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CHARACTERISTICS OF ABDOMEN AND PELVIS CT SCAN'S EVALUATION OF PATIENTS WITH MALIGNANCIES

Natalia Staver
"Nicolae Testemitanu" State University
of Medicine and Pharmacy from Moldova,
165 Ștefan cel Mare și Sfânt

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Summary

According to the American Cancer Center, cancer causes about 1 in 6 deaths worldwide, more than AIDS, tuberculosis and malaria taken together, it is the second leading cause of death, after cardiovascular disease. Imaging examinations to examine the abdomen and pelvis are the methods of choice in detecting neoplastic formations with the provision of information that is essential for the subsequent management of these patients. From the PubMed databases and the Google Scholar search engine, the articles published during 2010-2020 were selected, according to the specific keywords. Information on international scientific studies on oncological pathology statistics has been selected and processed globally, according to data from the American Cancer Center and the International Agency for Research on Cancer, innovative methods for assessing the staging of patients with abdominal and pelvic neoplasms, and modern postprocessing in the case of examination by computed tomography of abdominal and pelvic neoplasms patients. After processing the information in the Google Scholar and PubMed database, according to the search criteria, 346 articles on the proposed topic were found. The final bibliography contains 176 relevant sources, of which 77 were considered representative for the elaboration of this synthesis article. We must aim to justify, optimize and customize each imaging procedure for patients with neoplasms, as they are frequently exposed to imaging examinations.

Keywords: *oncology statistics; computed tomography; abdominal neoplasms; pelvic neoplasms; staging in oncology; post-processing programs*

Rezumat

Caracteristicile abdomenului și pelvisului în evaluarea CT a pacienților cu afecțiuni maligne

Potrivit American Cancer Center, cancerul cauzează aproximativ 1 din 6 decese la nivel mondial, mai mult decât SIDA, tuberculoza și malaria luate împreună, este a doua cauză de deces, după bolile cardiovasculare. Examinările imagistice pentru examinarea abdomenului și pelvisului sunt metodele de elecție în depistarea formațiunilor neoplazice cu furnizarea de informații care sunt esențiale pentru managementul ulterioar al acestor pacienți. Din bazele de date PubMed și motorul de căutare Google Scholar au fost select ate articolele publicate în perioada 2010-2020, în funcție de cuvintele cheie specifice. Informațiile privind studiile științifice internaționale privind statisticile patologiei oncologice au fost selectate și procesate la nivel global, conform datelor de la Centrul American de Cancer și Agenția Internațională pentru Cercetare a Cancerului, metode inovatoare de evaluare a stadializării pacienților cu neoplasme abdominale și pelvine și postprocesare modernă. în cazul examinării prin tomografie computerizată a pacienților cu neoplasme abdominale și pelvine. După prelucrarea informațiilor din baza de date Google Scholar și PubMed, conform criteriilor de căutare, au fost găsite 346 de articole pe tema propusă. Bibliografia finală conține 176 de surse relevante, dintre care 49 au fost considerate reprezentative pentru elaborarea acestui articol de sinteză. Trebuie să ne propunem să justificăm, să optimizăm și să personalizăm fiecare procedură imagistică pentru pacienții cu neoplasme, deoarece aceștia sunt expuși frecvent la examinări imagistice.

Cuvinte-cheie*: statistica în oncologie, tomografie computerizată, neoplasme abdominale, neoplasme pelvine, stadializarea în oncologie, programe de postprocesare în tomografie computerizată*

Резюме

Особенности оценки КТ органов брюшной полости и таза у больных со злокачественными новообразованиями

