УДК 616.24-002.5-073.7-089:004.67

DOI: http://doi.org/10.30978/TB2024-2-27

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Use of Densitometric Indicators from Free DICOM-Viewer and Digital Data Processing Programs in the Surgical Treatment of Patients with Pulmonary Tuberculosis

Objective — to determine the potential of using freely distributed specialised digital data processing programs and free DICOM-viewers for assessing densitometric indicators obtained from computed tomography of the thoracic organs. This aims to facilitate the planning of surgical treatment for patients with pulmonary tuberculosis and to substantiate methods for preventing pulmonary-pleural complications.

Materials and methods. A retrospective analysis was conducted on the examination and treatment results of 103 patients with specific tuberculous lesions of the lungs. Histological examination of the resected material determined the degree of the specific inflammatory process in the affected tissue, based on which patients were categorised into groups. Group I included 32 patients with low activity of the specific inflammatory process, Group II comprised 37 patients with moderate activity and Group III included 34 patients with high activity. Using five common digital processing programs, densitometric indicators of the thoracic organs' structures were obtained. The accuracy of density indicators displayed by these programs was analysed in comparison with the results of histological examinations.

Results and discussion. According to our data, the densitometric indicators obtained using free DICOM-viewers and digital data processing programs show a strong correlation with the reference standard and among themselves. The determined density indicators have a strong association with histological findings of emphysema and fibrosis of the lung parenchyma. These indicators are reliably identified both in cases of high activity of specific inflammation in the lung parenchyma and in inactive processes, allowing for patient stratification. It was found that the average density values of the mediastinal lymph nodes in cases of inactive specific inflammatory processes in 80 % of cases were (54.4 ± 17.8) HU. Values of (15.0 ± 2.5) HU characterised high activity of specific inflammatory processes and the progressive phase of the disease. Clinically, 89 (86.4 %) of the patients with significant deviations in the densitometric density indicators of the lung parenchyma from the norm experienced prolonged air leakage in the postoperative period. In 96 (93.2 %) patients with altered density of mediastinal lymph nodes, prolonged postoperative exudation through pleural drains was noted. Patients with altered densitometric indicators had complicated intraoperative and postoperative courses. Changes in the density of the lung parenchyma detected on computed tomography of the thoracic organs were confirmed in 96.1 % of cases by histological examination of the resected material. These changes were reliably detected by all the programs studied.

Conclusions. Densitometric indicators obtained using DICOM-viewers and digital data processing programs enable the planning of surgical treatment for patients with pulmonary tuberculosis and the reasoned application of methods to prevent pulmonary-pleural complications.

Keywords

Tuberculosis, densitometry, digital image processing, surgical treatment.

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A disease known for centuries, tuberculosis (TB) remains one of the major infectious diseases worldwide, continuing to exhibit high incidence rates. According to the World Health Organization, the global treatment success rate for patients with drug-resistant TB stands at only 60 %, which is alarmingly low. Tuberculosis continues to pose a serious public health challenge, prompting ongoing research into optimal diagnostic and treatment strategies in medical institutions around the globe [16].

In a significant number of cases, clinical decision-making regarding tuberculosis treatment tactics is based on the results of radiological examinations [7].

A widely accepted standard format that enables doctors to evaluate, store and transmit medical images is DICOM (Digital Imaging and Communications in Medicine). Specialised software, known as a DICOM-viewer, is used to work with this format.

The study of pulmonary parenchyma and interstitial structures is typically conducted using a grayscale presentation on the monitor screen, which is visually convenient for researchers. To form more qualified conclusions, specialists have increasingly adopted objective CT evaluation methods, such as densitometric indicators, which reduce the subjective interpretation of medical images and aim for precise characterisations of intrathoracic processes.

To enhance the efficiency of specialists' work, computer-aided decision-making (CAD) systems have been developed and implemented. It has been demonstrated that the use of CAD systems is more efficient in terms of both time and research quality [8].

Furthermore, the existence of independent clinical protocols and medical imaging tools underscores the need to study the compatibility and performance of CT-imaging software [3].

The development of software incorporating artificial intelligence (AI) for analysing and evaluating medical reports is significant. Studies show a higher correlation between the conclusions derived by specialists and those by AI systems than between specialists themselves in certain clinical scenarios [10].

The increasing demand for imaging studies, coupled with the heightened workload on doctors—particularly in emergency situations—may lead to a rise in diagnostic errors [2]. However, it has been demonstrated that artificial intelligence can significantly enhance the diagnostic accuracy of radiography in tuberculosis screening [6].

The primary objective of integrating software with artificial intelligence (AI) in medical imaging is not to surpass radiologists in diagnostic efficiency, but to enhance it. AI-based image analysis, particularly through deep learning techniques, has gained popularity in recent years. It is extensively used for classifying and segmenting large volumes of unlabeled data, which are prevalent in medical settings. This approach aims to reduce the subjectivity and time burden traditionally associated with manual labeling processes [15].

