

## COMPUTED TOMOGRAPHY IMAGING IN THE PEDIATRIC EMERGENCY DEPARTMENT

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### ABSTRACT

**Introduction.** The Computerised Tomography (CT) plays a crucial role in the emergency diagnosis.

**Objective.** Our purpose was to identify CT-scan's utility in Pediatric Emergency Department.

**Materials and methods.** We used a cross-sectional approach, for the year 2010. From a total of 92959 visits in the Emergency Room (ER) of the "Clinical Emergency Hospital for Children "M.S. Curie", Bucharest, 9258 patients were considered emergencies (group A) and 90 patients were major emergencies (group B). We performed 102 CT scans. Results were given as percents.

**Results.** The global percent of ER visits associated with a CT scan was 1% within the group A and it scored 1% from all ER visits. All patients from group B underwent a CT scan. Main indications were: major head injuries - 50%, intracranial hypertension - 35%, polytrauma - 12.7%, suspicions of malformations - 5.9%. The global detection rate for any kind of lesion was 51%. For brain trauma the rate scored 49%, identifying the following lesions: diffuse cerebral edema (19%), intracranial hemorrhage (15.6%), skull fractures (15.6%) and other facial or visceral lesions (29%). For intracranial hypertension the method's sensitivity was 43%, for multiple trauma 84.6% and for malformations' suspicions 100%. The lesions' detection rate, for different clinical conditions (or the method's sensitivity) is similar with other medical studies.

**Conclusion.** In all pediatric patients, indication of a CT scan was made after a careful selection of cases. The method proved to be useful for managing all kind of trauma and intracranial hypertension situations.

**Keywords:** CT, emergency, trauma, intracranial hypertension

### INTRODUCTION

Since its introduction in 1972, computed tomography has become a vital diagnostic tool in modern medicine. Current scanners are capable of rendering submillimetric resolution images, of the entire body, in a matter of seconds (1,2). Utilization of CT scan has risen in all medical fields, also in ER. From 60 millions of CT exams performed in USA in 2010, 7 million were in children (3); during the period 1995-2008, in pediatric population,

number has increased fivefold. This is of special concern, because of two special items: the radiation exposure and the amount of resources dedicated to this examination (5, 6, and 7). The increased use of CT is explained by higher rates of imaging for indications such as: minor (including brain) trauma (8, 9), headache, seizures (1), chest pain (11), abdominal and lumbar pain (12-14). Due to the potential malignant effects from ionizing radiation (15-18), questions have been posed over how the indication for CT in pediatric population should be made (19-

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21). The purpose of this study was to estimate the utility of CT method for pediatric patients visiting the ER of “MS Curie” Hospital Bucharest.

**MATERIALS AND METHODS**

A number of 92959 visits (patients between 0-18 years of age) have been recorded in ER of the “Clinical Emergency Hospital for Children “MS Curie” Bucharest, during the period January the 1<sup>st</sup> – December 31<sup>st</sup> 2010.

We used a cross-sectional design of the study, with secondary analysis of data. Estimates have been referred to the group A (9258 patients), considered to be emergencies. We used definition criteria for “emergency” from “The International Canadian Triage and Acuity Scale Paediatric Guidelines” (22) and actual legislation (23). Among these, we also identified 90 patients (group B) which represent major emergencies. We included here: loss of consciousness (Glasgow score, GSC under 13), intracranial hypertension (ICH) suspicions: headache, nausea, neurologic impairment, eyesight trouble and major isolated or multiple trauma. (24).

Lesion detection rates were given as percents, for each type of clinical indication. Formula is the following:

$$\text{Lesion detection rate} = (\text{number of lesions found} / \text{number of CT scans performed}) \times 100.$$