По данным Американского онкологического центра, рак вызывает примерно 1 из 6 смертей во всем мире, больше, чем СПИД, туберкулез и малярия вместе взятые, это вторая по значимости причина смерти после сердечно-сосудистых заболеваний. Рентгенологические исследования органов брюшной полости и малого таза являются методами выбора при выявлении опухолевых образований с предоставлением информации, необходимой для последующего ведения этих больных. Из баз данных PubMed и поисковой системы Google Scholar были отобраны статьи, опубликованные в период 2010-2020 гг., по определенным ключевым словам. Отобрана и обработана информация международных научных исследований по статистике онкологической патологии в глобальном масштабе, по данным Американского онкологического центра и Международного агентства по изучению рака, инновационным методам оценки стадирования пациентов с новообразованиями брюшной полости и малого таза, современной постобработке, в случае обследования с помощью компьютерной томографии больных новообразованиями органов брюшной полости и малого таза. После обработки информации в базе данных Google Scholar и PubMed по критериям поиска было найдено 346 статей на предложенную тему. Окончательная библиография содержит 176 соответствующих источников, 49 из которых были признаны репрезентативными для разработки этой сводной статьи. Мы должны стремиться обосновать, оптимизировать и адаптировать каждую рентгенологическую процедуру для пациентов с

новообразованиями, поскольку они часто подвергаются рентгенологическим исследованиям.

Ключевые слова: *онкологическая статистика, компьютерная томография, новообразования брюшной полости, новообразования малого таза, стадирование онкологии, программы постобработки компьютерной томографии.*

Introduction

Cancer is a group of diseases characterized by the uncontrolled growth and spread of abnormal cells. Although the causes of cancer remain largely unknown, many risk factors are known. Some of these are modifiable, such as tobacco use and excess body weight, while others are generally unchangeable, such as inherited genetic mutations, hormones, and immune disorders. These risk factors may act simultaneously or in succession to initiate and / or promote cancer growth.

Cancer causes about 1 in 6 deaths worldwide, more than AIDS, tuberculosis and malaria taken together [1]. Today, it is the second leading cause of death, after cardiovascular disease, worldwide (see Table)

Imaging examinations are the methods of choice in the detection of neoplastic formations that provide essential information for the diagnosis, treatment evaluation and subsequent management of these patients. Currently, the issue of developing standardized imaging techniques, identifying the correct methods for measuring tumor size, data processing and analysis, data collection and image interpretation, in order to make decisions in the strategy of applying appropriate treatment, remains open. Thus in the context of optimizing treatment, identifying and minimizing adverse effects we must adhere to the principle «as low as reasonably achievable» - ALARA, using methods and techniques aimed at optimizing imaging data, minimizing risks and providing the best care clinic of cancer patients [29-39].

The purpose of the research is evaluation of the peculiarities of imaging studies of patients with neoplasms of the abdomen and pelvis for the optimization of clinical-imaging management.

The researchers contributed to the choice of the effective way of forming protocols and proper image design, they proposed that imaging examinations be performed in stages, each stage having a specific

Table

Main causes of death worldwide, 2016 (millions)

		Worldwide	
	Rank	**Death**	**%**
Cardiovascular diseases	1	17,9	31
Malignant neoplasms	2	9,0	16
Infectious and parasitic diseases	3	5,5	10
Respiratory diseases	4	3,8	7
Unintentional injuries	5	3,4	6
Respiratory infections	6	3,0	5
Neurological conditions	7	2,5	4
Digestive diseases	8	2,5	4
Neonatal conditions	9	2,2	4
Diabetes mellitus	10	1,6	3
Intentional injuries	11	1,5	3
Genitourinary diseases	12	1,4	3
Congenital anomalies	13	0,6	1
Nutritional deficiencies	14	0,5	1
Endocrine, blood, immune disorders	15	0,4	1
All cases		56,9	

Source: American Cancer Society

purpose [2]. Imaging monitoring of cancer patients is the basic goal in the evolution of the disease undergoing anticancer treatment for several years after the end of treatment [3-5]. The Radiological Society of North America (RSNA) [6] and the American College of Radiology (ACR) [7] have developed techniques and methods that contain strategic details for assessing the disease's response to therapy and include: ways to determine tumor size measurements, plans in which tumor dimensions measurements are performed, the actual measurement method and the sequences used. All these were designed and executed due to the collaboration and communication between oncologists and radiologists-imagers. Thus, the need for personalization and dynamic imaging evaluation of neoplastic processes response to the administered therapy are directly proportional to imaging protocols design and the interpretation of their results. Thus, we can contribute to the study of models aimed at minimizing adverse effects, secondary to imaging diagnosis in the dynamic evaluation of the treatment of cancer patients, which may compromise the quality of life and longevity of these patients.