The assessment of the radiological picture is crucial in planning the surgical treatment of patients with pulmonary tuberculosis. Surgical treatment, recognised as a method that can significantly enhance the effectiveness of tuberculosis treatment, demands careful consideration of the optimal timing and extent of intervention [14].

X-ray diagnostics stands as a primary method that supports a reasoned approach to prescribing surgical treatment. It enables clinicians to thoughtfully formulate a plan for surgical intervention, whether it involves sublobar resection or lobectomy [17].

The introduction of high-tech and minimally invasive surgical techniques requires a thorough preoperative study of the patient's anatomy. Intraoperative 3D navigation, utilised in video-assisted thoracoscopic surgery (VATS) with a 3D viewer, enhances the safety and precision of anatomic resections [13].

Complex modern surgical procedures demand accurate identification of the state of intraparenchymal planes and vascularisation features within the affected segment to mitigate the risk of developing pulmonary and pleural complications. Currently, specialised solutions such as automated diagnostics and virtual reality are being employed in preoperative planning and medical research, incorporating artificial intelligence to improve outcomes. Notably, programs like LungQ (Thirona) and Sense Care-Chest DR Pro (SenseTime) have received certification under the European Union Medical Device Regulation (MDR). These programs are capable of automatically detecting pulmonary nodules, pneumonia-related lesions (including those associated with COVID-19) and fractures, and they provide comprehensive qualitative and quantitative analyses along with structured reports.

There remain challenges concerning the interpretation of data obtained and its practical application in clinical practice, which are crucial for integrating new technologies into everyday medical settings [12].

Objective — to explore the potential of utilising freely available specialised digital data processing programs and free DICOM-viewers for determining densitometric parameters from chest computed tomography. This study aims to facilitate the planning of surgical treatment for patients with pulmonary tuberculosis and to develop strategies for preventing pulmonary and pleural complications.

Materials and methods

This study is based on the examination and treatment of 103 patients with tuberculous lung lesions

Table 1. **The densitometric parameters obtained by the studied programs, HU**

Parameter	DICOM-Viewers K-Paks	DICOM-Viewers Philips	Free Online DICOM Images Viewer	3D Slicer	Dragonfly	Vitrea 2
Min	– 705 ± 392	– 701 ± 388	– 716 ± 385	– 702 ± 287	– 708 ± 392	– 716 ± 394
Max	– 293 ± 35	– 290 ± 328	– 302 ± 333	– 283 ± 346	– 297 ± 334	– 297 ± 332
Mean	– 618 ± 384	– 612 ± 375	– 626 ± 381	– 612 ± 378	– 623 ± 91	– 624 ± 385

Note. The Kruskal—Wallace criterion exceeds 0.081. Asymptotic signiticance is greater than 0.05.

who underwent surgery at the Thoracic Surgery Department of the state organisation «National Institute of Tuberculosis and Pulmonology named after by F.G. Yanovsky of the NAMS of Ukraine». The degree of the specific inflammatory process in the affected tissue was assessed through histological examination of the resected material.

Densitometric parameters of the chest structures were obtained using five commonly used digital processing programs and free DICOM-viewers. The accuracy of the density indices provided by these programs was then analysed by comparing them with the results of the histological examinations.

Densitometric parameters were evaluated across various thoracic structures: the ipsilateral lung parenchyma not involved in the specific process, mediastinal lymph nodes, segmental bronchial walls of the lung segment affected by the specific process and the density of the walls of cavities or foci with specific lesions of the lung parenchyma.

To ascertain the accuracy of these densitometric indices, patients were divided into three groups based on the activity level of the specific inflammatory process as determined by histological evaluation. Group I consisted of 32 patients with low activity, Group II included 37 patients with moderate activity, and Group III comprised 34 patients with high activity of the specific inflammatory process.

We analysed densitometric parameters on the axial sections of chest CT scans, specifically examining the minimum (min), maximum (max) and average (mean) density values in Hounsfield units (HU), which most software programs automatically determine. The average density values for each group were calculated, and these indicators were correlated with the activity levels of the specific inflammatory process to assess the diagnostic value of the derived criteria.

Widely used free DICOM-viewers such as K-Pacs, DICOM-Viewer Philips, 3D Slicer 4.13.0 from the Lung CT Analyser project, Online Free DICOM and Dragonfly software provided for non-commercial scientific research by Object Research Systems (ORS), Montreal, Canada, were employed to determine and compare densitometric parameters. The reference values were determined using Vitrea 2 software Version 4.1.14.0 of the Aquilion ISX-101A scanner (Toshiba, Japan).

Quantitative indicators were compared using the Kruskal—Wallace test. Generally, the study utilised freely downloadable programs that are accessible to a broad user base and not dependent on specialised equipment. The collection, storage and mathematical processing of the research data were conducted using licensed software products included in the Microsoft Office Professional 2007 package, OPEN No Level license No. 43437596.

Results and discussion

The DICOM-viewer application is generally consistent across most programs, though it exhibits subjective differences in the user interface that can affect perception. The ease of use largely depends on the user's familiarity and the technical specifications of the personal computer.

