

## The contribution of information health systems for the diagnosis of thyroid cancer

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### ABSTRACT

**Background:** The Information Health Systems are necessary for the coverage of managerial medical data needs, supporting the medical personnel for patients' diagnosis, through an advanced Electronic Health Record.

**Aim:** The present study aimed to present the need for an Electronic Health Record, in diagnosis thyroid cancer and also in the management of medical information.

**Method and material:** Access in the website Wikipedia and a study of PhD papers, articles and medical books.

**Results:** In order for an Information Health System to be affective, it is materialized in such a way that it acts like a human. In that case, experienced systems play an important role and more specifically, the Artificial Neurotic Networks as well as Artificial Intelligence. In addition, the same relation types must be applied to the models receiving information, with which the programs are supplied. Finally, it is the doctor who will determine the diagnosis based on his training results. A complete image of data observation of the course of a patient from a series of devices is possible if it is entered in a data base which can store information and data from the hospital information system and everything is compatible.

**Conclusions:** In the next few years, there is expected to be intense activity in subjects as the materialization of Electronic Medical Records, hospital computerized records and applications in the Health network with the aim of achieving more valid patient diagnosis and the amelioration of medical healthcare.

**Key words:** Advanced Electronic Health Record, Artificial Neurotic Networks, Artificial Intelligence, Thyroid cancer.

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### INTRODUCTION

**T**he thyroid is an endocrine gland. In medicine, a gland is a bodily organ which is composed of substances it excretes them outwards (exocrine gland), either into the circulation (endocrine gland) from which they are transferred to other target organs. The thyroid is located in the froth trachea area and is shaped like a coat of arms, namely resembling the symbol which wealthy families had in the past. It is composed of two lobes which are interconnected with the isthmus and looks like a butterfly. After birth it weighs approximately 1-2gr. Normally in adults it is 12-20 gr., vascular and mild contractions. Four parathyroid glands are four in the real region of each thyroid glands are found in the real region of each thyroid pole. The regressing laryngeal nerves cross the side of the thyroid gland. The blood perfusion of the thyroid gland is secured by the three arteries which provide the blood from the three veins which size the vein blood of the thyroid gland. The thyroid produces two related hormones: Thyroxin (T4), triiodothyronine (T3), while the parathyroid glands produce parathormone. Kalsitonin is a peptide hormone which is secreted from the C cells or parathyroid thyroid cells. The two basic thyroid hormones, T4 and T3,

play a crucial roll in cell differentiation during its development and help the preservation of metabolic homeostasis in the adult.<sup>1-3</sup>

## **Thyroid cancer**

It is the most regular malignancy of the endocrine system. It consists of 0.5-1% of all cancer situations in the premature phase might appear as a solitary nodule which in the scanning of the thyroid usually gives the impression of an indifferent nodule form. Of course every ascertainment of an indifferent nodule does not exclusively entail the existence of cancer, because more often (85%) an indifferent nodule is a benign discovers of the gland (adenoid or cyst) as is proved with biopsy and histological study. Functionally as a rule, the patient is Euthyroid. Women are afflicted in relation to men by 3:1. The development of thyroid cancer is affected by environmental (insufficiency of iodine, radioactive iodine), genetic and hormone factors and certain ones combined with other familiar neoplasm tic syndromes, like multiple endocrine neoplasia type 2 (MEN).<sup>1</sup> The most frequent type of thyroid cancer is papillary cancer (60%) while follicular is less frequent, as is non Ana plastic or Ana plastic and the

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Medullary, which seems to have a familiar appearance.<sup>2</sup>

