Distribution of ct scanners in the state of Rio de Janeiro: A guiding study for the inclusion of graduates of professional education courses in radiology

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ABSTRACT

Computed Tomography (CT) is a diagnostic imaging test that uses X-rays to capture images of internal organs as if they were slices of the body. Once recorded, the images are processed on a computer that provides a detailed analysis of the area to be examined. The objective of the work was to identify the distribution of CT scanners in operation in Rio de Janeiro, with a view to understanding professional education, with regard to the employability of graduates from courses in this branch of radiology. The National Health Surveillance Agency (ANVISA) requires that all diagnostic X-ray devices be registered with the Ministry of Health, in order to allow their traceability. In this way, it is possible to find a list of all CT scanners on the DATASUS website, responsible for controlling national data relating to public health. The methodology was based on a survey of all CT scanners installed in the state of RJ and registered on the DATASUS platform until April 2024. Simultaneously, a spreadsheet was created with the data collected. This spreadsheet contained the following information: establishment, business name, neighborhood, municipality, state, establishment management, existing equipment, equipment in use, SUS and last update. The results obtained through this research showed a total of 766 CT scanners existing in the state of RJ, of which 727 (95%) are in use and 39 (5%) are inoperative. It is concluded that of the 76% of CT scanners operating within municipalities in the state, these are concentrated in Rio de Janeiro, Niterói, Nova Iguaçu, São Gonçalo, Duque de Caxias, Campos dos Goytacazes, Volta Redonda, Belford Roxo, Macaé, São João de Meriti, Petrópolis, Cabo Frio, Itaguaí and Magé. It is considered that municipalities with large numbers of CT equipment advance in better serving the population and create a larger field of work for professionals in this category.

Keywords: Computed tomography, CT scanners, Unified Health System.

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INTRODUCTION

Computed Tomography (CT) is a diagnostic imaging test that uses X-rays to capture images of internal organs as if they were slices of the body. Once registered, the images are processed on a computer that provides a detailed analysis of the area to be examined (SAÚDE IG, 2018).

The inventors of this machine, which brings us many benefits today, were Hounsfield and Cormack. The first developed the technique for the reconstruction of tomographic images and the second was responsible for determining the mathematics required for the entire tomography procedure (BIASOLI, 2015).

CT equipment is called a CT scanner, a large device with an open tunnel in the center, allowing the examination table to slide in and out. The X-ray tube and detectors rotate around the patient and are inside a ring called a *gantry.* The control room where the technician monitors the exam and processes the images is in a separate environment from the exam (INSTITUTO VENCER, 2014).

The existence of functioning CT scanners is of great importance for the public and for the category of professionals involved in this area, as well as to know their distribution in certain states, in this case especially in Rio de Janeiro, since this procedure is fast, accurate and can detect small alterations, enabling an early diagnosis and later treatment for the population and, generating a job market for such professionals.

OBJECTIVE

The objective of this study was to identify the distribution of computed tomography equipment in operation in the state of Rio de Janeiro, with a view to understanding professional education regarding the employability of graduates of courses in this branch of radiology.

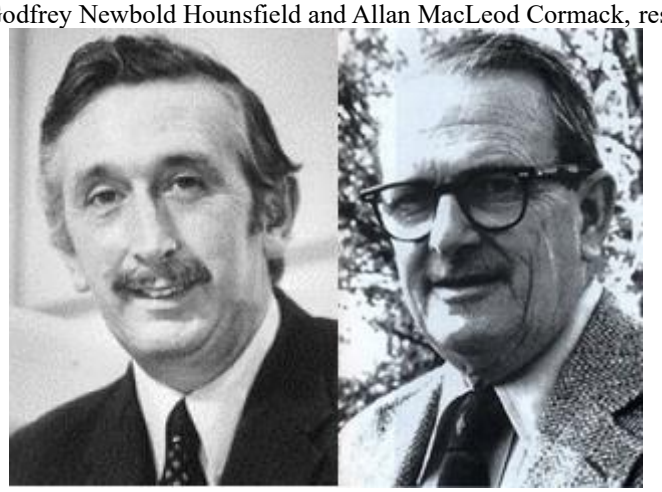
DEVELOPMENT

THE HISTORY OF CT SCANS

Computed tomography (CT) originated in 1961, through the description of an experimental system, by the American neurologist William Henry Oldendorf, with the purpose of visualizing the internal part of the brain based on a mathematical reconstruction, but the method was pointed out as unfeasible due to lack of mathematical support (BIASOLI, 2015).