Indicators of lung parenchyma density in areas free from lesions are accurately determined by all the tools presented. The processes of emphysematosis and fibrosis in the lung parenchyma, against the backdrop of specific therapy, are precisely and informatively assessed by these viewers. The phenomena of emphysematous disease are consistently reported by the viewers with 100 % accuracy. An increase in lung parenchyma density was determined with a minor error margin of (5 ± 2) Hounsfield Units (HU), relative to the standard set by the Vitrea 2 program, provided by the manufacturer of the Aquilion CT scanner. Additionally, during the automated determination of density indicators, a deviation of (7 ± 4) HU was observed.

No statistically significant differences were observed in the densitometric parameters obtained by the programs under study, as detailed in Table 1. It is noteworthy that there was a consistency in determining both the maximum and minimum densities of the lung parenchyma across the studied programs.

However, the analysis of segmental bronchial density demonstrated notable discrepancies in the estimation of indicators. Due to the anatomical complexities of the bronchus, which include mem-

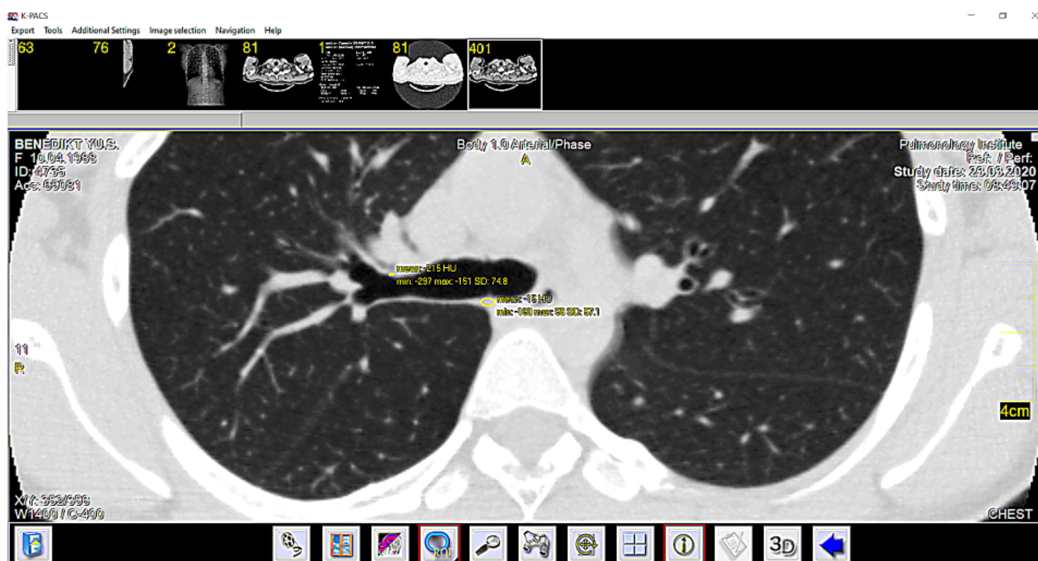


Fig. 1. **An example of forming a region of interest, bronchial walls**

branous and cartilaginous parts, accurately defining the region of interest (ROI) for the programs proved challenging (see Fig. 1).

The measurement of the bronchial wall thickness and the accuracy in defining the region of interest (ROI) contributed to significant discrepancies in densitometric parameters, detailed in Table 2. When assessing the densitometric parameters of the segmental bronchial wall, substantial deviations in Hounsfield Unit (HU) values were observed. Statistical analysis of the bronchial wall density, using data obtained from the studied programs, showed that the groups differed significantly in terms of maximum, minimum and average density values.

Furthermore, correlation analysis between segmental bronchial density and signs of specific inflammation did not demonstrate a significant relationship. This lack of significance precluded the inclusion of this indicator as a reliable diagnostic feature.

Distinct patterns emerged in the study of mediastinal lymph nodes. Examination of the densitometric characteristics of regional mediastinal lymph nodes indicated a decrease in their density associated with active specific inflammatory processes in the lung parenchyma. Furthermore, the presence of calcification within the lymph node stroma significantly influenced their densitometric characteristics, as evidenced by an increased variance in HU values within the regions of interest. The average values of mediastinal lymph node density are detailed in Table 3.

Table 2. **Densitometric parameters detected in segmental bronchi are presented in average values**

Parameter	DICOM-Viewers K-Paks	DICOM-Viewers Philips	Free Online DICOM Images Viewer	3D Slicer	Dragonfly	Vitrea 2
Min	– 383 ± 215	– 278 ± 10	– 160 ± 407	– 302 ± 151	– 207 ± 214	– 357 ± 228
Max	– 138 ± 127	– 182 ± 12	64 ± 312	106 ± 142	– 89 ± 153	– 13 ± 127
Mean	– 236 ± 168	– 230 ± 72	– 14 ± 277	45 ± 286	– 25 ± 124	– 236 ± 168

Note. The Kruskal—Wallace criterion exceeds 0.072. Asymptotic signiticance is less than 0.032.

