
# Information Security Report

## Unprotected patient data in the Internet – a review 60 days later

## or

## The Good, the Bad, and the Ugly

## Cyber Resilience Report

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# Contents

# 1 Executive Summary

After our initial measuring of the depth and breadth of data leaking PACS servers across the globe, we wanted to follow a good, standard information security practice: CONTROL. We were interested to see what – if any – has changed to what extent and decided to do this 60 days after the initial research, as this is the timeline given by the US Department of Health & Human Service for Medical Service Providers to report a major breach affecting 500 or more individuals. The results are mixed, some provide hope that the issue is taken seriously, some other destroy that hope right away.

The overall numbers for studies and images have risen to a staggering level, with studies amounting to 35 million and related images to 1,193,404,000, that is 1.19 billion images, (compared to 24.5 million studies and 737 million images in previous report).

In the following chapters, we sort the affected countries into three groups, which we call

- the “Good”
- the “Bad”, and
- the “Ugly”.

Specially the five countries belonging to the “Ugly” group need immediate attention by their respective Governments (i.e. federal or state-level DPO). Their combined number of datasets represents more than 75% of the full data set scrutinized.

During the initial research and report, we learned a lot and tuned our technology, so that we identified more PACS servers in the base set of IP addresses and added them to the count. For systems which have disappeared, their former count isn’t part of our current calculation anymore.

The highlights for interesting pieces of data and conclusions are:

- 129 new archiving systems found, and 172 went off grid
- 11 countries managed to take all PACS system off the public Internet, and nine ‘new’ countries got added to the overall data.
- USA and Ecuador have largely increased numbers of studies, PII, and images accessible.
- One system in the US is the largest so far (from an accessible image count perspective) and contains SSN’s for approx. 250,000 individual US citizens.
- Indications exist that Turkish PACS servers contain scans of Turkish National ID cards, accessible from the public Internet.
- One archive contains data from US army hospitals, where the patient IDs appears to be the DoD ID.
- Proper controls, like those mandated by HIPAA in the US are largely missing
- The potential financial risk related to Medical Identify Theft is amounting to $ 5.3 billion

We stated before that the information held by all the servers we found is covered by laws and regulations of the various countries and regions, like GDPR in Europe, HIPAA in the US and others.

- South Africa: Protection of Personal Information Act (POPI Act)
- Brazil: Lei Geral de Proteção de Dados Pessoais (LGPD)
- India: Information Technology Act 2000, Data Privacy Rules

It is sort of telling that as of NOV 12, 2019, we haven’t seen any reporting of specific PACS systems allowing access from the public Internet in the data breach list provided by HHS. We will continue to monitor the list, with a special eye on the companies owning and operating those large systems as they state full HIPAA compliance in their annual reports.

# 2 Updated Findings

Based upon the original dataset of IP addresses and combined with tuned and improved capabilities[1] in identifying and measuring the systems behind those addresses, the updated findings are causing great concern.

In total, the number of data records found (they are called studies in PACS terminology) has increased from 24.3 million to 35 million studies. There are two reasons for this: 1) with the things we learned during our initial research (our improved capabilities) we found 129 additional systems, which is smaller than the number of 172 PACS servers which have been taken off the Internet since our initial report and 2) these PACS server are in use, that is each and every day thousands of records are added to the data trove.

Related to the millions of studies are a staggering count of images, **1.19 billion**.

The number of studies for which it is possible to access the images linked to them without restrictions (and their count) has doubled, **from roughly 4.4 million to 9 million**. The number of images now accessible declined slightly to 370 million (previously 400 million).

While we had initially identified 52 areas of the world as affected, this review now covers 50 countries and territories. Some countries managed to take the PACS server located within their borders off the net (the “Good”), for some countries the situation remains largely unchanged (the “Bad”), and for a few the situation got worse (the “Ugly”)[2]. 9 countries are new is this review and 11 countries disappeared.

## *2.1 The “Good”*

After the initial release, several countries took immediate actions to address the issue at hand. Within a matter of days systems were taken off grid and the respective authorities of these countries made sure that the detailed information we provided them was taken seriously.

The following 11 countries have managed to take all identified PACS servers off and no new systems were found (in alphabetical order):

- Barbados
- Germany
- Greece
- Malaysia
- Netherlands
- Portugal
- Serbia
- Slovakia
- Thailand
- United Kingdom
- Venezuela

For these countries it is a kind of a ‘short term’ victory, as hospitals, clinics, and medical service providers are likely to make the same mistake in future. Good practice recommends to check the situation again on a regular base, which is explained further in our new section “Recommended Actions” further down.

[1] https://www.helpnetsecurity.com/2019/10/16/greenbone-security-feed-capabilities/
[2] Using these terms should be taken as a description of the situation from a data privacy and information security perspective, not as a general judgement about the respective country or its citizens. Credit is also given Sergio Leone’s movie masterpiece.

## 2.2 The "Bad"

Of those 50 countries covered in this revision, 45 are on their way to improve the situation related to PACS servers or – at least – the situation has not drastically gotten worse. For some of these countries there is still much to do and we even found new systems in this group, hence the new countries added. But the overall number of identified PACS servers is at 175, which is lower than in our first report (-12). The number of images went down significantly, from 228 million initially to 192 million in this revision. When it is about the count for those images freely accessible, the decrease is even better, from 204 million to 107 million.

Still, the number of studies for this group of countries has increased from 6.4 million to 8 million. This is due to the same reasons as stated above.

Some notable changes in this group:

- Turkey
  - 8 system went off the Internet, 9 PACS servers were added
  - The number of studies increased to 5.1 million (from 4.9m)
  - The number of images related to studies decreased to 75 million (from 179m)
  - Images of new servers seem to include scans of Turkish National ID cards

- Puerto Rico
  - Only one new system was found, and 4 went off grid
  - That new system really doubled the number of studies, 461K compared to 205K,
  - also the number of images accessible doubled from 4.9m to 9.8m

- Chile
  - The number of PACS servers did not change, but the improved capabilities increased the number of studies and images.
  - 400K studies now, previously 226K
  - 8.2m images linked, previously 4.9m
  - 4.1 images accessible, compared to 2.8 initially.

As said, there is room for improvement for this group of countries, the details for number of studies and images of each of it are listed in the appendix.

The following countries have been added to the list:

Azerbaijan, Ethiopia, Hungary, Jamaica, Kazakhstan, Pakistan, Reunion, Tunisia, and Uruguay

The list of countries along with the changes in identified servers can be found in the table below (alphabetical order).

| Countries | New systems found | Systems gone | Systems with access | Systems w/o access | Total | Status |
|---|---|---|---|---|---|---|
| **Albania** | 1 | 0 | 1 | 0 | 1 | unchanged |
| **Anguilla** | 0 | 0 | 1 | 0 | 1 | unchanged |
| **Argentina** | 1 | 2 | 9 | 17 | 26 | changed |
| **Australia** | 0 | 3 | 3 | 37 | 40 | changed |
| **Azerbaijan** | 1 | 0 | 1 | 0 | 1 | new |
| **Bolivia** | 2 | 2 | 2 | 0 | 2 | changed |
| **Bulgaria** | 0 | 2 | 0 | 3 | 3 | changed |
| **Canada** | 1 | 2 | 4 | 39 | 43 | changed |
| **Chile** | 3 | 3 | 18 | 34 | 52 | changed |
| **China** | 2 | 9 | 7 | 125 | 132 | changed |
| **Colombia** | 2 | 2 | 8 | 20 | 28 | changed |
| **Costa Rica** | 0 | 0 | 1 | 0 | 1 | unchanged |
| **Cyprus** | 0 | 0 | 1 | 0 | 1 | unchanged |
| **Czech Republic** | 0 | 1 | 1 | 3 | 4 | changed |
| **Egypt** | 0 | 0 | 2 | 0 | 2 | unchanged |
| **Ethiopia** | 1 | 0 | 1 | 0 | 1 | new |
| **France** | 2 | 2 | 7 | 30 | 37 | changed |
| **Guatemala** | 0 | 1 | 3 | 6 | 9 | changed |
| **Hungary** | 2 | 0 | 2 | 0 | 2 | new |
| **Iran** | 1 | 0 | 3 | 143 | 146 | changed |
| **Italy** | 1 | 6 | 6 | 23 | 29 | changed |
| **Jamaica** | 1 | 0 | 1 | 0 | 1 | new |
| **Japan** | 0 | 0 | 3 | 0 | 3 | unchanged |
| **Kazakhstan** | 1 | 0 | 1 | 0 | 1 | new |
| **Kenya** | 1 | 0 | 1 | 0 | 1 | unchanged |
| **Korea** | 0 | 0 | 2 | 0 | 2 | unchanged |
| **Mexico** | 1 | 4 | 7 | 34 | 41 | changed |
| **Netherlands Antilles** | 0 | 0 | 1 | 0 | 1 | unchanged |
| **Pakistan** | 1 | 0 | 1 | 0 | 1 | new |
| **Paraguay** | 0 | 0 | 1 | 0 | 1 | unchanged |
| **Peru** | 1 | 0 | 3 | 9 | 12 | changed |
| **Puerto Rico** | 1 | 4 | 20 | 8 | 28 | changed |
| **Reunion** | 1 | 0 | 1 | 0 | 1 | new |
| **Romania** | 1 | 0 | 1 | 0 | 1 | unchanged |
| **Russian Federation** | 0 | 3 | 2 | 10 | 12 | changed |
| **Sao Tome & Principe** | 0 | 0 | 1 | 0 | 1 | unchanged |
| **Spain** | 1 | 1 | 1 | 8 | 9 | changed |
| **Switzerland** | 0 | 1 | 1 | 2 | 3 | changed |
| **Tunisia** | 6 | 0 | 6 | 0 | 6 | new |
| **Turkey** | 8 | 9 | 35 | 46 | 81 | changed |
| **Ukraine** | 0 | 0 | 1 | 0 | 1 | unchanged |
| **Uruguay** | 1 | 0 | 1 | 0 | 1 | new |
| **Uzbekistan** | 0 | 0 | 1 | 0 | 1 | unchanged |
| **Vanuatu** | 0 | 0 | 1 | 0 | 1 | unchanged |
| **Vietnam** | 0 | 0 | 1 | 0 | 1 | unchanged |