Godfrey Newbold Hounsfield and Allan MacLeod Cormack, shown in figure 1, developed CT that was adopted as diagnostic imaging in 1970 (BIASOLI, 2015). Hounsfield demonstrated the technique for reconstructing the images, and Cormack developed the mathematics needed for the CT scan. Such contributions led to both receiving the Nobel Prize in Medicine in 1979 (CEFET, 2000).

Figure 1: Godfrey Newbold Hounsfield and Allan MacLeod Cormack, respectively.

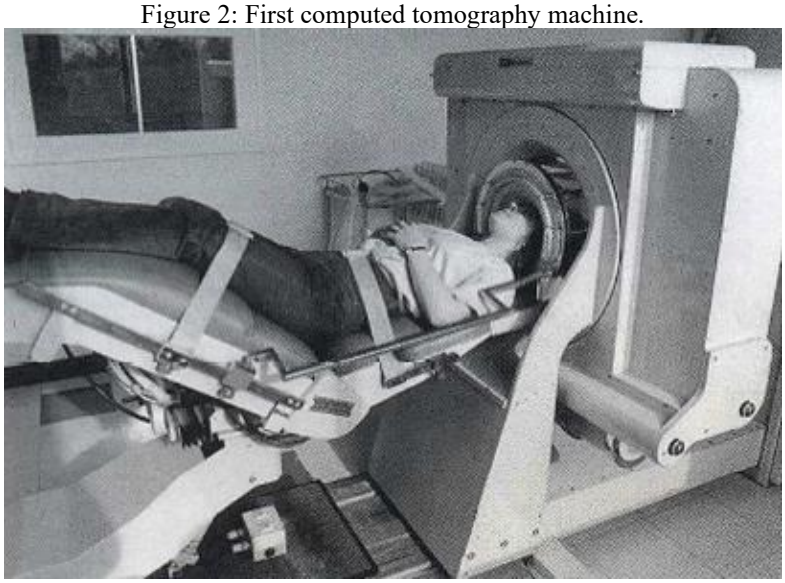


Source: CEFET, 2000.

As shown in figure 2, the first experimental CT scanner was built at Atkinson-Morley's Hospital, London. The first CT scan in history was performed on October 1, 1971, in a 41-year-old woman with a suspected frontal lobe tumor (BIASOLI, 2015, p. 453).

According to Biasoli (2015), in Brazil the first computed tomography scanner was installed at the Hospital da Real e Benemérita Sociedade Portuguesa de Beneficência, located in São Paulo, on December 10, 1976.

Figure 2: First computed tomography machine.



Source: BIASOLI, 2015.

BASIC PRINCIPLES AND EVOLUTION OF COMPUTED TOMOGRAPHY MACHINES

The term tomography derives from the Greek words "tomos" and "graphein" which mean respectively "slice" and "write". CT makes use of a computer and a mechanical system that provide anatomical images in axial, sagittal, and coronal planes (BONTRAGER; LAMPIGNANO, 2015).

A CT unit uses an X-ray tube and array detector to collect anatomical data from a patient. This data is reconstructed into an image (BONTRAGER; LAMPIGNANO, 2015, p. 1.983).

Over the years, CT scanners have evolved, with the emergence of several generations of CT scanners. According to Bontrager and Lampignano (2015), the **first generation** CT scanner had a thin X-ray beam similar to a pencil, rotation/translational movements, capable of performing examinations only of the skull and required 180º of rotations, only one detector and took approximately 5 minutes to form an image. The **second generation** emitted a beam of X-rays in the shape of a fan, rotation/translation movements, obtaining 30 or more detectors, with 15 seconds per cut to perform an examination.

The third generation **CT scanner** had a fan-shaped beam of radiation with an angle of up to 60º, only rotational movements, a bench of 200 to 800 detectors arranged on the opposite side of the X-ray tube, which rotated together around the patient in 360º, the scanning time (cut) decreased to less than 5 seconds. The **fourth generation**, on the other hand , had a fan-shaped radiation beam with a fixed detector, due to the inability to reduce scattered radiation, this equipment was not successful (BIASOLI, 2015).