Table 3. **Densitometric indices of mediastinal lymph nodes (mean values obtained using the studied programs) are presented in average values**

Parameter	DICOM-Viewers K-Paks	DICOM-Viewers Philips	Free Online DICOM Images Viewer	3D Slicer	Dragonfly	Vitrea 2
Min	– 18 ± 34	– 9 ± 42	– 11 ± 38	– 9 ± 42	– 25 ± 12	– 18 ± 34
Max	42 ± 17	38 ± 12	34 ± 25	53 ± 17	43 ± 17	50 ± 20
Mean	– 25 ± 32	– 15 ± 55	– 9 ± 37	– 7 ± 45	– 22 ± 36	– 21 ± 22

Note. The Kruskal—Wallace criterion exceeds 0.072. Asymptotic signiticance is greater than 0.05.

It was observed that the average density of mediastinal lymph nodes during inactive specific inflammatory processes, in 80 % of cases, was recorded at (54.4 ± 17.8) HU. Conversely, indicators of (15.0 ± 2.5) HU were indicative of high activity in the specific inflammatory process and the disease's progression phase. No statistical differences were noted between the density values obtained using the various programs studied.

The maximum, minimum and average density values of the mediastinal lymph nodes calculated by the programs demonstrated an asymptotic significance value greater than 0.05. This suggests that these density measures can be considered significant diagnostic features and may be utilised as criteria in clinical decision-making.

The accuracy of densitometric parameters within specific lesion foci or cavity walls was evaluated across the formed groups. In Group I, no statistically significant differences were observed in the density indices. An illustration showing how different viewers display density indicators at a low level of activity of a specific inflammatory process is provided in Fig. 2.

All the programs analysed determined the maximum and minimum density values consistently, with no significant differences noted in either the average values or the standard deviations. The Kruskal—Wallace test produced values ranging from 0.07 to 0.83, with an asymptotic significance of 0.08. These findings are detailed in Table 4.

In Group II patients, no statistically significant differences were observed in the maximum and average HU values. The Kruskal—Wallace test values ranged from 0.06 to 0.87, with an asymptotic significance of 0.07. These data are detailed in Table 5.

For patients in Group III, the density indices for maximum and average values exhibited a significant correlation with high activity levels of the specific inflammatory process. The Kruskal—Wallace test values varied from 0.08 to 0.92, with an asymptotic significance of 0.08. The minimum density values showed a weak correlation, and there was a standard deviation close to the mean values. Average values of the density indicators are presented in Table 6.

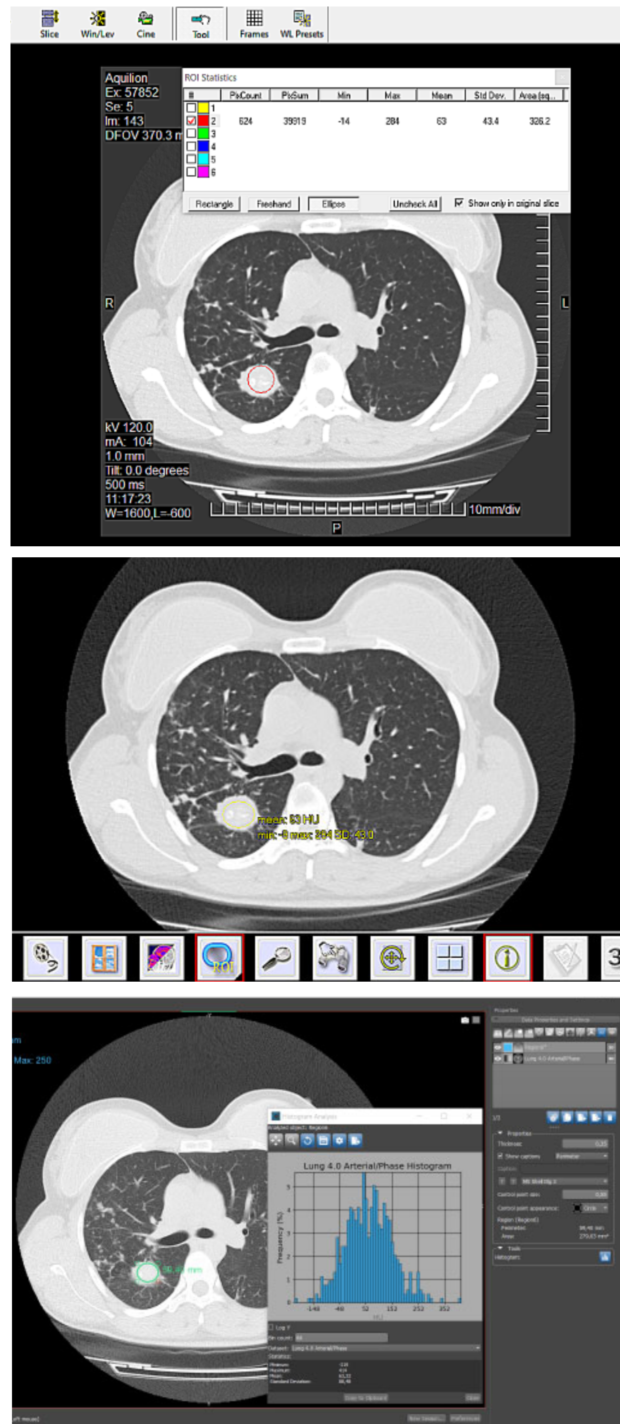


Fig. 2. **Display of density indices at a low degree of activity of a specific inflammatory process by different viewers 63 HU**