## 2.3 The "Ugly

(Note: the term serves as a descriptor for the situation of PACS servers, studies and image count, and number of images accessible within these countries, and should not be interpreted otherwise).

As mentioned above, the total numbers for studies, related images, and images accessible for this group has drastically increased. The five countries in this group are the main contributors to this increase, with 27million studies alone.

### 2.3.1 United States of America

In our first report about unprotected PACS servers, we listed the USA with the following number:

- 13.7 million studies
- 303 million images related to these studies
- 45.8 million images accessible
- 184 systems identified

As of November 10th, 2019, these figures have increased, some quite drastically

- 21.8 million studies, which allows to estimate that about 6 million US citizens are affected
- 786 million images related to those studies
- a subset thereof, 114,5 million images are fully accessible
- these are related to 1.78 million studies
- 195 systems identified
    - 60 news PACS servers have been found
    - 49 are not reachable in the public Internet any longer, were taken offline
- New datapoint: over 800 institutions (clinics, hospital, and radiology service providers) are affected, with more than 2,000 physicians related to these institutions.

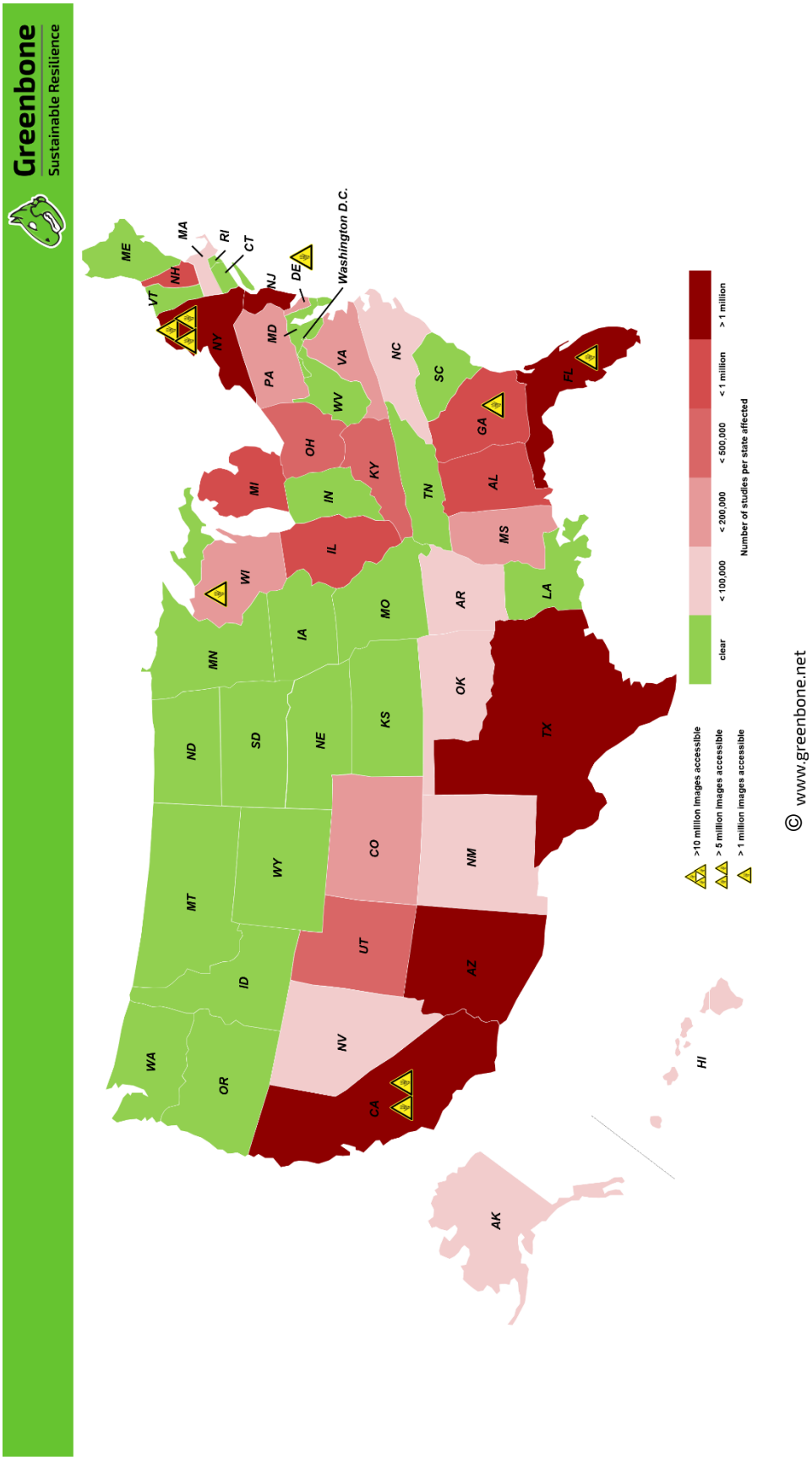
There are a few systems which hold either massive amounts of data (see below) or extremely sensitive data (like those from military hospitals or correction facilities).

Having this in mind, we appreciate the efforts made by Sen. Mark Warner (D-Va) and his team to raise the awareness about and the urgency of getting the PACS servers off the public Internet as soon as possible[3].

One particular system is a major data leak. That system alone holds about 1.23 million studies, allows full access to about 61 million images, and an estimated 75% of the records also contains the Social Security Numbers of the patients. A vast data trove for a hacker, ready to be used for Medical Identity Theft (see below).

For this revision of our report we attempted to locate the PACS servers within the US states, as shown in the graphic below.

[3] Press releases by the office of Senator Mark Warner (D-VA)
https://www.warner.senate.gov/public/index.cfm/2019/9/warner-seeks-answers-in-light-of-negligent-cybersecurity-practices-by-health-care-company
https://www.warner.senate.gov/public/index.cfm/2019/11/warner-raises-alarm-about-hhs-failure-to-act-following-exposure-of-sensitive-patient-data




A full sized/hi-res version of the image is available on our website.

There are two aspects related to the situation in the US that require additional scrutiny.

## HIPAA

For those not deeply familiar with the Health Insurance Portability and Accountability Act of 1996, aka HIPAA; some details related to our findings[4].

HIPAA sets and describes a range of safeguards, some being of administrative nature, other being of technical nature. There are at least four specific safeguards which have an impact here, as they are largely disregarded.

- Risk Analysis
  *"Conduct an accurate and thorough assessment of the potential risks and vulnerabilities to the confidentiality, integrity, and availability of electronic protected health information held by the covered entity."*

- Risk Management
  *"Implement security measures sufficient to reduce risks and vulnerabilities to a reasonable and appropriate level to comply with §164.306(a)."*

Identifying potential security risks, estimating their probability is sometimes not an easy task. But for a large medical archive connected to the public Internet without any safeguards, it isn't. It is almost certain that someone will find it.

- Access Control
  *"Implement technical policies and procedures for electronic information systems that maintain electronic protected health information to allow access only to those persons or software programs that have been granted access rights as specified in § 164.308(a)(4)[Information Access Management]."*
- Audit Controls
  *"Implement hardware, software, and/or procedural mechanisms that record and examine activity in information systems that contain or use electronic protected health information."*

The fact that the PACS systems identified and measured allowed repeated access without any need for credentials speaks for itself.

## Medical Identify Theft

The medical archives we found, specially that one system affecting the New York metropolitan area, are 'perfect' data troves for malicious actors with the intend to exploit individuals using medical identity theft. The data in these archives would enable Medical Identity Theft directly as well as indirectly. Directly because there are enough personal details contained in some of the archives to use them right away. Indirectly simply because – if there is a missing piece of information to go directly to this kind of fraudulent activity – it can still be used for Social Engineering so to obtain the missing part.

Studies[5] indicate that an individual victim of Medical Identity Theft pays about $13,500 to cover the financial consequences. Using this figure, the potential financial risk related to the data sets we found is enormous.