The helical CT scanner is considered the **fifth generation**, in this model the table moves together with the patient, since in previous generations, the table moved after the 360º rotation (after the acquisition of the cut) and was positioned for a new cut, that is, it suffered interruptions between cuts. In this method, there is no data acquisition by cuts, but on a constant basis (CEFET-SC, 2000).

In 1998, multislice devices were introduced, capable of obtaining images of four slices simultaneously. This equipment now has more than one row of detectors. One of the advantages of this process is the speed of obtaining images (BIASOLI, 2015).

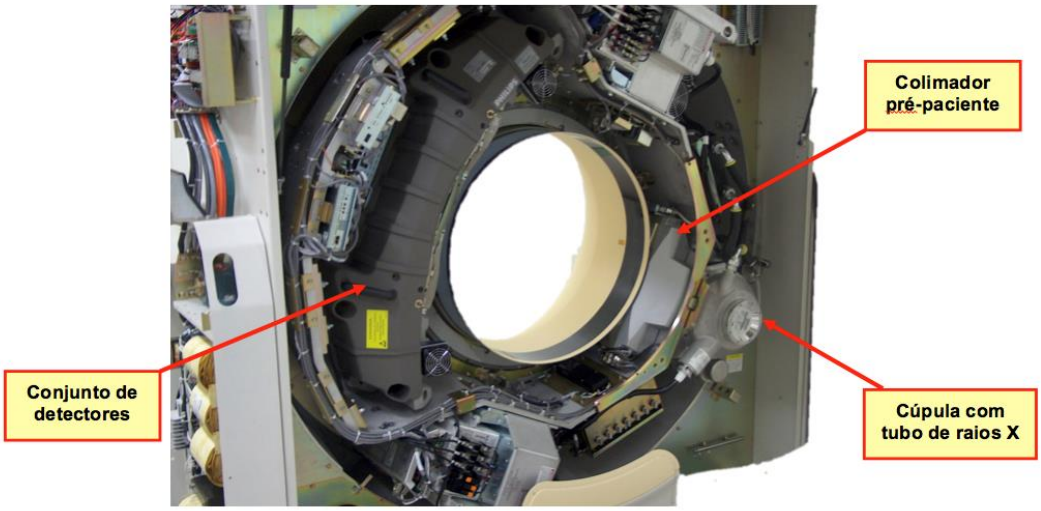
COMPONENTS OF A CT SCANNER

According to Bontrager and Lampignano (2015), the CT scanner is a fixed installation and consists of three main parts: gantry, computer, and operation panel.

GANTRY

It has a central opening, where the desired anatomical segment is scanned (BONTRAGER; LAMPIGNANO, 2015). According to Félix (2018), on the outside of the *gantry* there are commands for moving the table, while on the inside there is a combination of the X-ray tube, set of detectors, and collimators, shown in figure 3.

Figure 3: Inside the Gantry.



Cast iron: FÉLIX, 2018.

COMPUTER

The computer used in CT has a microprocessor and primary memory, which determine the time between the end of the exam and the reconstruction of the image (appearance of the image). The reconstruction time is related to the efficiency of the examination, especially when there is a large number of sections. Depending on the image format, 250,000 equations are made simultaneously (Bushong, 2010).

OPERATION PANEL

For Bontrager and Lampignano (2015), it is the place that allows controlling the parameters of the exam, protocols, visualization and manipulation of the images generated. The items that make up the operation panel are mouse, keyboard, and single or dual monitor, depending on the type of system, shown in figure 4.

Figure 4: Operation panel.

Source: BONTRAGER; LAMPIGNANO, 2015.

DATASUS PLATFORM

The National Health Surveillance Agency (ANVISA), through Collegiate Board Resolution (RDC) 611, of March 9, 2022, requires that all diagnostic X-ray devices and their components be registered with the Ministry of Health (MS), so that such equipment can be tracked (ANVISA, 2022).

As shown in Figure 5, it is possible to find the list of all CT equipment on the DATASUS website, which is the Department of Informatics of the Unified Health System, which emerged in 1991, after the creation of the National Health Foundation (FUNASA). The DATASUS platform has the function of promoting, operating and controlling national data and implementing systems to assist public health (DATASUS, 2024).