Table 4. **Densitometric indices of the affected areas detected at low activity of a specific inflammatory process, presented in average values**

Parameter	DICOM-Viewers K-Paks	DICOM-Viewers Philips	Free Online DICOM Images Viewer	3D Slicer	Dragonfly	Vitrea 2
Min	– 233 ± 53	– 243 ± 84	– 243 ± 61	– 260 ± 48	– 227 ± 17	– 225 ± 28
Max	– 331 ± 42	– 310 ± 58	– 418 ± 32	– 454 ± 25	– 436 ± 35	– 432 ± 24
Mean	42 ± 18	41 ± 22	40 ± 24	44 ± 27	38 ± 21	39 ± 14

Note. The Kruskal—Wallace criterion exceeds 0.06. Asymptotic significance is greater than 0.05.

Table 5. **Densitometric indices of the affected areas revealed a moderate degree of activity of a specific inflammatory process**

Parameter	DICOM-Viewers K-Paks	DICOM-Viewers Philips	Free Online DICOM Images Viewer	3D Slicer	Dragonfly	Vitrea 2
Min	– 11 ± 21	3 ± 14	27 ± 24	– 28 ± 27	12 ± 22	9 ± 16
Max	123 ± 29	102 ± 17	131 ± 17	111 ± 57	92 ± 23	115 ± 24
Mean	41 ± 14	27.6 ± 8.0	33 ± 21	33 ± 17	29 ± 12	28.2 ± 8.0

Note. The Kruskal—Wallace criterion exceeds 0.06. Asymptotic signiticance is greater than 0.05.

Table 6. **Densitometric indices of the affected areas revealed at a high degree of activity of a specific inflammatory process (mean values)**

Parameter	DICOM-Viewers K-Paks	DICOM-Viewers Philips	Free Online DICOM Images Viewer	3D Slicer	Dragonfly	Vitrea 2
Min	– 400 ± 98	– 260 ± 95	– 382 ± 97	– 312 ± 64	– 457 ± 37	– 478 ± 52
Max	80 ± 36	78 ± 24	53 ± 12	69 ± 47	83 ± 28	89 ± 32
Mean	15.0 ± 12.7	– 16 ± 14	– 9 ± 36	11.0 ± 12.4	8 ± 23	3 ± 22

Note. The Kruskal—Wallace criterion exceeds 0.06. Asymptotic signiticance is greater than 0.05.

The asymptotic significance values exceeded 0.05, suggesting a consistency in the Hounsfield indices determined by different programs. This confirms the similarity in both the maximum and minimum density indicators of the lung parenchyma as assessed by the evaluated programs.

An illustration depicting the region of interest (ROI) definition in the parenchyma and in areas affected by a specific inflammatory process for a second patient is shown in Fig. 3.

The average density values, measured in Hounsfield units by the various viewers, did not show statistical differences. However, when measuring precision to the «second decimal place» or to the hundredth, an advantage was observed with specialised research programs.

It was determined that automated digital data processing programs accurately depicted changes in the structure of the parenchyma. The identification of emphysematous areas localised in the region of surgical intervention facilitated the planning of reinforced suturing of the parenchyma. This strategic planning enabled timely implementation of methods to prevent increased bleeding at the intervention site.

Specialised programs facilitated the assessment of the spread of emphysematous areas, enabling the precise formulation of a surgical intervention plan. This strategic planning allowed for the reinforcement of lung sutures during surgery, which helped to prevent leakage. An example of the specialised program is illustrated in Fig. 4.