**Papillary carcinoma:** It is the most frequent malignant neoplasm of the thyroid (80%) in areas with sufficient iodine and is more closely connected with the exposure to external radiation or with the exposure to external radiation or with radioactive dust (Chernobyl accident). It appears with the form of a small to a huge, solid-papillary filtered thyroiodine mass or as cervical lymph node involment. It is more frequent in women than men and appears at any age with an average age appearance of around 40. It has a good prognosis because even the metastasis (lymph like) are removed surgically but the prognosis is adverse when the cancer infiltrates the thyroid capsule, is larger than 2.5cm, belongs to the alternant of high cells and affects the lymph glands. Different histological types papillary carcinoma are distinguished, such as the common papillary (the most frequent), microcancer (occult or latent clinical, with a size of <1 cm and the best prognosis), the variety with capsules (encapsulated), the follicular type (follicular variant), (diffuse sclerosing), the type with tall cells (tall cell variant) and the type with columnar cells (columnar cell variant). The last three types of carcinoma are more aggressive

and because of that, have the worst prognosis.<sup>4-6</sup>

**Follicular carcinoma** is somewhat more aggressive and may spread with local infiltration of the lymph glands or with hemogenic dispersion to the bones, the brain or to the lungs. It has a worse prognosis than papillary carcinoma and affects more often people over the age of 40. It is less frequent than papillary carcinoma (5-15% in areas with excess iodine, 25-40% in iodine insufficiency areas). The diagnosis is based on the demonstration of definite malignant criteria, which is the infiltration of the capsule and its blood vessels. Two basic types of follicular carcinoma are distinguished, one with minimal infiltration (minimally invasive) and one with wide infiltration (widely invasive) and with a more aggressive behavior.<sup>4, 7-9</sup>

**Carcinoma from Hurtle cells:** It is characterized almost exclusively by cells with eosinophil granular cytoplasm, which contains plenty of mitochondria. According to the classification of the International Health Organization, it comprises an oxyphilic variety of follicular carcinoma. It affects women more often in their 60s and cause distant and lymph nodule metastases more often in relation to the typical follicular carcinoma, while on the contrary, from

other studies it is considered to have the same prognosis.<sup>4</sup>

**Medullary thyroid cancer.** It consists of 5-10% of thyroid carcinoma, is located in the mid trimolecule of the lobe and derives from the parafollicles or C-cells, which excrete in normal circumstances the hormone kalsitonine. It usually appears in middle aged people as a solitary, painless hard nodule. Swollen throat lymph glands sub exist in 50% of the patients during the diagnosis period, while distant metastasis in the lungs, liver and bones might appear at an average up to 10%: Local phenomena from the size of the initial mass, such as dysphasia or paresis of the lower larynx are rare. Medullary thyroid cancer (MTC) excretes Kalsitonine which consists of a valuable indicator of observation in the development of marrow carcinoma of thyroid and is also useful for the preclinical detection of the afflicted in the familiar forms of the illness. The ten-year survival of medullary thyroid cancer of the thyroid is 40-60%. In (MTC), death occurs from extensive metastasis, which concerns mainly the throat lymph glands and the mid thorax and the lungs, liver and bones follow. The only effective therapy is surgical, which concerns total thyroidectomy and radical lymph throat clearing.<sup>4, 10</sup>

**The Anaplastic carcinoma** is the most undiversified and the most malignant neoplasm of the thyroid gland. It has a worse prognosis and appears more often in elderly people over the age of 60. It features a quick development, more often in areas with endemic goiter, usually as a quick developing hard mass with an extent to the throat and causes pain very quickly and local phenomena (difficultly in eating, coarse voice) and generally leads to the death within 12 months. The proposed therapy is the combination of aggressive surgical tumor removal, radiation and chemotherapy.<sup>11-</sup>

<sup>13</sup>

The rest of the thyroid cancers are very rare and for this reason the monstrosities have a very quick development. Secondary metastatic tumors in the thyroid are observed from primary cancer of the lungs, the breasts, the kidneys and from melanoma. Its diagnosis is not optimistic.<sup>1</sup>

The main explanatory factor of thyroid cancer is the exposure of the brain and the throat to radiation during one's childhood or teenage life. Recently, because of exposure to radiation from nuclear power plants, it has contributed to the increase in frequency of thyroid cancer. Because TSH is a stimulating factor, the patients who are exposed to

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that, it is possible that it is due to the suppression of TSH with thyroid hormones. Patients with a history of radiation must be submitted to a feel a thyroid ultrasounds every 2 years.<sup>1</sup>

### **Diagnosis, background and physical examination**

#### Factors related to the presence of thyroid malignancy

##### Radiation background in children.

Radiation in children in the neck region increases the changes of thyroid cancer and suggests the existence of genetic disposition.