Based upon recent statistics[6] stating that 6.6% of consumers became victims of identity theft, the calculation is like this:

[4] More information here: https://www.hhs.gov/hipaa/for-professionals/security/index.html
[5] http://www.medidfraud.org/wp-content/uploads/2015/02/2014_Medical_ID_Theft_Study1.pdf
[6] https://www.identityforce.com/blog/identity-theft-odds-identity-theft-statistics

1. 21.8 million studies represent approx. 6.00 million individuals (based on a validated ratio of 3.5 to 1 between studies and persons).
2. 6.6% of 6.00 million equals to about 396,000, which has to be multiplied by $13,500
3. The overall financial risk related to Medical Identity Theft embedded in this state of US PACS systems today is:

**$5,346,000,000**

This figure, like any risk estimate, is theoretical at first. Still it can also serve as an indicator and base for comparison to fines imposed on Medical Service Providers in recent data breaches.

### 2.3.2 India

The PACS servers located in India accounted for a substantial number of datasets in the first report, and these figures have increased for the named reasons (figures in brackets are from first reporting).

- 1.02 million studies (627,000)
- 121 million images related to those (105 million)
- a subset thereof, 114.7 million images are fully accessible (104 million)
- related to 904,000 studies
- 97 systems identified

- 20 news PACS servers have been found
- 19 are not available any longer, were taken offline

It is a notable fact for the systems located in India, that almost 100% of the studies allow full access to related images.

In addition to the data privacy rules contained in the Information Technology Act of 2000, India is preparing a new Data Privacy Bill[7]. The new bill foresees that the Data Privacy Authority of India will set standards for security safeguards.

The following table lists the details, as per affected state in India.

| India States | Studies | Images | Images accessible | Studies with image access | Systems per state |
|---|---|---|---|---|---|
| **Maharashtra** | 308.451 | 69.789.685 | 69.789.685 | 308.451 | 46 |
| **Karnataka** | 182.865 | 13.731.001 | 13.731.001 | 182.865 | 7 |
| **West Bengal** | 172.885 | 3.411.255 | 3.411.255 | 172.885 | 2 |
| **Telangana** | 126.160 | 5.997.360 | 110.160 | 7.344 | 3 |
| **Gujarat** | 111.408 | 13.997.757 | 13.997.757 | 111.408 | 19 |
| **Punjab** | 45.973 | 7.156.545 | 7.156.545 | 45.973 | 6 |
| **Delhi** | 40.709 | 2.105.605 | 2.105.605 | 40.709 | 4 |
| **Andhra Pradesh** | 17.302 | 446.870 | 446.870 | 17.302 | 2 |
| **Haryana** | 10.713 | 1.548.165 | 1.548.165 | 10.713 | 2 |
| **Uttar Pradesh** | 6.013 | 1.749.150 | 1.749.150 | 6.013 | 4 |
| **Madhya Pradesh** | 4.329 | 432.900 | - | - | 1 |
| **Chandigarh** | 1.121 | 672.600 | 672.600 | 1.121 | 1 |

[7] https://meity.gov.in/writereaddata/files/Personal_Data_Protection_Bill,2018.pdf

### 2.3.3 South Africa

South Africa ranked third for the number of studies in our initial report (2.3 million) and it still ranks 3rd in this revision. The details are:

- 2.46 million studies (2.3 million)
- 38.2 million images related to those (38.9 million)
- a subset thereof, 3.7 million images are fully accessible (4 million)
- 43 systems identified

- 8 news PACS servers have been found
- 9 are not available any longer, were taken offline

South Africa's regulation about data privacy, the Protection of Personal Information Act of 2013, covers this kind of data and states mandatory organizational and technical security safeguards (like risk management) and that those safeguards should be regularly verified and updated.[8]

For the regional, per South African state split, see table below.

| RSA States | Studies | Images | Images accessible | Studies with image access | Systems per state |
|---|---|---|---|---|---|
| **Gauteng** | 917.222 | 19.321.308 | 1.956.228 | 6.404 | 13 |
| **Free State** | 96.466 | 1.419.575 | - | - | 2 |
| **Limpopo** | 141.022 | 2.244.994 | 1.747.000 | 69.880 | 2 |
| **North-West** | 804.106 | 5.911.012 | - | - | 3 |
| **Western Cape** | 467.201 | 9.344.020 | - | - | 1 |

### 2.3.4 Brazil

The situation of PACS servers in Brazil didn't improve since our initial reporting. All figures increased by about 35% to 50%.

- 957,114 studies (643,892)
- 42.3 million images related to those (31.1 million)
- a subset thereof, 23.3 million images are fully accessible (15.1 million)
- related to 539,329 studies
- 35 systems identified

- 11 news PACS servers have been found
- 9 are not available any longer, were taken offline

The data protection law in Brazil is considered to be closely aligned with European Union's GDPR, but will only come into effect by August 2020[9]. Before that, it seems unlikely that the situation will improve.

[8] More information here: https://www.michalsons.com/blog/privacy-in-healthcare/8637
[9] https://www.dlapiperdataprotection.com/index.html?t=law&c=BR

The details per region are:

| BR States | Studies | Images | Images accessible | Studies with image access | Systems per state |
|---|---|---|---|---|---|
| **Bahia** | 18.824 | 752.960 | 752.960 | 18.824 | 1 |
| **Esperito Santo** | 61.049 | 3.711.008 | 3.548.936 | 31.379 | 4 |
| **Federal District** | 54.134 | 10.930.570 | 10.930.570 | 54.134 | 3 |
| **Goias** | 150.462 | 2.809.910 | 2.809.910 | 150.462 | 2 |
| **Mato Grosso** | 36.923 | 1.338.340 | 1.338.340 | 36.923 | 2 |
| **Parana** | 195.271 | 13.692.832 | 34.092 | 8.523 | 3 |
| **Piaui** | 2.146 | 1.663.150 | 1.663.150 | 2.146 | 1 |
| **Rio de Janeiro** | 164.439 | 5.055.435 | 5.055.435 | 164.439 | 8 |
| **Rio Grande do Sul** | 8.745 | 874.500 | 874.500 | 8.745 | 1 |
| **Sao Paulo** | 282.395 | 5.803.251 | 645.763 | 81.144 | 11 |
| **Tocantins** | 116 | 1.160 | - | - | 1 |

### 2.3.5 Ecuador

Ecuador's PACS servers were scrutinized more thoroughly with the extended capabilities we developed. That resulted in substantially higher numbers of studies and images compared to our initial count.

Ecuador has recently suffered the largest data breach in its history, affecting almost all citizens. That has led the Government and Ecuadorian lawmakers to propel a new data protection law[10] closely aligned to GDPR. Still, similar to Brazil, it is unlikely to see improvement before that law is in place.

- 866,823 studies (81,363)
- 13 million images related to those (5.3 million)
- a subset thereof, 7.5 million images are fully accessible (4.6 million)
- related to 210,309 studies
- 29 systems identified

- 11 news PACS servers have been found
- 1 is not available any longer, taken off net

[10] https://www.dataguidance.com/ecuador-data-protection-bill-resembles-the-gdpr-in-several-aspects/

Please refer to the details in the table below.

| Ecuador provinces | Studies | Images | Images accessible | Studies with image access | Systems per state |
|---|---|---|---|---|---|
| Azuay | 27.540 | 495.720 | 495.720 | 27.540 | 1 |
| Canar | 35.855 | 537.825 | 537.825 | 35.855 | 1 |
| Chimborazo | 10.831 | 108.310 | - | - | 1 |
| El Oro | 17.291 | 3.458.200 | 3.458.200 | 17.291 | 1 |
| Guayas | 646.048 | 6.593.487 | 1.931.736 | 65.282 | 14 |
| Loja | 38.086 | 457.032 | 457.032 | 38.086 | 1 |
| Manabi | 1.284 | 513.600 | - | - | 1 |
| Pichincha | 88.249 | 797.919 | 555.814 | 24.616 | 8 |
| Santo Domingo d.l.T. | 1.639 | 122.925 | 122.925 | 1.639 | 1 |

# 3 Recommended Actions

The following is an attempt to derive a list of recommended actions for each of the involved parties. It is obvious that those recommendations don't lead to immediate resolution and also have the character of a plea.

## 3.1 Hospitals, clinics, and service providers

Much has been written about what hospitals, clinics, and medical service providers in the various regions of the world have to do related to information security and data privacy. Several regulations exist, HIPAA being one of them. Still there are a few things a member of this group can do to improve the situation around PACS servers or any medical device connected to the internet.

- Establish a comprehensive list of public facing IP addresses of your organization and maintain that list all time.
- Regularly check whether any of your IP addresses is listed in public repositories like Shodan or Censys.
- Submit you public IP addresses to regular, frequent vulnerability assessments, not only to identify vulnerabilities but also unknown/unwanted services exposed to the public Internet.
- If you maintain public WIFI areas, scan them and scan your IP address ranges from that network location.

Whatever you do about your IT infrastructure, be transparent about it. Patients will start to prefer those who have a clear position about the privacy and protection of their data.