The article presents a synthesis of international scientific studies on the statistics of oncological pathologies worldwide, according to the American Cancer Center and the International Agency for Research on Cancer, a presentation of innovative methods for assessing the staging of patients with neoplasms of the abdomen and pelvis, list of modern post-processing programs in the case of examination by computed tomography of patients with abdominal and pelvic neoplasms.

Material and methods

In order to achieve the established goal and objectives, a search was performed for the specialized scientific literature, identified by the Google Scholar search engine and from the PubMed database. The articles published during 2010-2022 were selected according to the keywords: statistics in oncology, imaging in oncology, computed tomography (CT), abdominal neoplasms, pelvic neoplasms, staging in oncology, postprocessing programs in computed tomography, follow-up of cancer patients, diagnostic algorithm. Information on international scientific studies on oncological pathology statistics has been selected and processed globally, according to data from the American Cancer Center and the International Agency for Research on Cancer, innovative methods for assessing the staging of patients with abdominal and pelvic neoplasms, and modern postprocessing in the case of examination by CT of patients with abdominal and pelvic neoplasms.

For the advanced search of the desired bibliographic sources, the following filters were applied: articles in English, articles with full text, articles published during the years 2010-2022.

The information in the publications generated by the search engine was classified, synthesized and evaluated. Additional sources of information were consulted to clarify ambiguous notions. Publications and articles that did not correspond to the purpose and objectives of the paper, but also those that could not be accessed for full view, were excluded from the list of publications generated by the search engine.

Results

Following the purpose of the research, in the international specialized literature, of evaluation of the peculiarities of imaging studies of patients with neoplasms of the abdomen and pelvis for the optimization of clinical-imaging management, the following results were structured:

The cancer risk associated with radiation dose in CT is not zero, that's why reducing the dose of radiation in CT examination must continue to be one of the main priorities of the radiological community.

The radiological community (radiologists, medical physicists, equipment manufacturers) has implemented CT dose management procedures that correspond to the ALARA principle (As Low As Reasonably Achievable).

Optimizing the use of radiological examinations with the help of clinical decision guidelines is essential. Once it has been established that an imaging procedure is clinically justified, the physician (and the entire imaging team) has the responsibility to optimize the patient's individual radiation exposure, which must be a continuous and regularly updated process.

The irradiation dose should be reduced only if the diagnostic image quality is not sacrificed. Therefore, in order to understand how the radiation dose in the CT scan can be reduced, it is necessary to become familiar with the relationship between image quality and radiation dose.

A common method to optimize the radiation dose is to adapt the tube to the radiological current, using protocols based on weight or size. A more advanced technique is Automatic Exposure Control (AEC), which aims at automatically modulating the current of the radiological tube to adjust for attenuation differences due to the patient's anatomy, shape, and size.

The staging of patients with abdominal neoplasms represents the fundamental importance for the selection and planning of treatment.

Contrast-enhanced CT examination plays a central role in cancer management, because is the preferred scanning methodology for identifying tumors, local metastases, and spreading them remotely. Anatomical measurements can now be made much more accurately, and early metastatic lesions can be detected with much greater confidence in earlier stages than was the case even a decade ago.

Additional imaging studies such as MRI, mammography and ultrasound may be used in combination with CT for staging.

Exists 3 groups of factors that are influence the evaluation of the anatomical response: technical factors (parameters of the scanner, intravenous contrast, type of contrast, volume of contrast, timing, injection rate and CT scan beam settings), the factors associated with the patient (respiration phase during which the image is acquired and whether or not the patient can suspend breathing) and factors related to the radiologist interpreting the images.