Pre-existing thyroid disease. Many studies have shown that many times, benign thyroid disease pre-exists in the development of malignancy. Benign tumors are more often found in patients with Grave's disease (and the co-existence of non- functional nodules), while Hashimoto thyroiditis is accompanied by an increased possibility of lymphoma connection.

Hereditary background: Rare familiar syndromes are connected with an increased impact of thyroid nodules and cancer. Also hereditary is Medullary thyroid cancer in patients with MEN-2(A-B) (multiple endocrine neoplasia).

Sex: Thyroid cancer is 2-4 times more frequent in women than in men. Thyroid

nodules are more frequently benign in men than in women.

Age: Thyroid cancer is rare in children and in ages under 16 with a year impact of 0.002-0.3/100.000 children. In women it increases from 16-40 while in men it increases from 75-79 years of age. Middle age diagnosis is from 45-50 years of age.

Weight: An increase in weight is correlated with an impact of thyroid cancer.

Iodine: It is reported that there is an increase in the impact of iodopenias regions, where the endemic goiter appears frequently, with follicular and anaplastic cancer prevailing, in contact to the papillary which prevail in regions sufficient in iodine and possibly where there is an over-sufficiency of iodine.

Ethnic differences-Race: The different impact of thyroid cancer in different either backgrounds leads to the study of the pathogenic genetic role, environment, arbitration and their combinations.<sup>14, 2</sup>

### **Symptoms**

In the first stages thyroid cancer gives no signs or symptoms. The patients are euthyroid as a rule. Some of the most common signs and symptoms of advanced thyroid cancer are: <sup>1, 15</sup>

- i. Palpable compacted nodule which the patient himself reveals, or the doctor (>1.5cm nodule palpation)
- ii. Sore throat
- iii. Coarse voice
- iv. Swelling of the cervical lymph glands
- v. Tiredness or difficulty breathing
- vi. Persistent cough
- vii. Diarrhea with medullary carcinoma

## Laboratory Research

On finding a compacted nodule in the thyroid, the thyroid stimulating hormone (TSH) is measured in the blood. If the TSH (n.r. 0.270-4.20  $\mu$ iu/ml) is compromised, a thyroid scanning is followed so that it can be clarified if the nodule is functional or non-functional. In the case of it being functional, FNA is conducted. If the TSH is normal, FNA is conducted directly, because the nodule is considered non-functional. Almost all patients with thyroid cancer are euthyroid. It is controversial if the measurement of calcitonin [CT (0.0-10.0pg/ml)] must be conducted on all patients with functional nodule or only in the cases where there is family background of medullary carcinoma or multiple endocrine neoplasia type 2 (MEN 2), taking into consideration the rarity of medullary carcinoma (1:250 patient with nodules). In cases where CT

is increased, for the diagnosis of medullary carcinoma, a stimulation test must be conducted with pentagastrin [0.5mg/kg in 10sec] or infusion of calcium [2.5mg/kg weight in 30sec] or combined test of calcium- pentagastrin [CA++ (2.5mg/kg in 1min) and pentagastrin (0.5 mg/kg in 30 sec). The measurement of thyroglobulin [TG (1.4-78ng/ml)] does not assist the department of benign and malignant nodules. The measurement of antithyroid antibodies (ANTI-TG (<115 iu/ml)) is useful for the different diagnosis or the co-existence with autoimmune thyroid disease.<sup>4, 16</sup>

