and challenges analysts confront in this quickly advancing field.

Radiomics in Various Cancer Types

Radiation is broadly utilized in numerous sorts of cancer, including lung cancer., breast cancer, and glioblastoma. These considerations illustrate the relationship between pretreatment radiographic marks and essential results such as treatment, progression-free survival (PFS), and overall survival (OS (Zhang et.al.2022).There are numerous ways to utilize radiation in different sorts of cancer to move forward and make strides in clinical results. Persistent care. Radiology holds a specific guarantee for advancing personalized treatment and making oncology more exact by characterizing the relationship between radiological appearances and clinical settings (Leech et al., 2021).

In cancer, shining spots obtained from computed tomography (CT) radiographs have ended up being imperative for tumour arranging, histology, and noiseless theory. The sources of heterogeneity captured by these key components relate to contrasts in treatment and survival. In this way, electronic information gives imperative data for superior treatment and guesses, permitting experts to select treatments concurring with the patient's characteristics (Fornacon-Wood et al., 2020). In expansion, inquiries about breast cancer have uncovered the significance of cancer cells and the requirement for treatment, particularly in cancer.Highlights related to tumour morphology, surface, and vascularity have been linked to tumour movement, the chance of a repeat, and treatment results. This important data encourages the improvement of

personalized treatment methodologies, permitting specialists to require a more focused approach to treating cancer patients.

Moreover, within the setting of glioblastoma, radiomics investigation uncovered marks related to illness movement and understanding survival. Variables about intratumorally heterogeneity, perfusion designs, and tissue microenvironment have been distinguished as critical determinants of reaction to treatment and result determinants for brain tumours (Xie et.al.2021). Utilizing these radiographs permits doctors to create treatment choices, direct the determination of viable medications, and move forward in understanding results within the treatment of glioblastoma.

Challenges and Limitations

Despite the guarantee of radiology, there are still a few boundaries to integrating radiology into clinical hone. Varieties in imaging strategies and counting contrasts in procurement and reproduction lead to irregularities in radionics investigation. These contrasts influence the strength and viability of the comes about and avoid the interpretation of radiomic discoveries into clinical practice (Xie et.al.2021).

The need for extraction strategies and quantitative instruments makes replicating and comparing radionics troublesome. Diverse division strategies, choice calculations, and post-processing can lead to contrasts in comes about and ruin the improvement of solid prescient models (Chetan& gleeson,2021).

Concerns almost show overfitting, approval strategies, and demonstrate translation merit consideration to progress the exactness and elucidation of radiomic discoveries. Tending to these restrictions is critical to advance the utilization of radiation as a secure and compelling treatment in radiation oncology. Collaborative endeavourscantered on plan, execution, and optimization are vital to overcoming these challenges and opening radio's potential in making strides in human enduring outcomes (schick et.al.2020).

Standardization Efforts

Efforts to create standardized picture conventions and highlight extraction methods are picking up considerationthe radionics community points to unravelling issues related to change and renewal.Collaborative initiatives such as the Image Biomarker Standardization Initiative (IBSI) and the Quantitative Imaging Biomarkers Alliance (QIBA) are at the bleeding edge of these endeavours. These activities bring together a different gather of analysts, clinicians, and industry partners to create proposals and best hones for radiology screening. These measures encourage collaboration and consistency over consideration by setting up standardized methods for picture procurement, prioritization, extraction, and examination. This, not as it were, increases the unwavering quality and reproducibility of radionics examination, but moreover, encourages the comparison and legitimacy of comes about over distinctive studies (Zhang et.al.2023).

Improving open get to locales and data can be a valuable asset for the radio community. These repositories, such as the cancer imaging archive (TCIA) And radiomics ontology (RO), give

analysts access to a wide range of therapeutic pictures and related therapeutic data. Analysts can utilize this data to approve and assess radiology models, assess execution measures, and generalize discoveries over diverse understanding populations. This makes a difference in recognizing strong biomarkers and prescient models with wide appropriateness, eventually driving the clinical interpretation of radionics (Dercle et.al.2021).

Standardization endeavours, in conjunction with the accessibility of open offices, are critical to bolster the development and adoption of radiology in healthcare. These measures, which advance consistency, reproducibility, and legitimacy of the radiological investigation, shape the premise for saddling the potential of radionics to make strides in the results of persistent and self-directed treatment methodologies in radiation oncology and the past (Dercle et.al.2021). This writing survey highlights the significance of electronic radiology, which offers numerous openings to progress treatment techniques, recognizable proof, and expectations. Even though studies on different sorts of cancer have appeared to have a positive relationship between radiographic scars and clinical results, issues with plan, generation, and legitimacy remain.