In addition, each CT exam must be customized for each patient. Justification is a common responsibility between applicant clinicians and radiologists. Thus, a CT scan should be performed only if the radiation dose is considered to be justified by the potential clinical benefit to the patient.

Discussion

Since the cancer risk associated with radiation dose in CT is not zero, it is clear that reducing the dose of radiation in CT examination must continue to be one of the main priorities of the radiological community, especially in light of the continuous increase in CT examinations performed annually [29-34].

The radiation dose in the CT scan can be quantified in a variety of ways [43-46]. Output of radiation from the scanner, dose per organ and effective dose are the most common dose values.

The effective dose, usually expressed in the unit of measurement mSv, is a unit that represents a "whole body equivalent" of a dose that would have a similar health risk to that due to partial body irradiation. The actual dose allows for a rough comparison of risk-induced radiation between different types of examinations [41].

The irradiation dose is one of the most important determinants of the image quality of the CT examination and, therefore, the accuracy of the diagnosis and the result of a CT examination. The irradiation dose should be reduced only if the diagnostic image quality is not sacrificed. Therefore, in order to understand how the radiation dose in the CT scan can be reduced, it is necessary to become familiar with the relationship between image quality and radiation dose.

The dose reduction goal can be approached from the following two perspectives. The first perspective is to properly define the quality of the target image for each specific diagnostic task, which does not require low noise or higher spatial resolution than necessary.

The second perspective of dose reduction is to improve some aspects of image quality, such as image noise reduction, which can then be implemented in order to allow radiation dose reduction. This task can be accomplished by optimizing the techniques of the CT scanning system and improving the reconstructions processing [41].

A huge effort has been made to improve the effective dose on CT systems, which is related to several components of this system, including detector, collimator and beam filter modeling.

A common method to optimize the radiation dose is to adapt the tube to the radiological current, using protocols based on weight or size. A more advanced technique is Automatic Exposure Control (AEC), which aims at automatically modulating the current of the radiological tube to adjust for attenuation differences due to the patient's anatomy, shape, and size [47-49].

The intention of the AEC is to use the optimal level of radiation for each patient in order to obtain an adequate image quality related to a given diagnostic task. For smaller patients, less tube current, and therefore lower irradiation dose, is sufficient to achieve the desired image quality. For older patients, the radiation dose must be increased to ensure proper image quality.

As CT use has increased, concerns about the dose of the population by CT have begun to be expressed in the literature, making it clear that the responsible use of CT requires an adjustment of technical factors for radiation dose reduction [29-34]. In response to these concerns, the radiology community (radiologists, medical physicists, equipment manufacturers) has implemented CT dose management procedures that correspond to the ALARA principle (As Low As Reasonably Achievable) [29-39]. The basic principle in selecting the right dose for a CT scan is that the attenuation of a particular patient and the specific diagnostic task must be considered. For large patients, the dose is higher than for small patients, which is in accordance with the ALARA principle. This development has forced the radiology community to define a variety of dose reduction products [34].

Another aspect would be that dose reduction strategies should be based not only on the use of dose optimization technology, but on the appropriate use of imaging [40]. A considerable part of CT scans could be replaced by alternative practical methods, or they could simply be eliminated. There is a possibility of reducing the use of many routine CT scans in favor of other diagnostic methods.

Here are some questions that every doctor should answer before recommending a radiological examination: What diagnostic procedure is most appropriate for a particular pathology in a particular patient? It is a clinically justified radiological procedure [41]. If so, which radiological procedure is most appropriate?

Optimizing the use of radiological examinations with the help of clinical decision guidelines is essential. Once it has been established that an imaging procedure is clinically justified, the physician (and the entire imaging team) has the responsibility to optimize the patient's individual radiation exposure, which must be a continuous and regularly updated process [40].