Figure 5: DATASUS website with the list of all CT scanners in the state of Rio de Janeiro.

Ministério da Saúde

CNESNet
Secretaria de Atenção à Saúde
DATASUS

Cadastro Nacional de Estabelecimentos de Saúde

Home | Institucional | Serviços | Relatórios | Consultas

Indicadores - Equipamentos
Estado - RJ
Tipo Equipamento - Equipamentos de Diagnostico por Imagem - Tomógrafo Computadorizado

CNES	Estabelecimento	Município	Existentes	em Uso	SUS
9407650	ALFA RADIOLOGIA ODONTOLOGICA LTDA	RIO DE JANEIRO	1	1	N
7973306	ALTA BARRA SHOPPING	RIO DE JANEIRO	1	1	N
9304061	ALTA LEBLON DIAGNOSTICOS	RIO DE JANEIRO	1	1	N
3471314	AMACOR SERVICOS MEDICOS CAMPO GRANDE	RIO DE JANEIRO	1	1	N
3339823	AMEP ASSISTENCIA MEDICA ESPECIALIZADA	RIO DE JANEIRO	1	1	N
6496202	AMERICAS OFTALMO CENTER	RIO DE JANEIRO	1	1	N
7557817	ANATO SCAN CENTER DIAGNOSTICOS POR IMAGEM	RIO DE JANEIRO	1	1	N
6403859	ASSOCIACAO AMOR E VIDA	ITAGUAI	1	1	N
5159636	ASSOCIACAO DE APOIO A TERCEIRA IDADE CENTRO	RIO DE JANEIRO	1	1	N
5329167	ASSOCIACAO DE APOIO A TERCEIRA IDADE TIJUCA 1	RIO DE JANEIRO	1	1	N
3221601	BARRA EYE CLINIC	RIO DE JANEIRO	1	1	N
6649106	BAYAO DIAGNOSTICOS MEDICOS	NITEROI	1	1	N
3030415	BENEFICENCIA PORTUGUESA DE PETROPOLIS	PETROPOLIS	1	1	N
3383040	BRONSTEIN BOTAFOGO	RIO DE JANEIRO	1	1	N
5160375	BRONSTEIN MED DIAG VILA VALQUEIRE	RIO DE JANEIRO	1	1	N
6987400	BRONSTEIN MEGA CAMPO GRANDE	RIO DE JANEIRO	1	1	N
3383067	BRONSTEIN MEGA COPACABANA	RIO DE JANEIRO	1	1	N
6987516	BRONSTEIN POLO I	RIO DE JANEIRO	1	1	N
7442548	CADI DIAGNOSTICO	CASIMIRO DE ABREU	1	1	S
7011547	CADI DIAGNOSTICOS	ARMACAO DOS BUZIOS	1	1	S
2282291	CAMIL	BOM JESUS DO ITABAPOANA	1	1	N
9280944	CAMIM CLINICA MEDICA	RIO DE JANEIRO	1	1	N
2287919	CASA DE CARIDADE SANTA RITA	BARRA DO PIRAI	1	1	S
3113205	CASA DE PORTUGAL	RIO DE JANEIRO	2	2	N
3016501	CASA DE SAUDE E MATERNIDADE SANTA MARTHA	NITEROI	1	1	N

Fonte: DATASUS, 2024.

METHODOLOGY

A survey was carried out of all computed tomography equipment installed in the state of RJ and registered on the DATASUS platform until April 2024. The information regarding each establishment with CT scanners was available through the DATASUS website, as shown in Figure 6.

Figure 6: Data from the establishment that has CT scanners in Rio de Janeiro.