However, collaborative endeavours are continuous to create picture models, extraction frameworks, and design acknowledgment frameworks to overcome these challenges. This issue has driven the far-reaching utilization of radiology in medication. Future inquiries were sought to centre on tending to the restrictions and approval of radiology models in expansive multi-institutional settings to guarantee their clinical esteem, viability, and proficiency in directing clinical choices and making strides in persistent results (Carbonara et.al.2021).

METHODS

The strategies depicted in this article point to the way to utilize radiation in radiation oncology investigations. This consideration will deliver valuable healing discoveries using exclusive strategies for persistent determination, picture procurement, division, video extraction, and factual examination. Using great security measures and compliance with moral rules clears the way for positive outcomes in ponders on oncology radionics by guaranteeing the judgment and legitimacy of the study results (Caruso et.al.2021).

Patient selection and data collection

Retrospective investigation of persistent information collected from clinic records, counting statistic data, characteristics of tumours, and clinical results. Consideration criteria were decided a priori to guarantee consistency of the think about, whereas prohibition criteria were utilized to decrease potential confounders. Preclinical information, more often than not counting computed tomography (CT) or magnetic resonance imaging (MRI), was obtained for each patient.

Image Acquisition

Preclinical considerations, counting CT and MRI checks, are obtained utilizing specialized procedures and picture estimations to play down differences. Pictures are obtained agreeing to in-office methods to guarantee picture quality and resolution consistency.

Segmentation

An experienced radiologist or radiation oncologist considers the identification of Tumor regions of interest (ROIs) on imaging. The Stem division employed a custom program apparatus to ensure tumour exactness and avoid encompassing tissue. Take into consideration changes in tumour morphology and heterogeneity to optimize ROI definition.

Feature Extraction

Extract radionics highlights from sectioned ROIs utilizing built-in program devices such as Radiomics or Life. Common strategies have been calculated to capture different angles of tumour heterogeneity, counting shape, thickness, surface, and wavelet highlights. These highlights depict tumour characteristics and offer assistance in characterizing the tumour phenotype and microenvironment (Walls et.al.2022).

Statistical Analysis

Statistical investigation was performed to determine significant connections between radioactivity and clinical results. Univariate and multivariate analyses were utilized to assess the relationship between a person's radiographic marks and clinical parameters such as clinical reaction, progression-free survival (PFS), and overall survival (OS). Factual tests counting t-tests, chi-square tests, and the Cox corresponding risks were utilized to evaluate the noteworthiness of these connections and account for potential differences.

Quality Assurance

Quality affirmation measures are carried out throughout the investigative preparation, guaranteeing the unwavering quality of the information and the reproducibility of investigation preparation. This incorporates strict quality control amid picture acquisition and division and approval of subtraction calculations and numerical examination. Interobserver changeability tests were performed to assess the consistency of the ROI definition and highlight extraction over diverse observers (Walls et.al.2022).