The exact cancer stage is of fundamental importance for the selection and planning of treatment. Current staging paradigms focus primarily on a detailed delineation of the primary tumor in order to determine its resection capacity, and subsequently on assessing the presence of metastatic spread that would alter the surgical approach, or the mandate of non-surgical therapy. This approach is based on the assumption that the best, and sometimes the only, way to cure a cancer patient is surgical resection. Unfortunately, not all non-invasive techniques have the perfect ability to identify those primary tumors that are capable of being completely excised, nor the degree of their metastatic dissemination. However, due to relatively low costs and widespread availability, CT is the preferred scanning methodology for identifying tumors, local metastases, and spreading them remotely [10].

This technique is often complemented by other examinations that have improved their performance in staging areas. For example, magnetic resonance imaging (MRI), mammography, or ultrasound can be used as complementary T-stage examinations; surgical sampling of lymph nodes - for N-stage; bone scanning, MRI or ultrasound examination - for M-stage. Consequently, many patients undergoing a set of investigations are incorrectly organized based on the results obtained.

The definition of the malignant involvement degree is the foundation on which current oncological practice is based. This information defines applicable therapeutic strategies and provides a guide to the patient's prognosis. Diagnostic imaging methods, especially CT, are the primary techniques that are used to detect the cancer stage. These ways play a key role in cancer management.

Each of the different methodologies used to determine the cancer stage has inaccuracies. Due to its relatively low cost, widespread availability, and ability to define primary tumor relationships, lymph node drainage, and detect metastatic deposits in disparate tissues, CT scanning with contrast is administered the preferred methodology for the initial staging of the majority TNM [11]. From an imaging perspective, tumor progression is generally defined as an increase in tumor load (measured on imaging studies) or the detection of new lesions seen in imaging studies, and the tumor response refers to tumors that become smaller or disappear [12]. Measurements of solid tumors were generally determined by imaging studies, and therefore guidelines, criteria, and classifications were given based on measurements from imaging studies developed in the 1980s and 1990s. These guidelines and classifications reflect the emphasis on the overall response rate, which was the norm at the time.

3D CT and MRI imaging has replaced standard radiography. Anatomical measurements can now be made much more accurately, and early metastatic lesions can be detected with much greater confidence in earlier stages than was the case even a decade ago [13-15].

Therefore, the measurements obtained from image scans must be as reproducible as possible. It should not matter what hospital a patient goes to or on what day, or on which manufacturer's scanner is scanned, the result should be the same. To achieve this, there must be a rigorous standardization and attention to detail on all hardware, software parameters, as well as the responsibility of human resources, which can introduce variability.

Many factors affect the target lesions measurement and the new lesions detection, ranging from the choice of imaging modalities, imaging acquisition techniques and image reconstruction parameters, to the variability related to the expertise and different measurement methods of physicians interpreting images [16].

Improper use of imaging, imaging technique and/or imaging reconstruction parameters in oncology clinical trials can lead to loss or delay in the detection of new (metastatic) lesions and thus misinterpretation of when a disease progresses.

Technical factors in the image acquisition process that are known to influence the measurement of the size of the lesion and therefore the evaluation of the anatomical response include differences in the technical parameters of the scanner, intravenous contrast, type of contrast, volume of contrast, timing, injection rate and CT scan beam settings. During the scan acquisition, the factors associated with the patient also play an important role, such as the respiration phase during which the image is acquired and whether or not the patient can suspend breathing. If the patient is unable to hold his breath for the entire scan (<30 seconds), normal and abnormal structures may fade. This will generally cause the lesions to be measured larger than they really are and may result in complete loss of the small lesions.

Thus, in order to reduce the measurements variability, it is important that the CT scan images be reconstructed with the same slice thickness for a given patient.

Factors related to the radiologist interpreting the images are another significant source of variability in the interpretation and measurement of target lesions [17, 18]. These factors include the expertise and ability of the radiologist in the quantitative and qualitative evaluation of the therapy response, measurement biases due to the systematic excess of the radiologist or under interpretation of tumor contraction, biases due to the radiologist's knowledge of treatment, discrepancies in measurements due to different patient descriptions by radiologists and human errors that can be caused by tracking different target lesions over time and overlooking the development of a new lesion.