Estabelecimento de Saúde

Identificação
CADASTRADO NO CNES EM: 5/12/2012 ULTIMA ATUALIZAÇÃO EM: 13/6/2024 DATA DE ATUALIZAÇÃO LOCAL: 4/6/2024

Veja onde se localiza: | Exibir Ficha Reduzida por Competência | Exibir Ficha Reduzida Atual

Nome:			CNES:	CNPJ:
CLINICA DE IMAGEM WINSTON			7143680	36173797000338
Nome Empresarial:			**CPF:**	**Personalidade:**
CLINICA DE IMAGEM WINSTON DE ANDRADE LTDA			--	JURÍDICA
Logradouro:			**Número:**	**Telefone:**
RUA CATORZE			S/N	2433621272
Complemento:	**Bairro:**	**CEP:**	**Município:**	**UF:**
HOSPITAL	PRAIA BRAVA	23950080	ANGRA DOS REIS - IBGE - 330010	RJ
Tipo Estabelecimento:	**Sub Tipo Estabelecimento:**	**Gestão:**		**Dependência:**
UNIDADE DE APOIO DIAGNOSE E TERAPIA (SADT ISOLADO)		MUNICIPAL		INDIVIDUAL
Número Alvará:	**Órgão Expedidor:**		**Data Expedição:**	
0125/12	SMS		05/06/2012	
Horário de Funcionamento:				
VISUALIZAR HORÁRIO				

Fonte: DATASUS, 2024.

At the same time, a spreadsheet was prepared with the data collected from the previously mentioned site. As can be seen in figure 7, the spreadsheet was fed with the following information: establishment, business name, neighborhood, municipality, state, management of the establishment (municipal or state), existing equipment, equipment in use, SUS (i.e., yes for those who provided services through SUS and not for those who did not offer the same services) and last updated on June 13, 2024.

Figure 7: Spreadsheet with all establishments that have CT scanners installed in the state of Rio de Janeiro.