## 3.2 Physicians

Physicians quite often use medical service provider and specialized colleagues, and refer their patients to them. The results of the specific examinations rendered by these specialists are in some form transferred back or made available to the referring physician, who can do the following:

- If you are provided with the examination results in an electronic form, check whether access is gated and the data is encrypted.
- If not, ask why. Make sure your supplier accepts your preference.
- Document your own approach to data privacy and information security, be precise about the steps and measure, and be transparent about them.

Tell your patients about these actions, as it will their build trust in you.

## 3.3 Individual patients

For patients it is usually difficult to verify the measures taken by the chain of medical service providers they face. What they can do is to be clear about their expectations about data protection and privacy.

- Ask your doctor about their data protection regime, what they do precisely.
- In case you get the generic answer (We do what is required by law), demand further details like how often do they verify their IT security and data privacy posture.
- You might not get good or immediate responses, but the same question asked by many again and again will lead to an improvement.

The following paragraphs are the same as in our previous reporting. They are repeated in this report for the ease of any new reader to get additional background information.

# 4 Attack scenarios (reminder)

The possible attack scenarios are manifold. Since it concerns personal data, all kinds of attacks are conceivable that exploit this data:

- Social Engineering
- Spear Fishing / Whaling
- Business Email Compromise

In addition, the intersection of these data with other sources (already leaked data sets) is another use to prepare even more targeted attacks. Extortion attempts are conceivable, as is identity theft (the US data also partly contains the Social Security Number).

The US Department of Health (HHS) has listed a number of scenarios that exploit patient data:

*„Medical Identity Theft“*

The use of another person's medical information to obtain a medical service, which includes

- Medical prescriptions
- Surgery or other medical treatment
- Counterfeit settlements against health insurers

*“Weaponizing of Medical Data”*

The use of sensitive medical data to threaten, extort, or influence individuals, in order to:

- to extort money
- to disparage someone by false or real additional data
- in particular people in public life are at risk
  (In our research we did not search for names of VIPs in the data)

*„Financial Fraud“*

Use of Personally Identifiable Information (PII) contained in electronic medical records to create credit card or bank profiles to facilitate financial fraud.

- Medical service providers often store financial information on patient data
  (We have seen billing information references in the data)
- Loans and credit lines are often linked to health data found in patient files.
- Tax fraud through false billing

*“Cyber Campaigns”*

Medical data will be used as complementary data in other future hacking campaigns.

- Contact information that can be used for phishing or scams (CEO Fraud, see above).
- Credential/Authentication information that can be used for a privilege escalation.
  (We have not searched for such information in the data)

Within the mass of data and personal information, a number of groups are particularly vulnerable because their exploitation can remain unnoticed for years.

- Children and adolescents whose data is used for identity theft. These can be easily identified in the data found by the date of birth.
- Old people, combined with the assumption that they are an easier target ("age-associated financial vulnerability"). This group can be identified e.g. by the name of the institute that is present in the data found (e.g. "Senior Care").
- Deceased persons or presumed dead. Based on the date of birth, data is filtered for persons in old age. Here the expected detection rate is very low.

# 5 Remediation (reminder)

Since this is a faulty configuration of the infrastructure and the PACS server and not a software vulnerability, there are also possibilities for remedying or eliminating it. These are:

- Access Control Lists (ACLs) for IP-addresses and/or port filters
- Access control through the implementation of AAA systems
- VPN access for selected persons, institutions
- Detailed configuration of AE-titles

These possible measures are suitable to make the free access to the found systems more difficult or to prevent it. In doing so, it is certainly important to consider which authorized authorities must have access to the data (hospital associations or general practitioners).

The respective individual case will limit the available possibilities. However, according to our observations, there is no case in which a higher degree of security is impossible.

A comprehensive and repeated inventory of IT systems and their vulnerabilities within an organization is the best way to uncover such flawed configurations.

# 6 Modus operandi (reminder & expansion)

Various sources were used to identify PACS servers worldwide, including the well-known sources Shodan.io and Censys.io. The basic data consisted of a list of about 2,300 IP addresses and port numbers of the DICOM protocol.

The DICOM protocol uses ports 104/TCP and 11112/TCP as standard for communication between DICOM-enabled applications. This involves the loading of image data and patient information into the archive system by imaging devices (X-ray, CT, MRT) and the reading retrieval of this data e.g. by the treating physician.

*The expanded capabilities include other ports used by the DICOM protocol and tuned discovery features.*

The DICOM protocol or format is of essential importance in this analysis and is described as follows in the English standard:

*"DICOM (Digital Imaging and Communications in Medicine) is a standard for handling, storing, printing, and transmitting information in medical imaging. It includes a file format definition and a network communications protocol. The communication protocol is an application protocol that uses TCP/IP to communicate between systems. DICOM files can be exchanged between two entities that are capable of receiving image and patient data in DICOM format."*

For this security report only the use case 'reading access' was of interest, a manipulation of image data and the subsequent upload was not investigated.

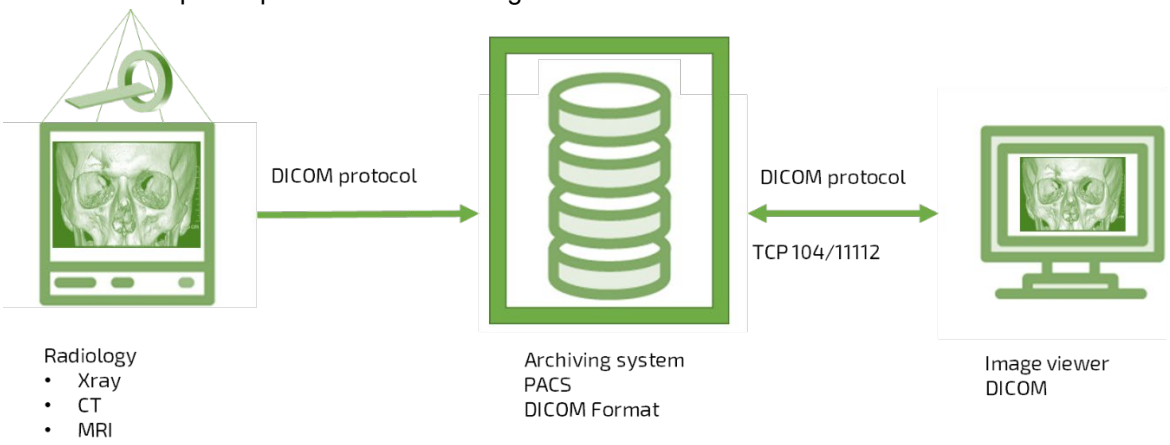



**Figure 1: Image 1: Sketched procedures in DICOM protocol / format**

In accordance with the C-I-A Triad (Confidentiality-Integrity-Availability), this report deals only with the confidentiality of the data. This is definitely not guaranteed.

The Radiant DICOM Viewer was used to illustrate how easy it is to read this medical data. Other tools are not needed to understand how the data works. The Radiant DICOM Viewer is sufficiently documented on the Internet to enable even an Internet-savvy beginner to configure the application itself. To configure the viewer, the server parameters IP and Port are required (see Shodan / Censys) and two further specifications, the contents of which can be selected completely arbitrarily (ae-title and description).

Once the configuration is complete, the viewer can be used to check whether the PACS is sending data or whether other protective measures have been taken (which was the case for around 1,700 of the systems checked).

If no further protective measures are available, the PACS sends the patient data to the viewer. In addition, the viewer also allows the images to be viewed, although there may be a limitation (possibly a question of image compression, not subject to analysis).

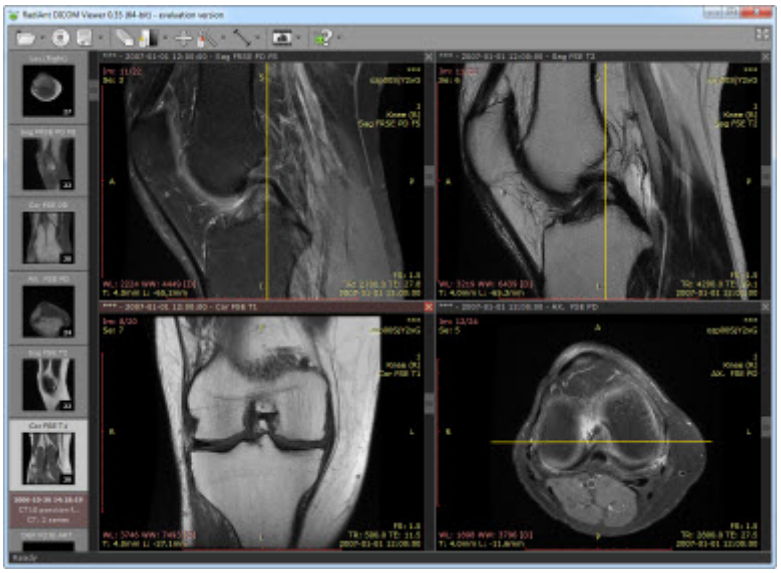


**Figure 2: Radiant DICOM Viewer Content**
**(Source: https://commons.wikimedia.org/wiki/File:RadiAnt_DICOM_Viewer.jpg)**

As soon as the viewer receives the data, the individual patient data are displayed and counted in a table. This was used for the analysis to determine the number of affected patient records.