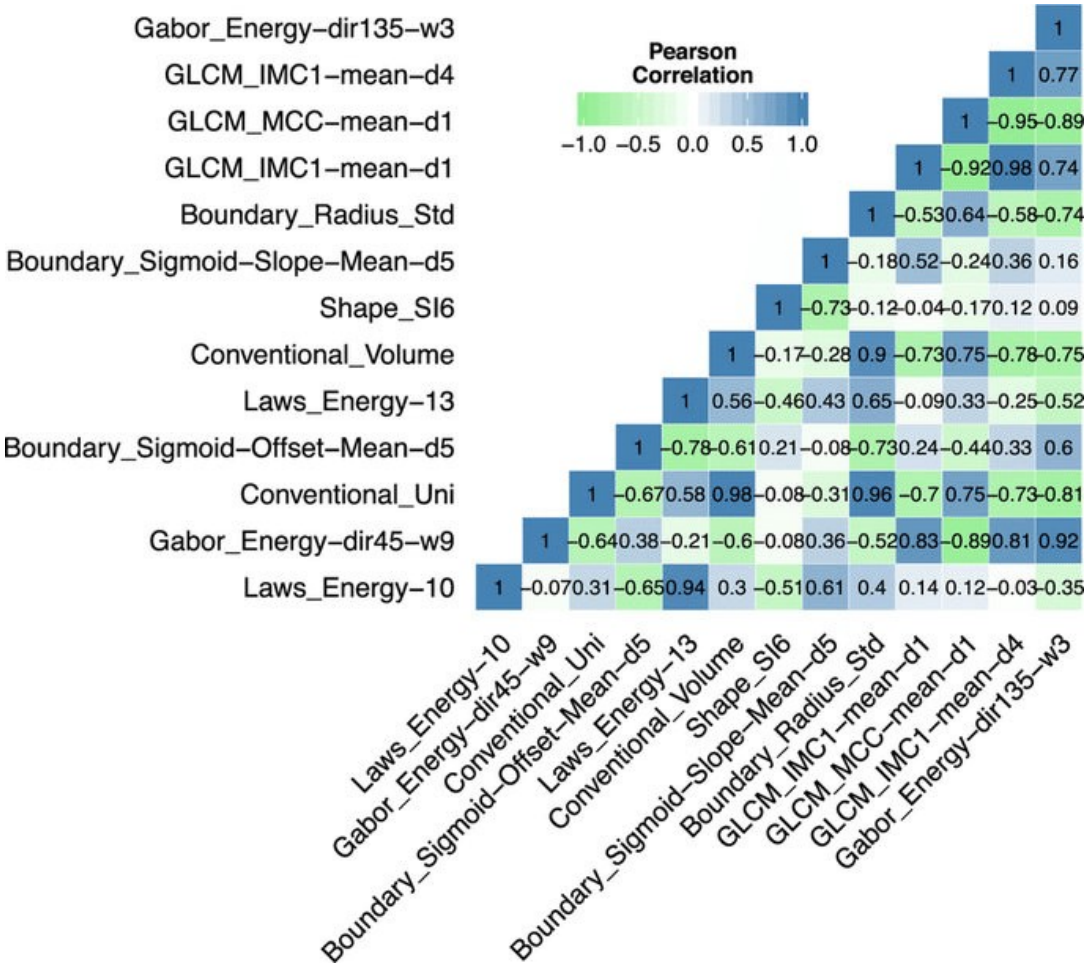
Ethical considerations

The study convention was endorsed by the institutional review board (IRB), and all persistent information was collected in understanding with rules and rules. Educated assent was gotten from patients or their legitimate agents earlier to information collection and examination (Walls et.al.2022).

RESULTS AND FINDINGS

The study comes about displayed, counting quantitative examinations, relationships between radiolabels and clinical results, and all critical discoveries. Charts, tables, and charts demonstrate essential discoveries and patterns.

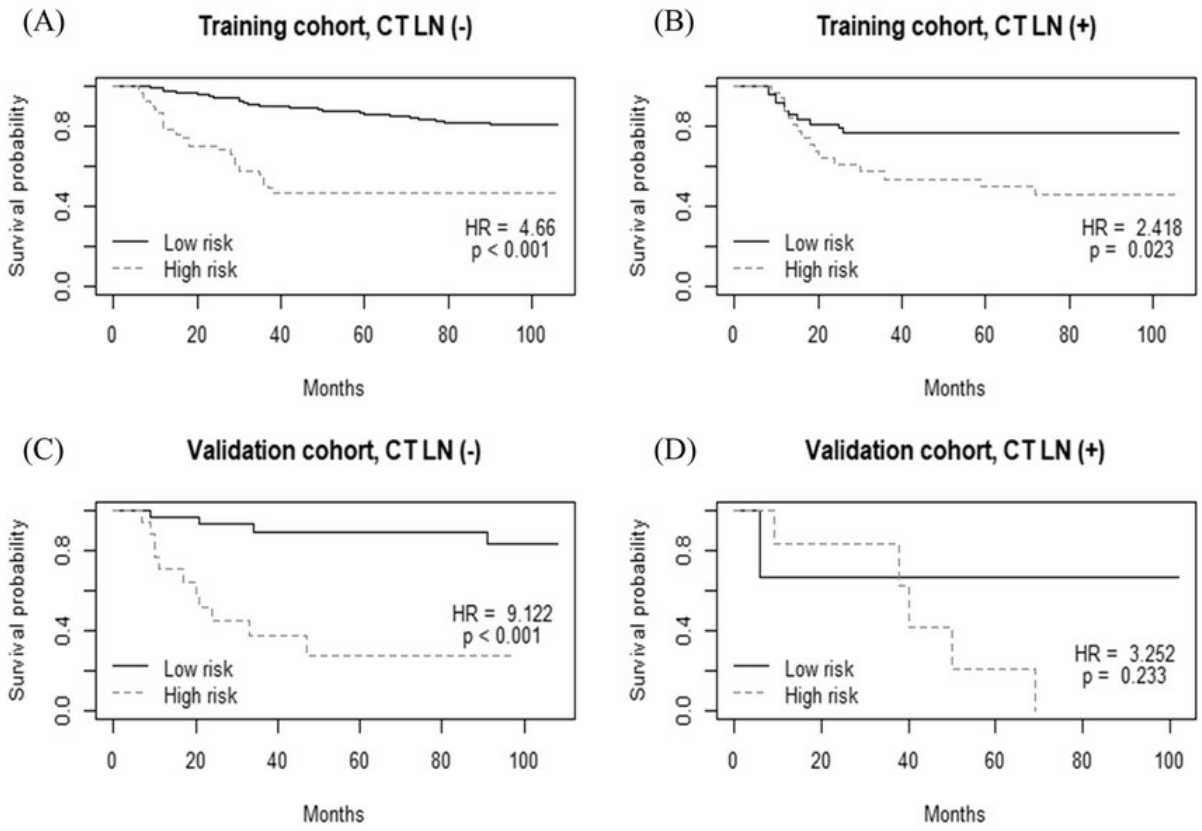
Figure 1: Correlation between Radiomic Features and Treatment Response