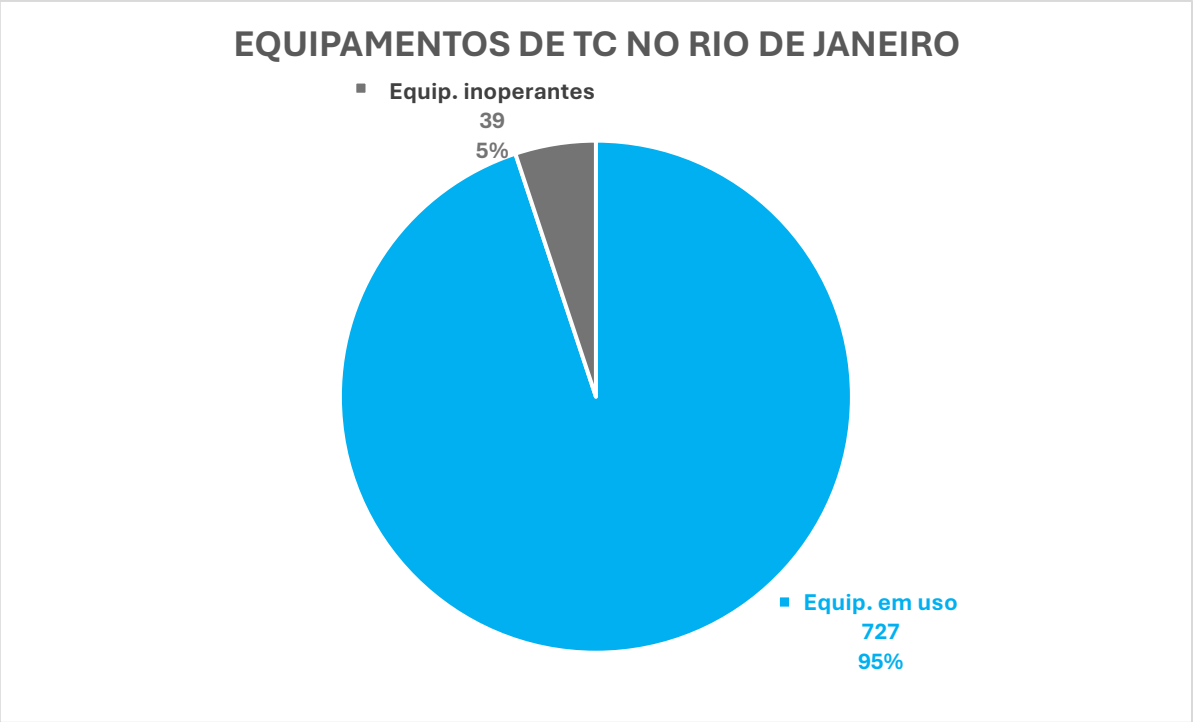
CnesNet - Cadastramento Nacional de Estabelecimentos de Saúde								
Tomografia Computadorizada								
Estabelecimento	Nome empresarial	Bairro	Município	UF	io do estabeleciuip. existeuip. em u			SUS
Alta Barra Shopping	Diagnósticos da América S A	Barra da Tijuca	Rio de Janeiro	RJ	Municipal	1	1	Não
Alta Leblon Diagnósticos	Diagnósticos da América S A	Leblon	Rio de Janeiro	RJ	Municipal	1	1	Não
Amacor Serviços Médicos Campo Grande	Amacor Serviços Médicos LTDA	Campo Grande	Rio de Janeiro	RJ	Municipal	1	1	Não
Amep Assistência Médica Especializada	AMEP Amep Assistência Médica Especializada LTDA	Freguesia	Rio de Janeiro	RJ	Municipal	1	1	Não
Américas Oftalmo Center	Américas Oftalmocenter Serviços Oftalmológicos LTDA	Barra da Tijuca	Rio de Janeiro	RJ	Municipal	1	1	Não
Anato Scan Center Diagnósticos Por Imagem	Anato Scan Center Diagnósticos Por Imagem LTDA ME	Tijuca	Rio de Janeiro	RJ	Municipal	1	1	Não
Associação Amor e Vida	Associação Amor e Vida	Centro	Itaguaí	RJ	Municipal	1	1	Não
Associação de Apoio a Terceira Idade Centro	Associação de Apoio a Terceira Idade	Centro	Rio de Janeiro	RJ	Municipal	1	1	Não
Associação de Apoio a Terceira Idade Tijuca 1	Associação de Apoio a Terceira Idade	Tijuca	Rio de Janeiro	RJ	Municipal	1	1	Não
Barra Eye Clinic	Barra Eye Clinic LTDA	Barra da Tijuca	Rio de Janeiro	RJ	Municipal	1	1	Não
Bayão Diagnósticos Médicos	rviços de Diagnósticos Médicos Complementares LTD	Centro	Niterói	RJ	Municipal	1	1	Não
Beneficência Portuguesa de Petropolis	SMH Sociedade Médico Hospitalar LTDA	Valparaíso	Petrópolis	RJ	Municipal	1	1	Não
Bronstein Botafogo	Diagnósticos da America S A	Botafogo	Rio de Janeiro	RJ	Municipal	1	1	Não
Bronstein Med Diag Vila Valqueire	Diagnósticos da America S A	Vila Valqueire	Rio de Janeiro	RJ	Municipal	1	1	Não
Bronstein Mega Campo Grande	Diagnósticos da America S A	Campo Grande	Rio de Janeiro	RJ	Municipal	1	1	Não
Bronstein Mega Copacabana	Diagnósticos da America S A	Copacanaba	Rio de Janeiro	RJ	Municipal	1	1	Não
Bronstein Polo 1	Diagnósticos da America S A	Madureira	Rio de Janeiro	RJ	Municipal	1	1	Não
Cadi Diagnóstico	L S Serviços Radiológicos LTDA	Centro	Casimiro de Abreu	RJ	Municipal	1	1	Sim
Cadi Diagnóstico	LES Serviços de Diagnósticos Por Imagem	Manguinhos	Armação de Búzios	RJ	Municipal	1	1	Sim
Camil	Centro de Assistência Médica Itabapoana LTDA	Centro	Jesus do Itabapo	RJ	Municipal	1	1	Não
Camim Clínica Médica	Camim Clínica Médica LTDA	Campinho	Rio de Janeiro	RJ	Municipal	1	1	Não
Casa de Caridade Santa Rita	Casa de Caridade Santa Rita	Centro	Barra do Piraí	RJ	Municipal	1	1	Sim
Casa de Portugal	Casa de Portugal	Rio Comprido	Rio de Janeiro	RJ	Municipal	2	2	Não
Casa de Saúde e Maternidade Santa Martha	Casa de Saúde e Maternidade Santa Martha	Santa Rosa	Niterói	RJ	Municipal	1	1	Não
asa de Saúde e Maternidade Terezinha de Jesus LTDA	asa de Saúde e Maternidade Terezinha de Jesus LTDA	Centro	São João de Meriti	RJ	Municipal	1	1	Não
Casa de Saúde Nossa Senhora de Fatima N Iguacu S A	de Saúde e Mat Nossa Senhora de Fatima Nova Igu	Centro	Nova Iguaçu	RJ	Municipal	1	1	Não

Source: Author's collection, 2024.