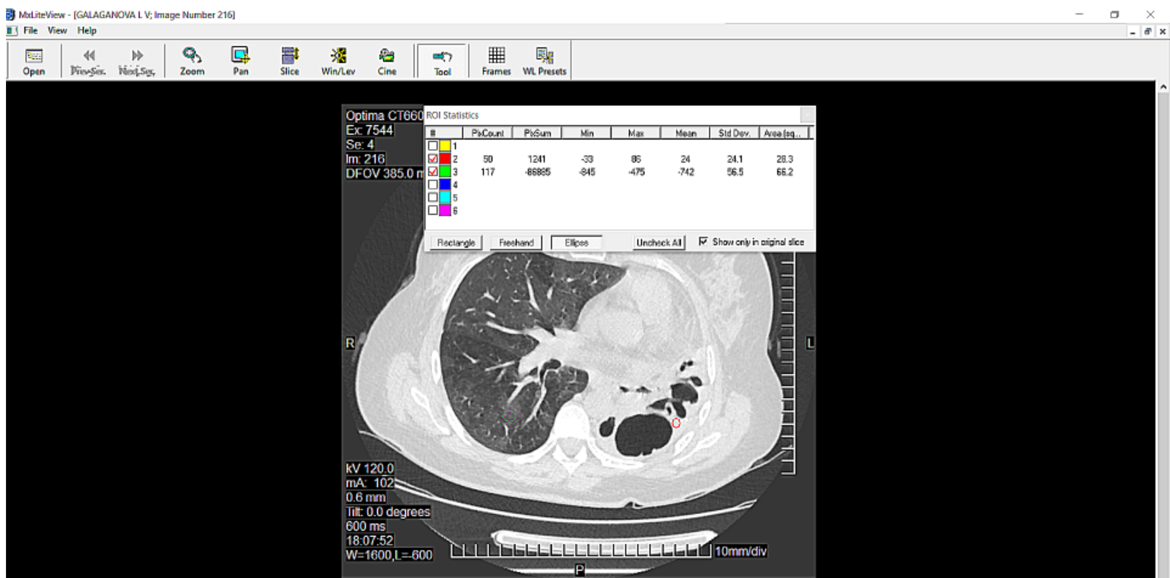
Clinically, 86.4% of the patients (89 out of 103) with significant deviations in the densitometric parameters of lung parenchyma density experienced prolonged air discharge during the postoperative period. Additionally, prolonged postoperative exudation through pleural drains was observed in 93.2 % of the patients (96 out of 103) who exhibited altered density of the mediastinal lymph nodes.

In 4.85% of cases (5 out of 103), the scope of the surgical intervention was expanded from atypical resection to lobectomy. This adjustment involved the removal of both the parenchyma affected by the specific disease process and areas of emphysematous-altered parenchyma, aiming to prevent potential postoperative complications.

In 11.6 % of the cases, the detected compaction and fibrosis in the surgical area manifested as prolonged air discharge during the postoperative period. This was observed in 23.3 % more cases compared to patients who underwent surgery on parenchyma that was unchanged in density.

Patients exhibiting altered densitometric parameters experienced a complicated intraoperative and postoperative course. Notably, changes in the lung parenchyma's density detected by chest CT were morphologically confirmed through histological examination of the resected material in 96.1 % of cases. These findings were consistently identified by all the programs studied. Therefore, the detection of density changes in chest structures during surgical planning enabled the implementation of preventive measures, reducing the risk of pulmonary and pleural complications postoperatively.

It has been established that free DICOM-viewers and digital data processing programs, accessible to a wide range of users, can effectively be used to determine the heterogeneity of tissues and structures within the chest. These tools help identify