## Ultrasound

The ultrasound gives information about the nature of the nodule (compacted, cystic or mixed), its echogenicity (hyperechogenic, hypoechogenic, isoechogenic), the appearance or not calcifications, the limits (clear, unclear or rough) and the size of the nodule. Hypoechogenicity advocates malignancy, the appearance of micro calcifications, the rough outline thick or rough halo, the absence of halo, increased blood flow, in the nodule with Doppler and more specifically, the findings of filtered development of the nodule.<sup>15,17</sup>

## Scanning



The scanning depiction of thyroid nodules, which is done on nodule > 10mm, gives information about the possibility of a malignant nodule, if a nodule is dominant in a multinodular goiter and about the possible extent of the thyroid under the chest area. The scanning is conducted with iodine-123, iodine-131 and technetium-99m-pertechnetate. The nodules are distinguished in functional and non-functional, depending on whether they have a smaller or increased contraction from the rest of the thyroid parenchyma. Approximately 90% of nodules are non-functional and 10% are functional.<sup>15, 18</sup>

#### **Fine Needle Aspiration (FNA)**

The biopsy extraction of thyroid tissue with a fine needle is a diagnostic examination, which is used in order to separate the thyroid nodules into benign or malignant. It is recommended for nodules with a diameter of >10mm or smaller if there is a suspicion of malignancy. The paracentesis is conducted in two ways: directly with throat palpation and nodule paracentesis or with an ultrasound direction.<sup>15</sup> The needle which is used in paracentesis is fine, (finer than the one used to take blood) therefore the pain from the prick is minimal. Topical anesthesia is not required for paracentesis to be done. The

cellular examination is of great importance because there is a possibility, a 95% average, that it will answer the question of whether a thyroid nodule is benign or malignant. In the case of suspecting malignancy, the patient is operated on and the thyroid is removed. In cases where it is benign, (which most of them are) the patient receives medical treatment or is observed. Side effects of paracentesis are rare. The most common is the creation of blood perfusion, (because the thyroid is a gland with rich blood perfusion) which is automatically absorbed in a few days.<sup>19, 20</sup>

#### **Other methods**

The X-Ray Computer Tomography (CT) and Magnetic Resonance Imaging (MRI) can't reliably distinguish benign from malignant nodules but in comparison with other techniques they are more accurate in the estimation of goiter extending beneath the sternum and pressure of the trachea.<sup>15</sup>

#### **The current situation of the Electronic Health Record in Greece**

With today's standards, the bulk of a single conventional medical record is big because of the increase of laboratory examinations, while at the same time there is a great danger of some of the records being lost. In addition, in many

hospitals, there are two separate records for each patient, one for the outpatient and one for the clinic. More specifically, clinical information for outpatients is recorded manually by the doctors in handwriting folders, which are not always retrieved in the following appointments even if the patient has been recorded individually, automatically receiving a Registration Number from the check-in desk or from the secretary in the outpatient department.<sup>21</sup>

In the last few years, the need to upgrade the duality of the services offered is becoming greater as is the need to reduce the cost. For this purpose, Information and Communications Technology can offer great help. Therefore, more and more hospitals around the world have materialized complete information systems to a great extent for the coverage of management needs for management-economics as well as medical data. The experienced systems which compose the Electronic Health Record (EHR), compile, organize and offer knowledge to the health sector, assisting doctors' tasks for the diagnosis and treatment of patients. The experienced systems are considered derivatives of Artificial Intelligence and are very successful in the treatment of

different problems and situations. Artificial Intelligence is the field of computer science which has to do with symbolic methods in order to solve problems, for example the diagnosis of a disease and it also allows computers to do tasks, which for the time being, people are better at.<sup>22</sup>

The purpose of the new standard EHR is to produce precise, rigid and long-lasting architecture, with the aim of supporting the systems operations as well as the recommendations, which are needed to interact with the services provided by the EHR, to have access and to form different new medical record entries, to make use of electronic messages or allocated objects, to preserve the original clinical data which is recommended by the designer of the EHR, to provide data confidentiality for the patient, to reduce bureaucracy, to minimize mistakes.