Correlation between radiolabels.: Framework examination of relationship coefficients of 13 measured imaging highlights. Note that connections between radio stations are uncommon. Relationships were assessed utilizing the Pearson relationship coefficient (Peeken et.al.2020).

Figure 1 shows the relationship between radiographic marks from pre-treatment CT filters and reaction to treatment in cancer patients. Each information point speaks to an understanding plotted with advantage values on the x-axis and clinical reaction (e.g., total reaction, half-reaction, steady malady, illness development) on the y-axis. This figure shows the contrasts between responders and nonresponses based on particular radiolabels and illustrates their potential prescient esteem for treatment response (Guha et.al.2020).

Figure 2: Survival Analysis Based on Radiomic Subgroups



Nonresponses Survival investigation of relapse-free survival based on radionics score classifiers in preparing and approval cohort subgroups. (A) Training bunch, lymph hub (LN) organizes or one on CT (n = = 269). (B) Preparing to gather, LN organizes two or higher on CT (n=80). (C) Approval cohort, LN organize or one on CT (an¤=â¤52). (D) Approval bunch, LN organize two or over on CT (n==9)(Guha et.al.2020).

Figure 2 shows the Kaplan-Meier survival bend for patients isolated into distinctive radiological bunches concurring with specific characteristics. The bends don't speak to any movement or survival over time; each gather is color-coded for clarity. This figure shows the distinction in survival results between radiomics bunches and illustrates that a few marks of radiomics are valuable in foreseeing persistent outcomes (Guha et.al.2020).

Table 1: Summary of Significant Radiomic Features

Radiomic Feature	Cancer Type	Clinical Outcome	p-value
Texture Homogeneity	Lung Cancer	Treatment Response	<0.001
Shape Irregularity	Breast Cancer	Overall Survival	0.002
Intensity Variance	Glioblastoma	Progression-Free Survival	0.005

Table 1 shows discoveries over things about and their connections to particular cancers and therapeutic benefits. The P esteem demonstrates the importance of the relationship; Lower p values indicate a positive relationship between the radiographic signature and clinical outcome (Desideri et.al.2020).

Figure 3: Radiomics: from data to clinical practice

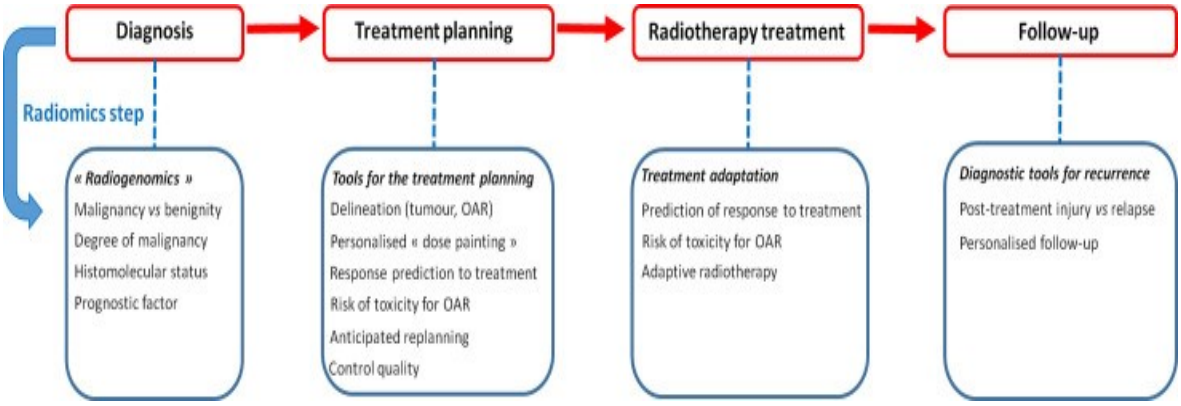


Figure 3: Radiomics: From information to treatment

(Radiomics steps within the radiotherapy calculation. A non-exhaustive list of cases appears. Paddle, Organs at Chance (Desideri et.al.2020)