For each individual data record, there is almost always information on the number of medical images linked to the data record. This listing of all data records was averaged and multiplied by the number of data records to obtain an estimate of the number of images in the archive system.

From the first elements of the list, an entry was randomly selected to verify the actual access to the image data. As soon as a stable data stream in the viewer indicated that image information was being transferred, this was aborted. In some cases, however, the image transmission was so fast that patient images were also displayed.

The following data points were collected for analysis:

- Number of patient files (called Viewer Studies in DICOM),
- Total number of images on the PACS server,
- Data timeliness (e.g. patient data from AUG/SEP 2019 // NOV 2019)
- Access to images allowed/possible
- Human or veterinary medical archives

In the further course of the analysis, the IP addresses were also scanned with a vulnerability scan and this was added as an additional data point (high severity vulnerabilities).

The evaluation of the vulnerability scan revealed some indications of compromising systems, this information was also added as a data point.

In addition to the actual analysis, page findings were checked, e.g. references to freely downloadable DICOM archives or web apps that allow uncontrolled access to patient data.

# 7 Attachments

The following documents about the details are provided only on request and only to organizations with legitimate interest. These include in particular the data protection authorities of the countries concerned, who can contact security@greenbone.net .

- File „DICOM details per system, updated”

## 7.1 Listings

The following listings are attached to this document.

- Results for US states and territories (by state/territory, alphabetical)
- Results sorted by country (alphabetical, ascending A-Z)
- Results sorted by systems (numbers, descending)
- Results sorted by studies (numbers, descending)
- Results sorted by linked images (numbers, descending)
- Results sorted by retrievable images (numbers, descending)
- Updated status of HIPAA Characteristics for PHI included in the findings

Results for US states and territories (by state/territory, alphabetical)

| US States & Territories | Studies | Images | Images accessible | Studies with image access | Systems per state |
|---|---|---|---|---|---|
| Alabama | 685.428 | 27.079.464 | 0 | 0 | 4 |
| Alaska | 7.416 | 296.640 | 296.640 | 7.416 | 1 |
| Arizona | 1.181.916 | 10.992.636 | 0 | 0 | 2 |
| Arkansas | 67.884 | 2.647.714 | 0 | 0 | 2 |
| California | 2.732.667 | 78.552.989 | 7.425.310 | 54.675 | 19 |
| Colorado | 147.978 | 591.912 | 0 | 0 | 2 |
| Delaware | 107.575 | 3.227.250 | 3.227.250 | 107.575 | 1 |
| Florida | 4.746.216 | 322.386.502 | 1.798.508 | 42.284 | 32 |
| Georgia | 529.895 | 5.298.389 | 4.010.760 | 84.216 | 12 |
| Hawaii | 4.514 | 180.560 | 180.560 | 4.514 | 1 |
| Illinois | 658.329 | 21.666.845 | 597.168 | 1.131 | 6 |
| Kentucky | 364.625 | 4.494.998 | 0 | 0 | 3 |
| Massachusetts | 29.437 | 117.748 | 0 | 0 | 1 |
| Michigan | 505.832 | 3.841.656 | 0 | 0 | 8 |
| Mississippi | 209.668 | 8.386.720 | 0 | 0 | 1 |
| Missouri | 105.595 | 316.875 | 0 | 0 | 2 |
| Nevada | 43.425 | 3.587.250 | 0 | 0 | 2 |
| New Hampshire | 550.179 | 3.851.253 | 0 | 0 | 1 |
| New Jersey | 1.098.121 | 54.559.030 | 159.300 | 1.593 | 13 |
| New Mexico | 91.792 | 367.168 | 0 | 0 | 1 |
| New York | 3.884.277 | 129.302.867 | 64.526.424 | 1.299.780 | 22 |
| North Carolina | 3.364 | 147.954 | 140.980 | 2.014 | 4 |
| Ohio | 486.471 | 7.743.506 | 0 | 0 | 4 |
| Oklahoma | 13.742 | 54.968 | 0 | 0 | 1 |
| Pennsylvania | 126.314 | 629.050 | 0 | 0 | 2 |
| Texas | 2.246.960 | 48.316.596 | 0 | 0 | 17 |
| Utah | 359.812 | 8.166.587 | 0 | 0 | 2 |
| Virginia | 161.163 | 1.532.196 | 0 | 0 | 3 |
| Wisconsin | 117.945 | 5.219.460 | 4.036.860 | 19.395 | 4 |
| Z- Puerto Rico | 448.066 | 9.277.843 | 9.277.843 | 448.066 | 19 |
| Z- unassigned | 236.557 | 2.238.282 | 721.798 | 31.210 | 10 |
| Z- US Virgin | 169.979 | 3.399.580 | 0 | 0 | 1 |

Results sorted by country (alphabetical, ascending A-Z)

| Countries | new system | systems gone | systems with acces | Studies | Images | Images accessible | Studies with image acces |
|---|---|---|---|---|---|---|---|
| Albania | 0 | 0 | 1 | 428 | 2140 | 0 | 0 |
| Anguilla | 0 | 0 | 1 | 3258 | 48870 | 0 | 0 |
| Argentina | 1 | 2 | 9 | 143751 | 431253 | 0 | 0 |
| Australia | 0 | 3 | 3 | 42601 | 1011280 | 914280 | 30476 |
| Azerbaijan | 0 | 0 | 1 | 65146 | 19543800 | 0 | 0 |
| Bolivia | 2 | 2 | 2 | 12341 | 75715 | 75715 | 12341 |
| Brazil | 11 | 9 | 35 | 957114 | 42300616 | 23321156 | 539329 |
| Bulgaria | 0 | 2 | 0 | 899 | 23150 | 22050 | 49 |
| Canada | 1 | 2 | 4 | 167704 | 6708665 | 0 | 0 |
| Chile | 3 | 3 | 18 | 404978 | 8269597 | 4103929 | 96588 |
| China | 2 | 9 | 7 | 371630 | 19187071 | 317460 | 63492 |
| Colombia | 2 | 2 | 8 | 74477 | 2046078 | 2045614 | 74245 |
| Costa Rica | 0 | 0 | 1 | 2193 | 13158 | 13158 | 2193 |
| Cyprus | 0 | 0 | 1 | 3774 | 1226550 | 1226550 | 3774 |
| Czech Republic | 0 | 1 | 1 | 21977 | 65931 | 0 | 0 |
| Ecuador | 11 | 1 | 29 | 866823 | 13085018 | 7559252 | 210309 |
| Egypt | 0 | 0 | 2 | 1483 | 405725 | 405625 | 1475 |
| Ethopia | 0 | 0 | 1 | 328 | 984 | 984 | 328 |
| France | 2 | 2 | 7 | 109557 | 7001993 | 3041113 | 59347 |
| Guatemala | 0 | 1 | 3 | 10026 | 858242 | 858242 | 10026 |
| Hungary | 0 | 0 | 2 | 15419 | 351756 | 0 | 0 |
| India | 20 | 19 | 97 | 1027929 | 121038893 | 114718793 | 904784 |
| Iran | 1 | 0 | 3 | 123948 | 2373398 | 2218098 | 122395 |
| Italy | 1 | 6 | 6 | 110179 | 6005078 | 1003550 | 4111 |
| Jamaica | 0 | 0 | 1 | 657 | 98550 | 0 | 0 |
| Japan | 0 | 0 | 3 | 7169 | 1141700 | 1141100 | 6869 |
| Kazakhstan | 0 | 0 | 1 | 4579 | 870010 | 0 | 0 |
| Kenya | 0 | 0 | 1 | 92 | 5520 | 0 | 0 |
| Korea | 0 | 0 | 2 | 30947 | 162746 | 0 | 0 |
| Mexico | 1 | 4 | 7 | 29667 | 874207 | 196081 | 7920 |
| Netherlands Antilles | 0 | 0 | 1 | 14349 | 286980 | 286980 | 14349 |
| Pakistan | 0 | 0 | 1 | 1543 | 3086 | 3086 | 1543 |
| Paraguay | 0 | 0 | 1 | 24619 | 2338805 | 2338805 | 24619 |
| Peru | 1 | 0 | 3 | 27021 | 651061 | 606375 | 2475 |
| Puerto Rico | 1 | 4 | 20 | 461816 | 9827843 | 9827843 | 461816 |
| Reunion | 0 | 0 | 1 | 216030 | 1512210 | 0 | 0 |
| Romania | 0 | 0 | 1 | 72 | 864 | 0 | 0 |
| Russian Federation | 0 | 3 | 2 | 17268 | 1172685 | 1172685 | 17268 |
| Sao Tome and Principe | 0 | 0 | 1 | 13927 | 167124 | 0 | 0 |
| South Africa | 0 | 2 | 28 | 2426017 | 38240909 | 3703228 | 76284 |
| Spain | 1 | 1 | 1 | 56446 | 2822300 | 0 | 0 |
| Switzerland | 0 | 1 | 1 | 660 | 66000 | 66000 | 660 |
| Tunisia | 0 | 0 | 6 | 215406 | 14668224 | 370750 | 7415 |
| Turkey | 8 | 9 | 35 | 5117161 | 75111576 | 70642954 | 4504440 |
| Ukraine | 0 | 0 | 1 | 1229 | 307250 | 307250 | 1229 |
| United States | 60 | 49 | 195 | 21812977 | 786631095 | 114548098 | 1783704 |
| Uruguay | 0 | 0 | 1 | 2220 | 721500 | 721500 | 2220 |
| Uzbekistan | 0 | 0 | 1 | 42572 | 3618620 | 3618620 | 42572 |
| Vanuatu | 0 | 0 | 1 | 2029 | 2029 | 2029 | 2029 |
| Vietnam | 0 | 0 | 1 | 26785 | 26785 | 0 | 0 |