## **Advanced Electronic Health Record and its contribution- Suggestions**

In the Advanced HER, computerized observation of the total medical information will be feasible, while all the data will be embodied in the patient's record without the form playing a major role. In addition, the process of data will be made feasible as well as its direct transfer with electronic and



telecommunication means, at any distance and point. In other words, such a record is needed to combine a different type of information, which will help the doctor diagnose the disease and to treat it.

For example, a doctor who receives a patient with thyroid cancer, will use the EHR in order to record the patient's background, to register all the examinations (laboratory and depictive) and to proceed to the direct diagnosis of the disease and its future treatment. The new technology allows the process of the record text, as well as the objects which are embodied in it. For example, the x-rays can be related and enlarged, while it is possible to diagnose electrocardiogram (ECG) from the computer.

More specifically, the Advanced EHR will include:<sup>23</sup>

- Demographic facts
- Medical background- Risk factors
- The observation of certain backgrounds (anesthesia, obstetrics, chemotherapies, hormone therapies, radiotherapy)
- Clinical data of a natural examination-diagnoses and points
- Hospitalization-Surgery
- Medical treatment

- Laboratory examinations (blood analysis, urine, etc.)
- Biodynamic recording (electrocardiogram, Electromyography, etc)
- Medical tasks
- References- Opinions
- Diagnostic examinations and medical images (x-rays, MRI, CT)
- The issue of natural orders (connection with dietary applications)
- Therapy protocols
- The issue of orders towards the nursing staff
- Management- financial forms of medical and hospitalization deeds
- Possible records of the medical files
- Endoscopic sequences (video)
- GEHR charts (clinical drawings)
- Complete medical file and background printout
- Informative reductions of statistic exploitation

More extensively, the system must have the capacity for direct observation of each patient, regardless of the bulk of information, the number of patients and their residence.<sup>24</sup> Moreover, it must provide minimization in the management time of medical data, to

ensure safe connectivity and data transfer with the use of international standards, to be able to access through the network, preserving the same operations, to have the capacity for a parameterized search in patients' files with the use of multiple criteria, for data input and output of each patient's file and every examination date from/ to removable through storage and for the graphic depiction of statistical facts concerning the possible appearance of thyroid cancer, depending on the age of the patient. In addition, it must provide the protection of integrity and availability of information as well as the protection of personal data. The evidence of the Advanced EHR is based on possible theoretical models which correlated the different patient data, with the possibility of the development of the disease.<sup>25</sup> As it has been proved in the above, even though many efforts have been made in the organization of the medical data, the results are not the expected ones. The applications are usually intractable, with a lack of immediate access, not responding to the demands of each user, while there is distrust from the health professionals regarding the new technologies. In addition, the operation of an application happens to be on non-desirable levels in

relation to other applications and this fact makes it difficult to find information.<sup>23</sup>

For all the above reasons, the materialization of an advanced information health system is suggested. Specifically, the EHR will include a hierarchy of users where each one, depending on his specialization, will be able to enter the system and to enter data or to choose from the wider selection, the disease with which he wants to deal with extensively and to process different patient data. A necessary premise for the process of data which will lead to the diagnosis of disease (with a minimal error percentage), is the application of Artificial Neural Networks, which are a network of simple computer nodes (neurons) interconnected among themselves and inspired by the Central Nerve System (CNS), which tries to simulate.<sup>26</sup> Equally important is the easy access into the network even with smart portable devices at any time and its instant use from any geographical point, with the aim of solving complex medical problem through the information search in the world web.