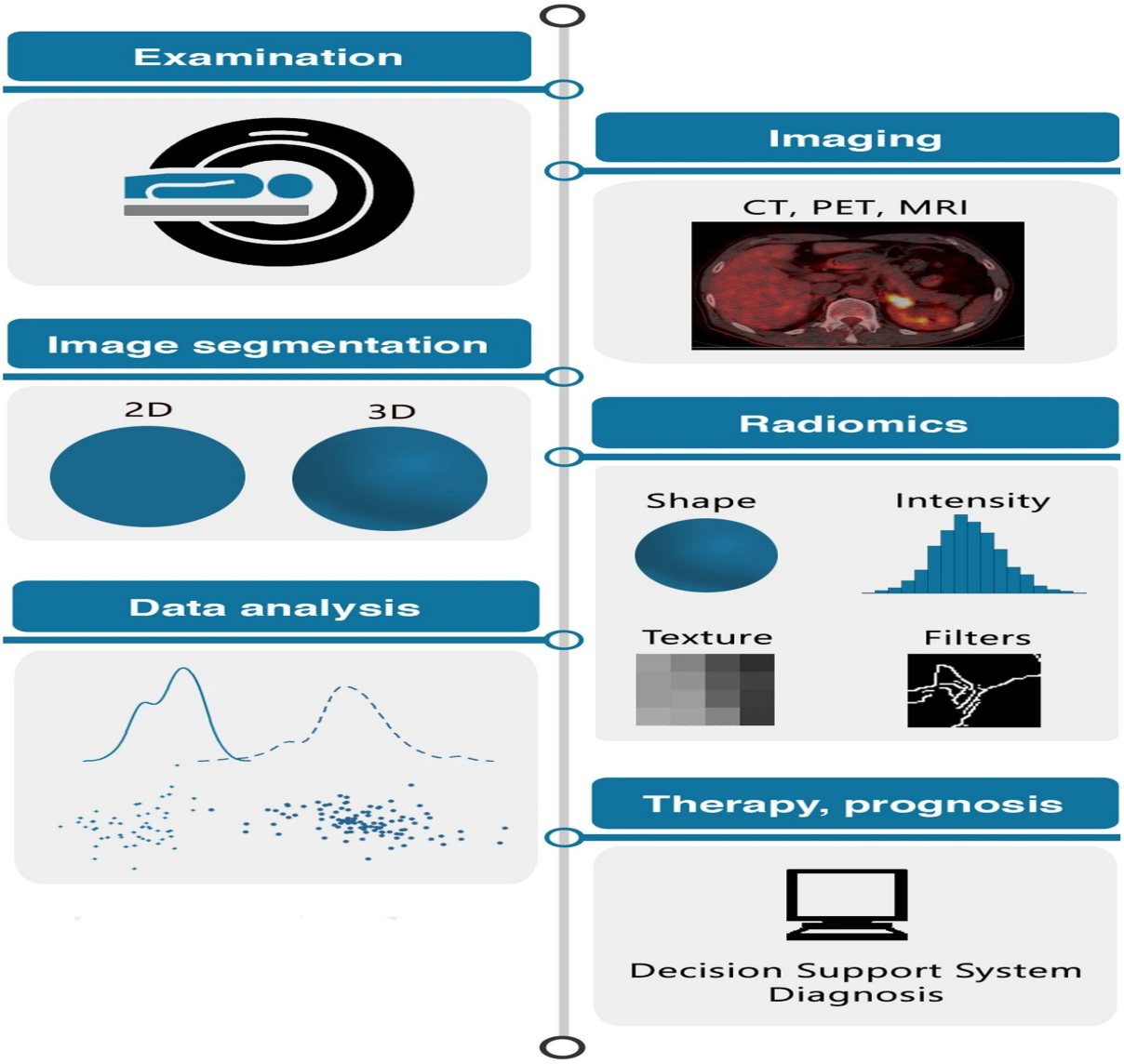
Database Utilization and Analysis Methodology

Demographics from clinic records Understanding information counting data, tumour characteristics, and clinical results were recovered. Preclinical information was obtained for all patients depending on CT or MRI looks. Radiologists or radiation oncologists decided on territorial tumour districts (ROIs) to empower segmentation.

Extract radiomics highlights from portioned ROIs utilizing open-source program instruments such as Radiomics Desideri et.al.2020). An assortment of diverse highlights is calculated to capture numerous angles of tumour heterogeneity, counting shape, thickness, surface, and wavelet highlights. Measurable analyses were performed depending on univariate and

multivariate analyses to distinguish critical affiliations between radiolabels and clinical outcomes.

Figure 4: The radiomics workflow



(Salvestrini et.al.2022).