Results sorted by systems (numbers, descending)

| Countries | new system | systems gone | systems with acces | Studies | Images | Images accessible | Studies with image acces |
|---|---|---|---|---|---|---|---|
| United States | 60 | 49 | 195 | 21812977 | 786631095 | 114548098 | 1783704 |
| India | 20 | 19 | 97 | 1027929 | 121038893 | 114718793 | 904784 |
| Brazil | 11 | 9 | 35 | 957114 | 42300616 | 23321156 | 539329 |
| Turkey | 8 | 9 | 35 | 5117161 | 75111576 | 70642954 | 4504440 |
| Ecuador | 11 | 1 | 29 | 866823 | 13085018 | 7559252 | 210309 |
| South Africa | 0 | 2 | 28 | 2426017 | 38240909 | 3703228 | 76284 |
| Puerto Rico | 1 | 4 | 20 | 461816 | 9827843 | 9827843 | 461816 |
| Chile | 3 | 3 | 18 | 404978 | 8269597 | 4103929 | 96588 |
| Argentina | 1 | 2 | 9 | 143751 | 431253 | 0 | 0 |
| Colombia | 2 | 2 | 8 | 74477 | 2046078 | 2045614 | 74245 |
| China | 2 | 9 | 7 | 371630 | 19187071 | 317460 | 63492 |
| France | 2 | 2 | 7 | 109557 | 7001993 | 3041113 | 59347 |
| Mexico | 1 | 4 | 7 | 29667 | 874207 | 196081 | 7920 |
| Italy | 1 | 6 | 6 | 110179 | 6005078 | 1003550 | 4111 |
| Tunisia | 0 | 0 | 6 | 215406 | 14668224 | 370750 | 7415 |
| Canada | 1 | 2 | 4 | 167704 | 6708665 | 0 | 0 |
| Australia | 0 | 3 | 3 | 42601 | 1011280 | 914280 | 30476 |
| Guatemala | 0 | 1 | 3 | 10026 | 858242 | 858242 | 10026 |
| Iran | 1 | 0 | 3 | 123948 | 2373398 | 2218098 | 122395 |
| Japan | 0 | 0 | 3 | 7169 | 1141700 | 1141100 | 6869 |
| Peru | 1 | 0 | 3 | 27021 | 651061 | 606375 | 2475 |
| Bolivia | 2 | 2 | 2 | 12341 | 75715 | 75715 | 12341 |
| Egypt | 0 | 0 | 2 | 1483 | 405725 | 405625 | 1475 |
| Hungary | 0 | 0 | 2 | 15419 | 351756 | 0 | 0 |
| Korea | 0 | 0 | 2 | 30947 | 162746 | 0 | 0 |
| Russian Federation | 0 | 3 | 2 | 17268 | 1172685 | 1172685 | 17268 |
| Albania | 0 | 0 | 1 | 428 | 2140 | 0 | 0 |
| Anguilla | 0 | 0 | 1 | 3258 | 48870 | 0 | 0 |
| Azerbaijan | 0 | 0 | 1 | 65146 | 19543800 | 0 | 0 |
| Costa Rica | 0 | 0 | 1 | 2193 | 13158 | 13158 | 2193 |
| Cyprus | 0 | 0 | 1 | 3774 | 1226550 | 1226550 | 3774 |
| Czech Republic | 0 | 1 | 1 | 21977 | 65931 | 0 | 0 |
| Ethopia | 0 | 0 | 1 | 328 | 984 | 984 | 328 |
| Jamaica | 0 | 0 | 1 | 657 | 98550 | 0 | 0 |
| Kazakhstan | 0 | 0 | 1 | 4579 | 870010 | 0 | 0 |
| Kenya | 0 | 0 | 1 | 92 | 5520 | 0 | 0 |
| Netherlands Antilles | 0 | 0 | 1 | 14349 | 286980 | 286980 | 14349 |
| Pakistan | 0 | 0 | 1 | 1543 | 3086 | 3086 | 1543 |
| Paraguay | 0 | 0 | 1 | 24619 | 2338805 | 2338805 | 24619 |
| Reunion | 0 | 0 | 1 | 216030 | 1512210 | 0 | 0 |
| Romania | 0 | 0 | 1 | 72 | 864 | 0 | 0 |
| Sao Tome and Principe | 0 | 0 | 1 | 13927 | 167124 | 0 | 0 |
| Spain | 1 | 1 | 1 | 56446 | 2822300 | 0 | 0 |
| Switzerland | 0 | 1 | 1 | 660 | 66000 | 66000 | 660 |
| Ukraine | 0 | 0 | 1 | 1229 | 307250 | 307250 | 1229 |
| Uruguay | 0 | 0 | 1 | 2220 | 721500 | 721500 | 2220 |
| Uzbekistan | 0 | 0 | 1 | 42572 | 3618620 | 3618620 | 42572 |
| Vanuatu | 0 | 0 | 1 | 2029 | 2029 | 2029 | 2029 |
| Vietnam | 0 | 0 | 1 | 26785 | 26785 | 0 | 0 |
| Bulgaria | 0 | 2 | 0 | 899 | 23150 | 22050 | 49 |

Results sorted by studies (numbers, descending)

| Countries | new system | systems gone | systems with acces | Studies | Images | Images accessible | Studies with image acces |
|---|---|---|---|---|---|---|---|
| United States | 60 | 49 | 195 | 21812977 | 786631095 | 114548098 | 1783704 |
| Turkey | 8 | 9 | 35 | 5117161 | 75111576 | 70642954 | 4504440 |
| South Africa | 0 | 2 | 28 | 2426017 | 38240909 | 3703228 | 76284 |
| India | 20 | 19 | 97 | 1027929 | 121038893 | 114718793 | 904784 |
| Brazil | 11 | 9 | 35 | 957114 | 42300616 | 23321156 | 539329 |
| Ecuador | 11 | 1 | 29 | 866823 | 13085018 | 7559252 | 210309 |
| Puerto Rico | 1 | 4 | 20 | 461816 | 9827843 | 9827843 | 461816 |
| Chile | 3 | 3 | 18 | 404978 | 8269597 | 4103929 | 96588 |
| China | 2 | 9 | 7 | 371630 | 19187071 | 317460 | 63492 |
| Reunion | 0 | 0 | 1 | 216030 | 1512210 | 0 | 0 |
| Tunisia | 0 | 0 | 6 | 215406 | 14668224 | 370750 | 7415 |
| Canada | 1 | 2 | 4 | 167704 | 6708665 | 0 | 0 |
| Argentina | 1 | 2 | 9 | 143751 | 431253 | 0 | 0 |
| Iran | 1 | 0 | 3 | 123948 | 2373398 | 2218098 | 122395 |
| Italy | 1 | 6 | 6 | 110179 | 6005078 | 1003550 | 4111 |
| France | 2 | 2 | 7 | 109557 | 7001993 | 3041113 | 59347 |
| Colombia | 2 | 2 | 8 | 74477 | 2046078 | 2045614 | 74245 |
| Azerbaijan | 0 | 0 | 1 | 65146 | 19543800 | 0 | 0 |
| Spain | 1 | 1 | 1 | 56446 | 2822300 | 0 | 0 |
| Australia | 0 | 3 | 3 | 42601 | 1011280 | 914280 | 30476 |
| Uzbekistan | 0 | 0 | 1 | 42572 | 3618620 | 3618620 | 42572 |
| Korea | 0 | 0 | 2 | 30947 | 162746 | 0 | 0 |
| Mexico | 1 | 4 | 7 | 29667 | 874207 | 196081 | 7920 |
| Peru | 1 | 0 | 3 | 27021 | 651061 | 606375 | 2475 |
| Vietnam | 0 | 0 | 1 | 26785 | 26785 | 0 | 0 |
| Paraguay | 0 | 0 | 1 | 24619 | 2338805 | 2338805 | 24619 |
| Czech Republic | 0 | 1 | 1 | 21977 | 65931 | 0 | 0 |
| Russian Federation | 0 | 3 | 2 | 17268 | 1172685 | 1172685 | 17268 |
| Hungary | 0 | 0 | 2 | 15419 | 351756 | 0 | 0 |
| Netherlands Antilles | 0 | 0 | 1 | 14349 | 286980 | 286980 | 14349 |
| Sao Tome and Principe | 0 | 0 | 1 | 13927 | 167124 | 0 | 0 |
| Bolivia | 2 | 2 | 2 | 12341 | 75715 | 75715 | 12341 |
| Guatemala | 0 | 1 | 3 | 10026 | 858242 | 858242 | 10026 |
| Japan | 0 | 0 | 3 | 7169 | 1141700 | 1141100 | 6869 |
| Kazakhstan | 0 | 0 | 1 | 4579 | 870010 | 0 | 0 |
| Cyprus | 0 | 0 | 1 | 3774 | 1226550 | 1226550 | 3774 |
| Anguilla | 0 | 0 | 1 | 3258 | 48870 | 0 | 0 |
| Uruguay | 0 | 0 | 1 | 2220 | 721500 | 721500 | 2220 |
| Costa Rica | 0 | 0 | 1 | 2193 | 13158 | 13158 | 2193 |
| Vanuatu | 0 | 0 | 1 | 2029 | 2029 | 2029 | 2029 |
| Pakistan | 0 | 0 | 1 | 1543 | 3086 | 3086 | 1543 |
| Egypt | 0 | 0 | 2 | 1483 | 405725 | 405625 | 1475 |
| Ukraine | 0 | 0 | 1 | 1229 | 307250 | 307250 | 1229 |
| Bulgaria | 0 | 2 | 0 | 899 | 23150 | 22050 | 49 |
| Switzerland | 0 | 1 | 1 | 660 | 66000 | 66000 | 660 |
| Jamaica | 0 | 0 | 1 | 657 | 98550 | 0 | 0 |
| Albania | 0 | 0 | 1 | 428 | 2140 | 0 | 0 |
| Ethopia | 0 | 0 | 1 | 328 | 984 | 984 | 328 |
| Kenya | 0 | 0 | 1 | 92 | 5520 | 0 | 0 |
| Romania | 0 | 0 | 1 | 72 | 864 | 0 | 0 |