## Results

A basic question is how a device which can be programmed is in the position to receive the same decisions as a doctor does, having at its disposal the same data and knowledge. For the program to be successful, it must be materialized so that it acts like a human being. In this case, the experienced systems and especially Artificial Intelligence play an important role. Furthermore, the same relation types must be applied in the decision reception models as well, with which the programs will be supplied. When we “teach” them about the relationship between the disease and the symptoms, the insurance of supplies is demanded with the ability to handle the reverse relationship, from the diseases to symptoms, in order for the reception of decisions to be made it possible, from the reception decision model. The patients’ symptoms with others having the same disease are greatly varied. This means that the symptoms and the corresponding measurement which are determined by a population of patients or healthy people may appear to vary greatly, which is usually expressed by medium rates and stable deviations. Finally, it is the doctor who will determine, based on his learning results, the final diagnosis. The complete image of data observation of the course of a patient from a series of devices is

possible if it is entered in a data base. In addition, the base may accommodate information and data from the hospital information system while all these systems must be compatible.<sup>25</sup>

### **Conclusions**

To sum up, we conclude that during next few years, intense activity is expected into issues such as the materialization of EHR, hospital computerization and applications of the health network, since there are now the premises for the launch of such tasks. The Health field is not able to tolerate any more experimentation. Computer science and the materialization of a National EHR are solutions for the future and the improvement of medical treatment.

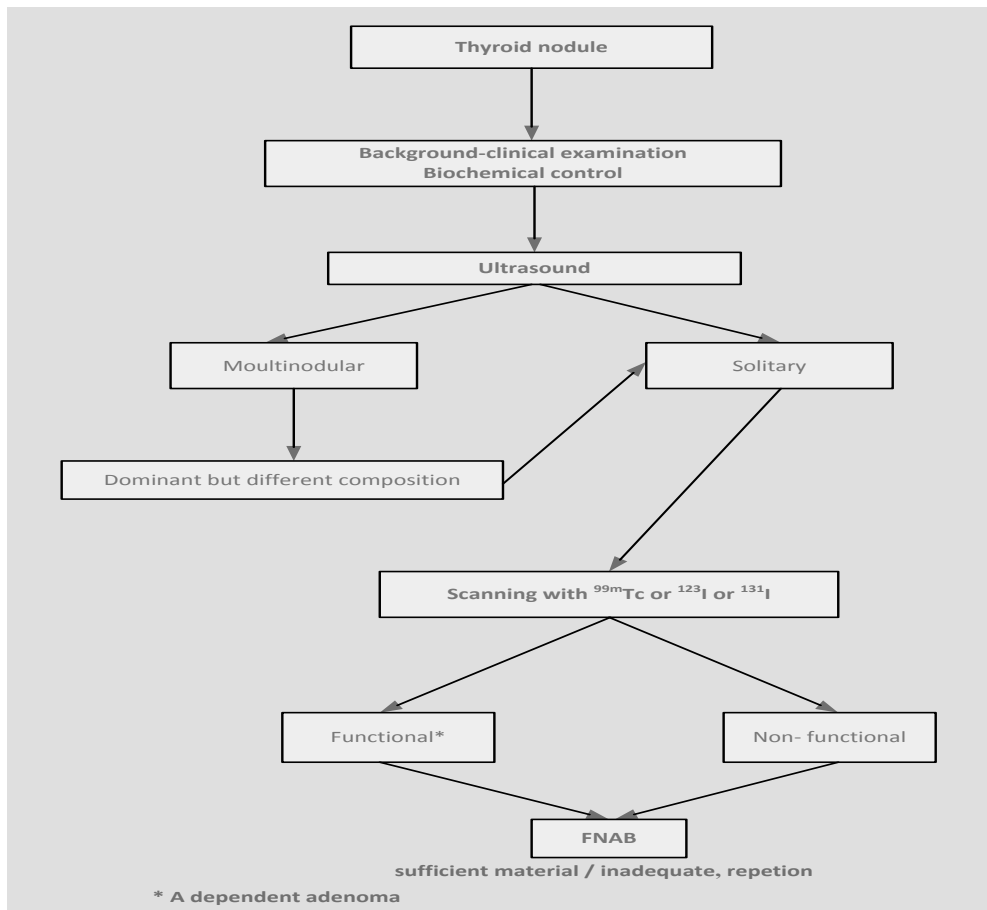
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## ANNEX



Algorithm diagnostic research of thyroid nodules <sup>15</sup>