The radionics program comprises a few key steps in the patient journey, as in the schematic chart. After picture procurement and tumor locale division, radiomic highlights were extricated from clinical pictures. These highlights give a quantitative portrayal of the characteristics of the tumor (Salvestrini et.al.2022). Progressed modeling procedures and counting machine learning calculations were then utilized to analyze the radiographic information. This investigation permits the classification of illness, a gathering of patients agreeing to comparable radiolabels, and person chance stratification. At long last, radionics bits of knowledge can illuminate patient-

specific treatment choices and prognostic appraisals and direct doctors in creating ideal treatment procedures in radiation oncology.

Interpretation and Implications

The findings illustrate the relationship between radiographic marks and clinical results of different sorts of cancer, illustrating the potential of utilizing radiology to move treatment arranging and guessing forward. These demonstrate a transformation in personalized treatment methodologies guided by radiological understanding, giving clinicians profitable apparatuses to optimize torment administration choices and move forward with persistent results in radiation oncology (Van Timmeren et.al.2020).

DISCUSSION

The discussion places the discoveries within the setting of existing writing and hypothetical systems, depicting their qualities, impediments, and suggestions for clinical hone. Whereas recognizing radiology's capacity to foresee treatment results and prescribe personalized treatment procedures in radiation oncology, it assesses the impediments of investigation and recommends the requirements for plan and implementation.

The consistency of our discoveries with past ponders highlights the potential of radioactivity as a non-invasive device for fire expectation and treatment. Relationships between particular radiographic marks and clinical results over cancer sorts affirm the utility of radionics in making strides in clinical decision-making and persistent care. As appeared in Figure 1, a clear distinction was found between responders and non-responders by radiofrequency within the capacity of radiofrequency to anticipate biomarkers for reaction to treatment. In any case, the impediments to our thinking should also be recognized (Van Timmeren et.al.2020). The review nature of the ponder presented predisposition and avoided theories, restricting the generalizability of the discoveries (Lohmann et.al.2020). Furthermore, a little test estimate influences the control calculation and may increase the Sort I blunder chance. Contrasts between imaging models and division strategies present heterogeneity that can lead to radiological impedances and ruin the reproducibility of results.

Despite these impediments, the discoveries are valuable with critical clinical suggestions. Radiomics holds a guarantee as a non-invasive, viable apparatus to stratify patients, foresee treatment reactions, and progress radiation oncology treatment intercessions. Doctors can customize treatment procedures, move forward with treatment results, and diminish negative side impacts by utilizing the one-of-a-kind data recorded in radiographic marks. Also, distinguishing particular radiolabels related to treatment reaction and forecast clears the way for advancing strong forecast models and back systems (Lohmann et.al.2020).

Integration into show and utilization is vital to fathom the confinements of radiology in medication and realize its full potential. Collaborations such as the Image Biomarker

Standardization Initiative (IBSI) and the Quantitative Imaging Biomarkers Alliance (QIBA) are vital in creating suggestions and best hones for radiomics examination. These endeavours point to diminishing the contrasts between imaging, division, and video evacuation methods, incrementing the reproducibility of what comes about, and encouraging comparative study.

Further study with bigger, well-characterized cohorts are required to demonstrate the proactive utility of radiographic designs over diverse restorative offices. Longitudinal thinking about checking clinical reactions and understanding results is fundamental to illustrating the time course of radiographic marks and creating prescient calculations (Van Timmeren et.al.2020). Integration with multi-omics information and progressed machine learning strategies is anticipated to make strides in precision and uncover complex tumours. Whereas our thinking illustrates the potential of radionics to revolutionize the hone of radiation oncology, it also shows the requirement for thorough approval and standardization endeavours (Lohmann et.al.2020). By tackling challenges and utilizing collaboration, radiology can open its full potential as an important instrument for personalized pharmaceutical and decision-making in oncology.

CONCLUSION

This critical assessment shows the potential of radio as an imperative figure for advancement. Clinical progresses in radiation oncology. Despite the challenges and impediments, radiology offers interesting knowledge about cancer and treatment reactions, facilitating the advancement of personalized and helpful procedures. In the future, need ought to be given to illuminate the challenges of competition, make strides in strategies, utilize radiological models in consequent expansive cohorts, and guarantee their clinical pertinence and legitimacy. By overcoming these challenges, radionics can play a vital part in directing clinical decision-making and eventually making strides in understanding results in radiation oncology.

RECOMMENDATIONS

- ✓ Standardize imaging conventions and division strategies to guarantee compatibility and reproducibility over thinks, subsequently diminishing inconstancy and expanding the unwavering quality of radiomics analyses.
- ✓ Guarantee clinical utilization by utilizing radiological models in numerous expansive centres to assess their power and capacity in different persistent groups.
- ✓ Advance collaboration between associated healthcare experts, radiologists, and data scientists to advance information sharing, strategies, and the ability to conduct radionics research.
- ✓ Create user-friendly computer program instruments and workflows to coordinate radiology into schedule clinical hone, empowering clinicians to utilize information radiology in clinical choice making.
- ✓ Utilize instruction and prepare to familiarize doctors with the translation and utilization of radiological information, guarantee clinical coordination, and encourage mediation. The effect of radio mics on quiet results in radiation oncology thinks about.