RESULTS

The results obtained through this research showed a total of 766 existing CT scanners in the state of Rio de Janeiro, of which 727 (95%) are those that are in use and 39 (5%) are inoperative, as shown in graph 1 below.

Graph 1: General quantification of CT scanners in the state of Rio de Janeiro.



As shown below in table 1, the distribution of CT scanners in operation in the municipalities of the state of Rio de Janeiro was as follows: 346 for the municipality of RJ, 33 for Niterói, 23 for Nova Iguaçu, 26 for São Gonçalo, 21 for Duque de Caxias, 20 for Campos dos Goytacazes, 17 for Volta Redonda, 16 for Belford Roxo, Macaé and São João de Meriti, 15 to Petrópolis, 11 to Cabo Frio and Itaguaí, 10 to Magé, 9 to Barra Mansa, Itaboraí and Nova Friburgo, 8 to Araruama, 7 to Angra dos Reis and Teresópolis, 6 to Nilópolis, Rio das Ostras and Saquarema, 4 to Barra do Piraí, Itaperuna, Maricá, Queimados, Resende, Rio Bonito, São Pedro da Aldeia and Três Rios, 3 to Armação de Búzios, Bom Jesus de Itabapoana, Mesquita, Paraíba do Sul, São Fidélis and Valença, 2 to Arraial do Cabo, Cachoeira de Macacu, Casimiro de Abreu, Itaocara, Paracambi, São João da Barra and Vassouras, 1 to Aperibe, Cambuci, Carapebus, Cantagalo, Cordeiro, Japeri, Mendes, Miguel Pereira, Miracema, Parati, Paty do Alferes, Porto Real, Rio Claro, São Francisco de Itabapoana and São Sebastião do Alto.

Table 1 - Distribution of CT scanners by municipalities in the state of Rio de Janeiro.

Municipalities	Equip. In use
Rio de Janeiro	346
Niterói	33
Nova Iguaçu	23
Duque de Caxias	21
São Gonçalo	26
Campos dos Goytacazes	20
Petrópolis	15
Belford Roxo	16
Macaé	16
São João de Meriti	16
Volta Redonda	17
Cabo Frio	11
Itaguaí	11
Magé	10
Barra Mansa	9
Itaboraí	9
Nova Friburgo	9
Araruama	8
Angra dos Reis	7
Teresópolis	7
Nilópolis	6
Rio das Ostras	6
Saquarema	6
Barra do Piraí	4
Itaperuna	4
Maricá	4
Queimados	4
Resende	4
Rio Bonito	4
São Pedro da Aldeia	4
Três Rios	4
Valença	3
Armação de Búzios	3
Bom Jesus de Itabapoana	3
Mesquita	3
Paraíba do Sul	3
São Fidélis	3
Arraial do Cabo	2
Cachoeira de Macacu	2
Casimiro de Abreu	2
Itaocara	2

Paracambi	2
São João da Barra	2
Vassouras	2
Aperibe	1
Cambuci	1
Carapebus	1
Cantagalo	1
Cordeiro	1
Japeri	1
Mendes	1
Miguel Pereira	1
Miracema	1
Parati	1
Paty do Alferes	1
Porto Real	1
Rio Claro	1
São Francisco de Itabapoana	1
São Sebastião do Alto	1
Total	**727**

CONCLUSION

According to the results obtained in this research, it was found that of the 766 CT scanners in the state of Rio de Janeiro, 39 of them are not in operation, which means that 727 are operational.

Of the 76% of CT scanners that are operating in the municipalities of the state, these are concentrated in: Rio de Janeiro, Niterói, Nova Iguaçu, São Gonçalo, Duque de Caxias, Campos dos Goytacazes, Volta Redonda, Belford Roxo, Macaé, São João de Meriti, Petrópolis, Cabo Frio, Itaguaí and Magé.

It is considered that municipalities with large numbers of CT equipment advance in better serving the population and create a greater field of work for professionals in the category.

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