Methods for tumor imaging and assessing tumor response to treatment have changed and continue to evolve [20-22]. The North American Radiology Society (RSNA) supports the Quantum Imaging Biomarkers Alliance (QIBA), which has published documents to standardize imaging acquisition for volumetric CT examination, FDG-PET, and contrast-enhanced dynamic MRI [23].

More consistent imaging strategies for tumor response include:

1. Implement a scanner calibration program and evaluate the quality for each patient. Two such accreditation programs that can be used are the Centered Quantitative Imaging Excellence (CQIE) programs and the clinical trial network site qualification programs supported by SNMMI and scanner validation.

2. The same radiologist evaluates the complete set of examinations for the same patient.

3. The radiologist evaluates the images in the order in which they were obtained clinically (providing sets of images in an orderly manner over time).

4. The same representative target lesions are measured at each scan [12].

The American Cancer Society (ACS) has recommended a screening of cancer patients every three years for people between the ages of 20 and 39, and annually for men and women between the ages of 40 and over [24]. However, as the routine controls intervals have been replaced by recommendations that apply to specific conditions and populations, the periodicity of a general health check when these case examinations could be performed has become less clear.

Contrast-enhanced CT or MRI examination plays a central role in long-term postoperative evaluation. The follow-up protocol includes imaging studies every 6 months for the first year and then at one-year intervals in negative cases. The monitoring interval is shorter (3 months) for intermediate lesions [25] and in patients undergoing chemotherapy [26].

Another source recommends evaluating the initial response at 4 weeks after surgery, with early detection of recurrence of recurrence by CT or MRI studies, every 3 months in the first 2 years and surveillance every 6 months later [27]. In case of tumor recurrence after curative treatments, re-evaluation of the patient should be performed using the staging system and treatment review [28]hern -/.

In addition, each CT exam must be customized for each patient. Justification is a common responsibility between applicant clinicians and radiologists. Therefore, for medical exposures, the main tasks of the radiology community are to work with the team of clinicians to direct patients to the most appropriate imaging modality for the required diagnostic task, and to ensure that all technical aspects of the examination are optimized, so that the required level of image quality can be achieved while keeping the doses as low as possible. The American College of Radiology provides evidence-based guidance and appropriate criteria to assist physicians in recommending a necessary examination [42]. The European Commission and the Royal College of Great Britain presented a document with a detailed presentation of the clinical indications for imaging examinations, including the CT "Reference Guide for Radiologists". Thus, a CT scan should be performed only if the radiation dose is considered to be justified by the potential clinical benefit to the patient.

Conclusions

The collective dose of the population resulting from medical imaging has increased six fold in the last quarter of a century, so our goals should be to use imaging only when the potential clinical benefit outweighs the potential risk and strive for a imaging examination that provides the lowest dose required to obtain the desired information: we must aim at justifying and optimizing each imaging procedure. Therefore, in order to understand how the radiation dose in the CT scan can be reduced, it is necessary to become familiar with the relationship between image quality and radiation dose.

Also, the staging of patients with abdominal neoplasms represents the fundamental importance for the selection and planning of treatment and contrast-enhanced CT examination plays a central role in cancer management, because is the preferred scanning methodology for identifying tumors, local metastases, and spreading them remotely.

The risks of exposure to iatrogenic radiation are often overlooked, and patients are rarely aware of these risks. That's why each CT exam must be customized for each patient. Justification is a common responsibility between applicant clinicians and radiologists. Thus, a CT scan should be performed only if the radiation dose is considered to be justified by the potential clinical benefit to the patient.

It is estimated that 30% of CT exams are unnecessary. The doctor requesting the examination must balance the risks and benefits, and the difficult cases should be discussed in a multidisciplinary clinical-radiological meeting for personalization of the radiological examination of cancer patients.

Declaration of conflict of interest. Nothing to declare.

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Natalia Staver, PhD student
tel.:+40751226181
e-mail: dr.nataliastaver@gmail.com

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