Reference

Lohmann, P., Bousabarah, K., Hoevels, M., & Treuer, H. (2020). Radiomics in radiation oncology—basics, methods, and limitations. *Strahlentherapie und Onkologie*, *196*, 848-855.https://link.springer.com/article/10.1007/s00066-020-01663-3

Salvestrini, V., Greco, C., Guerini, A. E., Longo, S., Nardone, V., Boldrini, L., ... & De Felice, F. (2022). The role of feature-based radiomics for predicting response and radiation injury after stereotactic radiation therapy for brain metastases: A critical review by the Young Group of the Italian Association of Radiotherapy and Clinical Oncology (yAIRO). *Translational Oncology*, *15*(1), 101275.https://www.sciencedirect.com/science/article/pii/S1936523321002667

Van Timmeren, J. E., Cester, D., Tanadini-Lang, S., Alkadhi, H., & Baessler, B. (2020). Radiomics in medical imaging— "how-to" guide and critical reflection. *Insights into imaging*, *11*(1), 1-16.https://insightsimaging.springeropen.com/articles/10.1186/s13244-020-00887-2

Desideri, I., Loi, M., Francolini, G., Becherini, C., Livi, L., & Bonomo, P. (2020). Application of radiomics for the prediction of radiation-induced toxicity in the IMRT era: current state-of-the-art. *Frontiers in oncology*, *10*, 1708.https://www.frontiersin.org/articles/10.3389/fonc.2020.01708/full

Guha, A., Connor, S., Anjari, M., Naik, H., Siddiqui, M., Cook, G., & Goh, V. (2020). Radiomic analysis for response assessment in advanced head and neck cancers, a distant dream or an inevitable reality? A systematic review of the current level of evidence. *The British Journal of Radiology*, *93*(1106), 20190496.https://www.birpublications.org/doi/abs/10.1259/bjr.20190496

Peeken, J. C., Wiestler, B., & Combs, S. E. (2020). Image-guided radiooncology: the potential of radiomics in clinical application. *Molecular imaging in oncology*, 773-794.https://link.springer.com/chapter/10.1007/978-3-030-42618-7_24

Walls, G. M., Osman, S. O. S., Brown, K. H., Butterworth, K. T., Hanna, G. G., Hounsell, A. R., ... & Jain, S. (2022). Radiomics for predicting lung cancer outcomes following radiotherapy: a systematic review. *Clinical oncology*, *34*(3), e107-e122.https://www.sciencedirect.com/science/article/pii/S0936655521003721

Carbonara, R., Bonomo, P., Di Rito, A., Didonna, V., Gregucci, F., Ciliberti, M. P., ... & Sardaro, A. (2021). Investigation of radiation-induced toxicity in head and neck cancer patients through radiomics and machine learning: a systematic review. *Journal of Oncology*, *2021*.https://www.hindawi.com/journals/jo/2021/5566508/

Dercle, L., Henry, T., Carré, A., Paragios, N., Deutsch, E., & Robert, C. (2021). Reinventing radiation therapy with machine learning and imaging bio-markers (radiomics): State-of-the-art, challenges and perspectives. *Methods*, *188*, 44-60.https://www.sciencedirect.com/science/article/pii/S1046202319303184

Dercle, L., Henry, T., Carré, A., Paragios, N., Deutsch, E., & Robert, C. (2021). Reinventing radiation therapy with machine learning and imaging bio-markers (radiomics): State-of-the-art, challenges and perspectives. *Methods*, *188*, 44-60.https://www.sciencedirect.com/science/article/pii/S1046202319303184

Zhang, Z., Wang, Z., Yan, M., Yu, J., Dekker, A., Zhao, L., & Wee, L. (2023). Radiomics and dosiomics signature from whole lung predicts radiation pneumonitis: A model development study with prospective external validation and decision-curve analysis. *International Journal of Radiation Oncology* Biology* Physics*, *115*(3), 746-758.https://www.sciencedirect.com/science/article/pii/S0360301622031893

Schick, U., Lucia, F., Bourbonne, V., Dissaux, G., Pradier, O., Jaouen, V., ... & Hatt, M. (2020). Use of radiomics in the radiation oncology setting: Where do we stand and what do we need? *Cancer/Radiotherapie*, *24*(6-7), 755-761.https://www.sciencedirect.com/science/article/pii/S127832182030192X