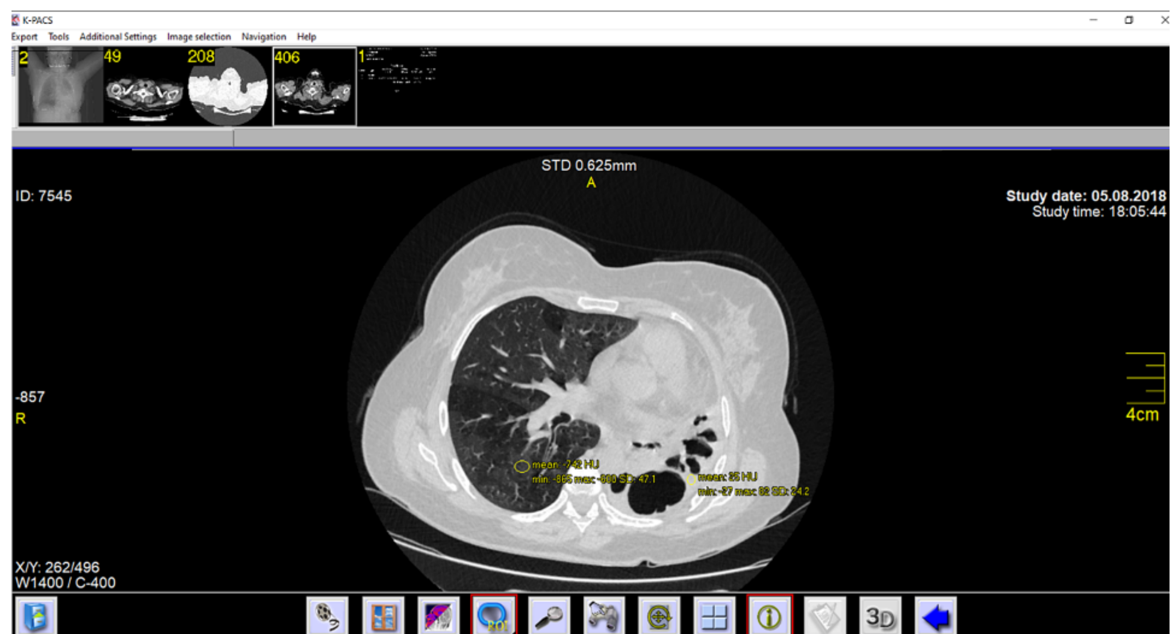
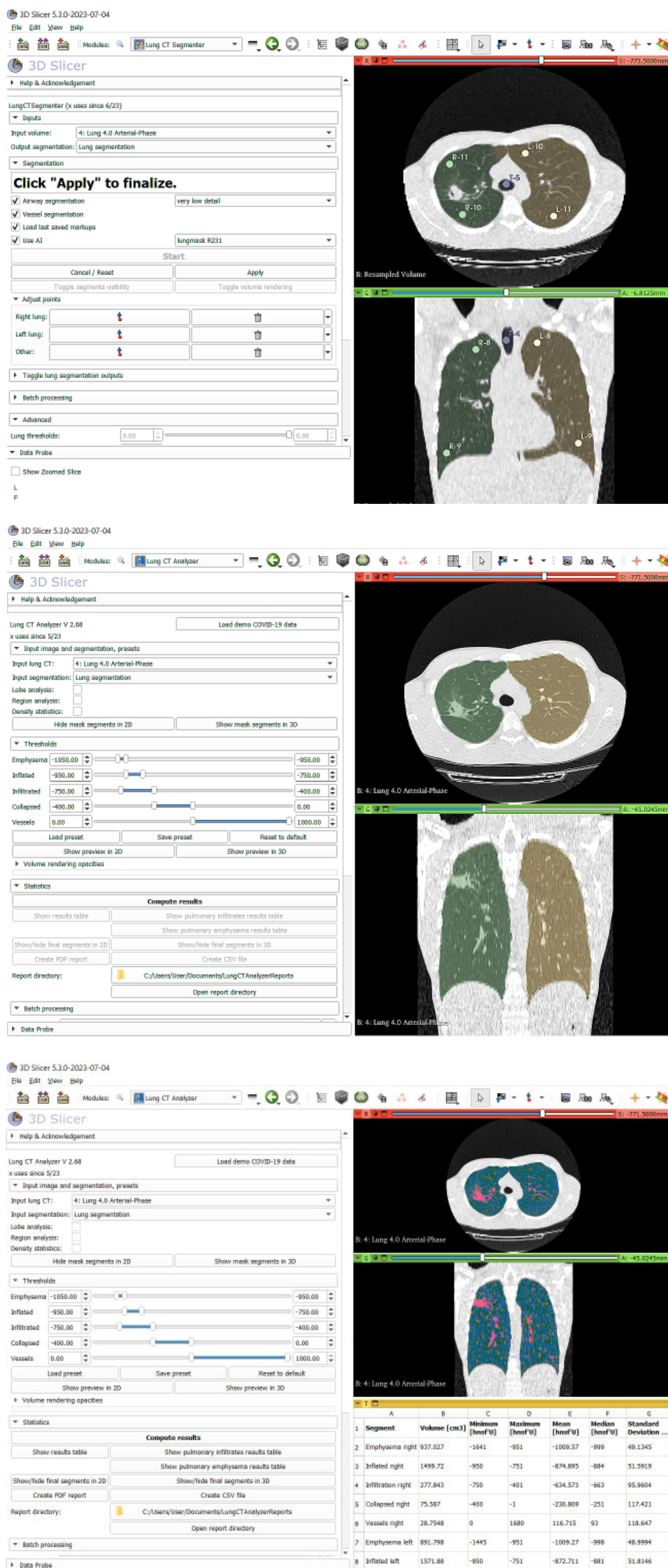


Fig. 3. **Display of the region of interest in the parenchyma and in the area affected by a specific inflammatory process**



changes associated with disease progression or treatment responses. Additionally, they play a crucial role in stratifying patients, both during initial diagnostic evaluations and subsequent treatment adjustments and personalisation.

The use of non-invasively obtained, objective data enables the identification of patterns across different stages of treatment, allowing for timely adjustments in patient management. Furthermore, the application of radiomics in detecting characteristics and mutations in lung tumors underscores the potential of specialised software systems to address complex diagnostic challenges [4, 5].

Researchers highlight that despite TB remaining a global health threat in the 21st century, its diagnosis and treatment still largely rely on a few diagnostic and research tools developed over a century ago. In contrast, molecular imaging techniques represent a significant advancement, focusing on visualising molecules of interest within living subjects, rather than relying on preserved tissue samples [1, 9].

In deep learning, datasets are essential for training models effectively. These models typically require extensive data to function optimally, as larger datasets generally lead to better generalisation. However, in the field of medical visualisation, the creation of these datasets poses significant challenges due to various complexities and ethical considerations [11].

The availability of free and widely distributed software enables the medical community to engage more effectively in solving diagnostic challenges and optimising treatment strategies in the surgical management of patients with pul-

Fig. 4. **An example of 3D-Slicer operation with AI installed, the ability to select the required density range in HU units, and automatic generation of parenchyma density reports**

monary tuberculosis, by providing universally accessible assessment tools.