Results sorted by linked images (numbers, descending)

| Countries | new system | systems gone | systems with acces | Studies | Images | Images accessible | Studies with image acces |
|---|---|---|---|---|---|---|---|
| United States | 60 | 49 | 195 | 21812977 | 786631095 | 114548098 | 1783704 |
| India | 20 | 19 | 97 | 1027929 | 121038893 | 114718793 | 904784 |
| Turkey | 8 | 9 | 35 | 5117161 | 75111576 | 70642954 | 4504440 |
| Brazil | 11 | 9 | 35 | 957114 | 42300616 | 23321156 | 539329 |
| South Africa | 0 | 2 | 28 | 2426017 | 38240909 | 3703228 | 76284 |
| Azerbaijan | 0 | 0 | 1 | 65146 | 19543800 | 0 | 0 |
| China | 2 | 9 | 7 | 371630 | 19187071 | 317460 | 63492 |
| Tunisia | 0 | 0 | 6 | 215406 | 14668224 | 370750 | 7415 |
| Ecuador | 11 | 1 | 29 | 866823 | 13085018 | 7559252 | 210309 |
| Puerto Rico | 1 | 4 | 20 | 461816 | 9827843 | 9827843 | 461816 |
| Chile | 3 | 3 | 18 | 404978 | 8269597 | 4103929 | 96588 |
| France | 2 | 2 | 7 | 109557 | 7001993 | 3041113 | 59347 |
| Canada | 1 | 2 | 4 | 167704 | 6708665 | 0 | 0 |
| Italy | 1 | 6 | 6 | 110179 | 6005078 | 1003550 | 4111 |
| Uzbekistan | 0 | 0 | 1 | 42572 | 3618620 | 3618620 | 42572 |
| Spain | 1 | 1 | 1 | 56446 | 2822300 | 0 | 0 |
| Iran | 1 | 0 | 3 | 123948 | 2373398 | 2218098 | 122395 |
| Paraguay | 0 | 0 | 1 | 24619 | 2338805 | 2338805 | 24619 |
| Colombia | 2 | 2 | 8 | 74477 | 2046078 | 2045614 | 74245 |
| Reunion | 0 | 0 | 1 | 216030 | 1512210 | 0 | 0 |
| Cyprus | 0 | 0 | 1 | 3774 | 1226550 | 1226550 | 3774 |
| Russian Federation | 0 | 3 | 2 | 17268 | 1172685 | 1172685 | 17268 |
| Japan | 0 | 0 | 3 | 7169 | 1141700 | 1141100 | 6869 |
| Australia | 0 | 3 | 3 | 42601 | 1011280 | 914280 | 30476 |
| Mexico | 1 | 4 | 7 | 29667 | 874207 | 196081 | 7920 |
| Kazakhstan | 0 | 0 | 1 | 4579 | 870010 | 0 | 0 |
| Guatemala | 0 | 1 | 3 | 10026 | 858242 | 858242 | 10026 |
| Uruguay | 0 | 0 | 1 | 2220 | 721500 | 721500 | 2220 |
| Peru | 1 | 0 | 3 | 27021 | 651061 | 606375 | 2475 |
| Argentina | 1 | 2 | 9 | 143751 | 431253 | 0 | 0 |
| Egypt | 0 | 0 | 2 | 1483 | 405725 | 405625 | 1475 |
| Hungary | 0 | 0 | 2 | 15419 | 351756 | 0 | 0 |
| Ukraine | 0 | 0 | 1 | 1229 | 307250 | 307250 | 1229 |
| Netherlands Antilles | 0 | 0 | 1 | 14349 | 286980 | 286980 | 14349 |
| Sao Tome and Principe | 0 | 0 | 1 | 13927 | 167124 | 0 | 0 |
| Korea | 0 | 0 | 2 | 30947 | 162746 | 0 | 0 |
| Jamaica | 0 | 0 | 1 | 657 | 98550 | 0 | 0 |
| Bolivia | 2 | 2 | 2 | 12341 | 75715 | 75715 | 12341 |
| Switzerland | 0 | 1 | 1 | 660 | 66000 | 66000 | 660 |
| Czech Republic | 0 | 1 | 1 | 21977 | 65931 | 0 | 0 |
| Anguilla | 0 | 0 | 1 | 3258 | 48870 | 0 | 0 |
| Vietnam | 0 | 0 | 1 | 26785 | 26785 | 0 | 0 |
| Bulgaria | 0 | 2 | 0 | 899 | 23150 | 22050 | 49 |
| Costa Rica | 0 | 0 | 1 | 2193 | 13158 | 13158 | 2193 |
| Kenya | 0 | 0 | 1 | 92 | 5520 | 0 | 0 |
| Pakistan | 0 | 0 | 1 | 1543 | 3086 | 3086 | 1543 |
| Albania | 0 | 0 | 1 | 428 | 2140 | 0 | 0 |
| Vanuatu | 0 | 0 | 1 | 2029 | 2029 | 2029 | 2029 |
| Ethopia | 0 | 0 | 1 | 328 | 984 | 984 | 328 |
| Romania | 0 | 0 | 1 | 72 | 864 | 0 | 0 |

Results sorted by retrievable images (numbers, descending)