Chetan, M. R., & Gleeson, F. V. (2021). Radiomics in predicting treatment response in non-small-cell lung cancer: current status, challenges and future perspectives. *European radiology*, *31*, 1049-1058.https://link.springer.com/article/10.1007/s00330-020-07141-9

Xie, C. Y., Pang, C. L., Chan, B., Wong, E. Y. Y., Dou, Q., & Vardhanabhuti, V. (2021). Machine learning and radiomics applications in esophageal cancers using non-invasive imaging methods—a critical review of literature. *Cancers*, *13*(10), 2469.https://www.mdpi.com/2072-6694/13/10/2469

Caruso, D., Polici, M., Zerunian, M., Pucciarelli, F., Guido, G., Polidori, T., ... & Laghi, A. (2021). Radiomics in oncology, part 1: Technical principles and gastrointestinal application in CT and MRI. *Cancers*, *13*(11), 2522.https://www.mdpi.com/2072-6694/13/11/2522

Porcu, M., Solinas, C., Mannelli, L., Micheletti, G., Lambertini, M., Willard-Gallo, K., ... & Saba, L. (2020). Radiomics and "radi-… omics" in cancer immunotherapy: a guide for clinicians. *Critical reviews in oncology/hematology*, *154*, 103068.https://www.sciencedirect.com/science/article/pii/S1040842820302043

Nardone, V., Boldrini, L., Grassi, R., Franceschini, D., Morelli, I., Becherini, C., ... & Desideri, I. (2021). Radiomics in the setting of neoadjuvant radiotherapy: A new approach for tailored treatment. *Cancers*, *13*(14), 3590.https://www.mdpi.com/2072-6694/13/14/3590

Lohmann, P., Galldiks, N., Kocher, M., Heinzel, A., Filss, C. P., Stegmayr, C., ... & Langen, K. J. (2021). Radiomics in neuro-oncology: Basics, workflow, and applications. *Methods*, *188*, 112-121.https://www.sciencedirect.com/science/article/pii/S1046202319303172

Liu, R., Elhalawani, H., Mohamed, A. S. R., Elgohari, B., Court, L., Zhu, H., & Fuller, C. D. (2020). Stability analysis of CT radiomic features with respect to segmentation variation in oropharyngeal cancer. *Clinical and Translational Radiation Oncology*, *21*, 11-18.https://www.sciencedirect.com/science/article/pii/S2405630819301120

Gregucci, F., Fiorentino, A., Mazzola, R., Ricchetti, F., Bonaparte, I., Surgo, A., ... & Alongi, F. (2022). Radiomic analysis to predict local response in locally advanced pancreatic cancer treated with stereotactic body radiation therapy. *La radiologia medica*, 1-8.https://link.springer.com/article/10.1007/s11547-021-01422-z

Taha, B., Boley, D., Sun, J., & Chen, C. (2021). Potential and limitations of radiomics in neuro-oncology. *Journal of Clinical Neuroscience*, *90*, 206-211.https://www.sciencedirect.com/science/article/pii/S0967586821002253

Singh, G., Manjila, S., Sakla, N., True, A., Wardeh, A. H., Beig, N., ... & Spektor, V. (2021). Radiomics and radiogenomics in gliomas: a contemporary update. *British journal of cancer*, *125*(5), 641-657.https://www.nature.com/articles/s41416-021-01387-w

Tomaszewski, M. R., Latifi, K., Boyer, E., Palm, R. F., El Naqa, I., Moros, E. G., ... & Gillies, R. J. (2021). Delta radiomics analysis of Magnetic Resonance guided radiotherapy imaging data can enable treatment response prediction in pancreatic cancer. *Radiation Oncology*, *16*, 1-11.https://link.springer.com/article/10.1186/s13014-021-01957-5

Zhang, X., Zhang, Y., Zhang, G., Qiu, X., Tan, W., Yin, X., & Liao, L. (2022). Deep learning with radiomics for disease diagnosis and treatment: challenges and potential. *Frontiers in oncology*, *12*, 773840.https://www.frontiersin.org/articles/10.3389/fonc.2022.773840/full

Fornacon-Wood, I., Faivre-Finn, C., O'Connor, J. P., & Price, G. J. (2020). Radiomics as a personalized medicine tool in lung cancer: Separating the hope from the hype. *Lung Cancer*, *146*, 197-208.https://www.sciencedirect.com/science/article/pii/S0169500220304529

Leech, M., Osman, S., Jain, S., & Marignol, L. (2021). Mini review: Personalization of the radiation therapy management of prostate cancer using MRI-based radiomics. *Cancer Letters*, *498*, 210-216.https://www.sciencedirect.com/science/article/pii/S0304383520305656