Undoubtedly, while artificial intelligence (AI) has rapidly integrated into our daily lives, it does not equate machines with humans but rather serves as a powerful instrument in the hands of skilled professionals. Experts emphasise the importance of adapting to the new reality where artificial intelligence and human expertise coexist [1].

Conclusions

1. Specialised digital data processing programs and free DICOM-viewers can effectively and accurately assess specific lesions of the lung parenchyma and intrathoracic structures.
2. Densitometric parameters of intrathoracic structures obtained using free DICOM-viewers and digital data processing programs show no statistically significant differences based on the method of data acquisition, supporting their use in the surgical planning for patients with pulmonary tuberculosis.
3. It is advisable to assess the state of the tracheobronchial tree using bronchoscopy results. The individual selection of the region of interest (ROI) for the bronchial wall did not yield statistically significant characteristic indicators.
4. Densitometric parameters obtained from chest CT scans of patients with pulmonary tuberculosis can guide the selection and application of preventive measures for pulmonary and pleural complications.
5. Indicators derived from CT scans of patients can facilitate machine learning applications and patient stratification, enhancing personalised treatment approaches.

The work was performed at the expense of the state budget, is a part of the research work «To develop an algorithm for the use of valve bronchoblocking in the treatment of patients with tuberculosis and nonspecific lung diseases with concomitant pathology» and «To develop an algorithm for the use of surgical treatment in patients with pulmonary tuberculosis using computerized densitometry» No. state registration 01180007366.
The author declares that he has **no conflict of interest.**

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Використання денситометричних показників free DICOM-viewer і програм цифрової обробки даних при хірургічному лікуванні пацієнтів із туберкульозом легень

Мета роботи —визначити можливості застосування безкоштовно поширюваних спеціалізованих програм цифрової обробки даних та free DICOM-viewer's для визначення денситометричних показників, отриманих при комп'ютерній томографії органів грудної клітки, для планування хірургічного лікування пацієнтів із туберкульозом легень і обґрунтування способів профілактики легенево-плевральних ускладнень.

Матеріали та методи. Проведено ретроспективний аналіз результатів обстеження та лікування 103 пацієнтів зі специфічним туберкульозним ураженням легень. При гістологічному дослідженні резекційного матеріалу визначено ступінь специфічного запального процесу в ураженій тканині, згідно з яким пацієнтів розподілили на групи. До групи І залучено 32 пацієнти з низькою активністю специфічного запального процесу, до групи II — 37 пацієнтів із помірною активністю, до групи III — 34 пацієнти з високою активністю. За допомогою п'яти поширених програм цифрової обробки отримано денситометричні показники структур органів грудної клітки пацієнтів. Проаналізовано точність відображення показників щільності досліджуваними програмами при зіставленні з результатами гістологічного дослідження.

Результати та обговорення. За нашими даними, денситометричні показники, отримані за допомогою free DICOM-viewer's і програм цифрової обробки даних, мають сильну кореляцію з еталонним показником та між собою. Визначені показники щільності мають сильний зв'язок із гістологічними виявами емфіземи та фіброзуванням легеневої паренхіми. Достовірно визначаються як при високій активності специфічного запалення в паренхімі легені, так і при неактивних процесах, що дає змогу провести стратифікацію пацієнтів. Установлено, що середні показники щільності медіастинальних лімфатичних вузлів при неактивному специфічному запальному процесі в 80 % випадків мали значення (54,4 ± 17,8) HU. Показники (15,0 ± 2,5) HU характеризували високу активність специфічного запального процесу і фазу прогресування захворювання. Клінічно 89 (86,4 %) пацієнтів зі значним відхиленням денситометричних показників щільності паренхіми легені від норми мали тривалий скид повітря в післяопераційний період. У 96 (93,2 %) пацієнтів зі зміненою щільністю лімфатичних медіастинальних вузлів відзначено тривалу післяопераційну ексудацію по плевральних дренажах. Пацієнти зі зміненими денситометричними показниками мали ускладнений інтраопераційний та післяопераційний перебіг. Виявлені при комп'ютерній томографії органів грудної клітки зміни щільності легеневої паренхіми в 96,1 % випадків підтверджено результатами гістологічного дослідження резектованого матеріалу. Ці зміни були достовірно виявлені всіма досліджуваними програмами.

Висновки. Денситометричні показники, отримані за допомогою DICOM-viewer's та програм цифрової обробки даних, дають змогу провести планування хірургічного лікування пацієнтів із туберкульозом легень і обґрунтовано застосовувати способи профілактики легенево-плевральних ускладнень.

Ключові слова: туберкульоз, денситометрія, цифрова програмна обробка зображень, хірургічне лікування.

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Стаття надійшла до редакції/Received 20.02.2024.
Стаття рекомендована до опублікування/Accepted 15.03.2024.

ДЛЯ ЦИТУВАННЯ

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