| Countries | new system | systems gone | systems with acces | Studies | Images | Images accessible | Studies with image acces |
|---|---|---|---|---|---|---|---|
| India | 20 | 19 | 97 | 1027929 | 121038893 | 114718793 | 904784 |
| United States | 60 | 49 | 195 | 21812977 | 786631095 | 114548098 | 1783704 |
| Turkey | 8 | 9 | 35 | 5117161 | 75111576 | 70642954 | 4504440 |
| Brazil | 11 | 9 | 35 | 957114 | 42300616 | 23321156 | 539329 |
| Puerto Rico | 1 | 4 | 20 | 461816 | 9827843 | 9827843 | 461816 |
| Ecuador | 11 | 1 | 29 | 866823 | 13085018 | 7559252 | 210309 |
| Chile | 3 | 3 | 18 | 404978 | 8269597 | 4103929 | 96588 |
| South Africa | 0 | 2 | 28 | 2426017 | 38240909 | 3703228 | 76284 |
| Uzbekistan | 0 | 0 | 1 | 42572 | 3618620 | 3618620 | 42572 |
| France | 2 | 2 | 7 | 109557 | 7001993 | 3041113 | 59347 |
| Paraguay | 0 | 0 | 1 | 24619 | 2338805 | 2338805 | 24619 |
| Iran | 1 | 0 | 3 | 123948 | 2373398 | 2218098 | 122395 |
| Colombia | 2 | 2 | 8 | 74477 | 2046078 | 2045614 | 74245 |
| Cyprus | 0 | 0 | 1 | 3774 | 1226550 | 1226550 | 3774 |
| Russian Federation | 0 | 3 | 2 | 17268 | 1172685 | 1172685 | 17268 |
| Japan | 0 | 0 | 3 | 7169 | 1141700 | 1141100 | 6869 |
| Italy | 1 | 6 | 6 | 110179 | 6005078 | 1003550 | 4111 |
| Australia | 0 | 3 | 3 | 42601 | 1011280 | 914280 | 30476 |
| Guatemala | 0 | 1 | 3 | 10026 | 858242 | 858242 | 10026 |
| Uruguay | 0 | 0 | 1 | 2220 | 721500 | 721500 | 2220 |
| Peru | 1 | 0 | 3 | 27021 | 651061 | 606375 | 2475 |
| Egypt | 0 | 0 | 2 | 1483 | 405725 | 405625 | 1475 |
| Tunisia | 0 | 0 | 6 | 215406 | 14668224 | 370750 | 7415 |
| China | 2 | 9 | 7 | 371630 | 19187071 | 317460 | 63492 |
| Ukraine | 0 | 0 | 1 | 1229 | 307250 | 307250 | 1229 |
| Netherlands Antilles | 0 | 0 | 1 | 14349 | 286980 | 286980 | 14349 |
| Mexico | 1 | 4 | 7 | 29667 | 874207 | 196081 | 7920 |
| Bolivia | 2 | 2 | 2 | 12341 | 75715 | 75715 | 12341 |
| Switzerland | 0 | 1 | 1 | 660 | 66000 | 66000 | 660 |
| Bulgaria | 0 | 2 | 0 | 899 | 23150 | 22050 | 49 |
| Costa Rica | 0 | 0 | 1 | 2193 | 13158 | 13158 | 2193 |
| Pakistan | 0 | 0 | 1 | 1543 | 3086 | 3086 | 1543 |
| Vanuatu | 0 | 0 | 1 | 2029 | 2029 | 2029 | 2029 |
| Ethopia | 0 | 0 | 1 | 328 | 984 | 984 | 328 |
| Azerbaijan | 0 | 0 | 1 | 65146 | 19543800 | 0 | 0 |
| Canada | 1 | 2 | 4 | 167704 | 6708665 | 0 | 0 |
| Spain | 1 | 1 | 1 | 56446 | 2822300 | 0 | 0 |
| Reunion | 0 | 0 | 1 | 216030 | 1512210 | 0 | 0 |
| Kazakhstan | 0 | 0 | 1 | 4579 | 870010 | 0 | 0 |
| Argentina | 1 | 2 | 9 | 143751 | 431253 | 0 | 0 |
| Hungary | 0 | 0 | 2 | 15419 | 351756 | 0 | 0 |
| Sao Tome and Principe | 0 | 0 | 1 | 13927 | 167124 | 0 | 0 |
| Korea | 0 | 0 | 2 | 30947 | 162746 | 0 | 0 |
| Jamaica | 0 | 0 | 1 | 657 | 98550 | 0 | 0 |
| Czech Republic | 0 | 1 | 1 | 21977 | 65931 | 0 | 0 |
| Anguilla | 0 | 0 | 1 | 3258 | 48870 | 0 | 0 |
| Vietnam | 0 | 0 | 1 | 26785 | 26785 | 0 | 0 |
| Kenya | 0 | 0 | 1 | 92 | 5520 | 0 | 0 |
| Albania | 0 | 0 | 1 | 428 | 2140 | 0 | 0 |
| Romania | 0 | 0 | 1 | 72 | 864 | 0 | 0 |

Results sorted by studies with retrievable images (number, descending)

| Countries | new system | systems gone | systems with acces | Studies | Images | Images accessible | Studies with image acces |
|---|---|---|---|---|---|---|---|
| Turkey | 8 | 9 | 35 | 5117161 | 75111576 | 70642954 | 4504440 |
| United States | 60 | 49 | 195 | 21812977 | 786631095 | 114548098 | 1783704 |
| India | 20 | 19 | 97 | 1027929 | 121038893 | 114718793 | 904784 |
| Brazil | 11 | 9 | 35 | 957114 | 42300616 | 23321156 | 539329 |
| Puerto Rico | 1 | 4 | 20 | 461816 | 9827843 | 9827843 | 461816 |
| Ecuador | 11 | 1 | 29 | 866823 | 13085018 | 7559252 | 210309 |
| Iran | 1 | 0 | 3 | 123948 | 2373398 | 2218098 | 122395 |
| Chile | 3 | 3 | 18 | 404978 | 8269597 | 4103929 | 96588 |
| South Africa | 0 | 2 | 28 | 2426017 | 38240909 | 3703228 | 76284 |
| Colombia | 2 | 2 | 8 | 74477 | 2046078 | 2045614 | 74245 |
| China | 2 | 9 | 7 | 371630 | 19187071 | 317460 | 63492 |
| France | 2 | 2 | 7 | 109557 | 7001993 | 3041113 | 59347 |
| Uzbekistan | 0 | 0 | 1 | 42572 | 3618620 | 3618620 | 42572 |
| Australia | 0 | 3 | 3 | 42601 | 1011280 | 914280 | 30476 |
| Paraguay | 0 | 0 | 1 | 24619 | 2338805 | 2338805 | 24619 |
| Russian Federation | 0 | 3 | 2 | 17268 | 1172685 | 1172685 | 17268 |
| Netherlands Antilles | 0 | 0 | 1 | 14349 | 286980 | 286980 | 14349 |
| Bolivia | 2 | 2 | 2 | 12341 | 75715 | 75715 | 12341 |
| Guatemala | 0 | 1 | 3 | 10026 | 858242 | 858242 | 10026 |
| Mexico | 1 | 4 | 7 | 29667 | 874207 | 196081 | 7920 |
| Tunisia | 0 | 0 | 6 | 215406 | 14668224 | 370750 | 7415 |
| Japan | 0 | 0 | 3 | 7169 | 1141700 | 1141100 | 6869 |
| Italy | 1 | 6 | 6 | 110179 | 6005078 | 1003550 | 4111 |
| Cyprus | 0 | 0 | 1 | 3774 | 1226550 | 1226550 | 3774 |
| Peru | 1 | 0 | 3 | 27021 | 651061 | 606375 | 2475 |
| Uruguay | 0 | 0 | 1 | 2220 | 721500 | 721500 | 2220 |
| Costa Rica | 0 | 0 | 1 | 2193 | 13158 | 13158 | 2193 |
| Vanuatu | 0 | 0 | 1 | 2029 | 2029 | 2029 | 2029 |
| Pakistan | 0 | 0 | 1 | 1543 | 3086 | 3086 | 1543 |
| Egypt | 0 | 0 | 2 | 1483 | 405725 | 405625 | 1475 |
| Ukraine | 0 | 0 | 1 | 1229 | 307250 | 307250 | 1229 |
| Switzerland | 0 | 1 | 1 | 660 | 66000 | 66000 | 660 |
| Ethopia | 0 | 0 | 1 | 328 | 984 | 984 | 328 |
| Bulgaria | 0 | 2 | 0 | 899 | 23150 | 22050 | 49 |
| Azerbaijan | 0 | 0 | 1 | 65146 | 19543800 | 0 | 0 |
| Canada | 1 | 2 | 4 | 167704 | 6708665 | 0 | 0 |
| Spain | 1 | 1 | 1 | 56446 | 2822300 | 0 | 0 |
| Reunion | 0 | 0 | 1 | 216030 | 1512210 | 0 | 0 |
| Kazakhstan | 0 | 0 | 1 | 4579 | 870010 | 0 | 0 |
| Argentina | 1 | 2 | 9 | 143751 | 431253 | 0 | 0 |
| Hungary | 0 | 0 | 2 | 15419 | 351756 | 0 | 0 |
| Sao Tome and Principe | 0 | 0 | 1 | 13927 | 167124 | 0 | 0 |
| Korea | 0 | 0 | 2 | 30947 | 162746 | 0 | 0 |
| Jamaica | 0 | 0 | 1 | 657 | 98550 | 0 | 0 |
| Czech Republic | 0 | 1 | 1 | 21977 | 65931 | 0 | 0 |
| Anguilla | 0 | 0 | 1 | 3258 | 48870 | 0 | 0 |
| Vietnam | 0 | 0 | 1 | 26785 | 26785 | 0 | 0 |
| Kenya | 0 | 0 | 1 | 92 | 5520 | 0 | 0 |
| Albania | 0 | 0 | 1 | 428 | 2140 | 0 | 0 |
| Romania | 0 | 0 | 1 | 72 | 864 | 0 | 0 |

Updated status of HIPAA Characteristics for PHI included in the findings

| Characteristic | Included? |
|---|---|
| Patient name | Yes |
| Dates (birth, treatment, death) | Yes |
| Physical addresses | Likely |
| Fax numbers | Likely |
| Social security numbers | Yes |
| certificate/license numbers | Yes |
| phone numbers | Likely |
| full face photos/other pictures | Yes |
| URLs/web addresses | Likely |
| E-mail addresses | Likely |
| health plan beneficiary information | Likely |
| Internet Protocol (IP) addresses | (Yes) |
| medical record #s | Yes |
| device identifiers and serial #s | Yes |
| biometric (finger, voice, etc.) info | No |
| account numbers | Likely |
| vehicle identification information | No |
| Other uniquely identifying info | Yes |