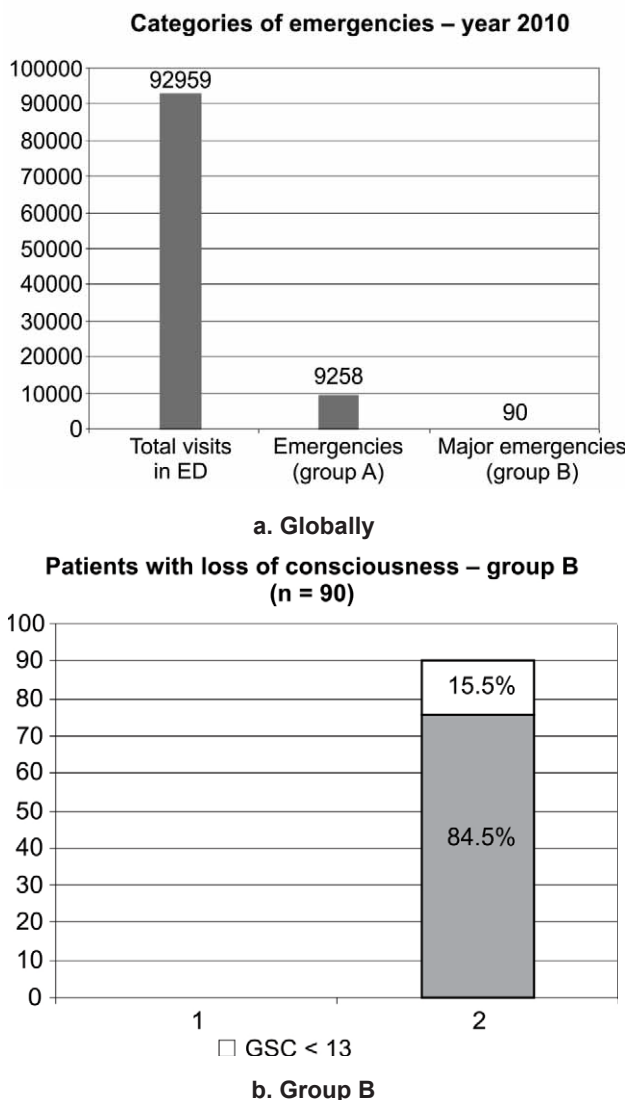
We used a General Electric BrightSpeed 2000 device, with X radiation emission (25). Multiseriate helical sections of different anatomic regions: cranio-cervical, thoracic, abdominal or whole body sections were taken. For abdominal trauma we used contrast iodide substances, at dose of 2 ml/Kg. Three dimensional reconstructions and refracting imaging were required in some special cases. (26).

Statistic analysis relied on software: Epiinfo 2000 and Excel, Windows XP professional.

**RESULTS**

From all the 92959 visits in ER in 2010, 10% were emergencies (22, 23), included in group A. Among these, 90 patients were major emergencies (24), included in group B. (Figure 1). Group B represents 1% of emergencies, and 1‰ from all visits in ER, in 2010. A percent of 15,5% patients from group B were experiencing loss of consciousness. (GSC < 13).

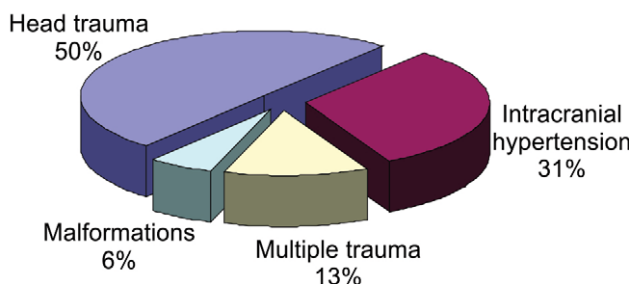
CT scan indications were made after the international and national guidelines, for pediatric population (27,28,29,30). Figure 2 shows specifically the indications for CT, in ER. All 90 patients from group



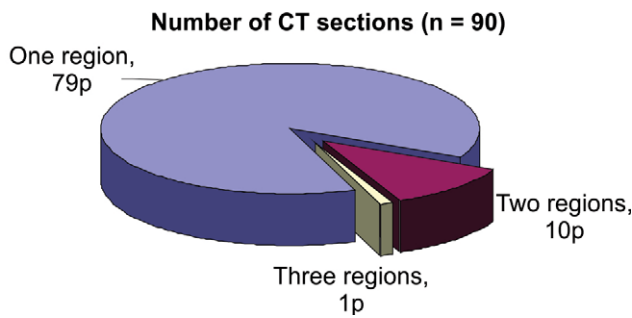
**FIGURE 1.** Distribution of cases, according to clinical severity at presentation in ED. a. Globally; b. In group B (major emergencies)

B underwent a single or multiple segment CT scan, meaning 102 examinations. Different CT sections: cranio-cervical, cranio-cervico-thoracic, thoracic, abdominal, or all body sections have been performed. Distribution of patients, according to number of sections tomographed is shown in Figure 3.

**Indications for CT scan in ED – group B (n = 90)**



**FIGURE 2.** Main indications for CT scan in ED.



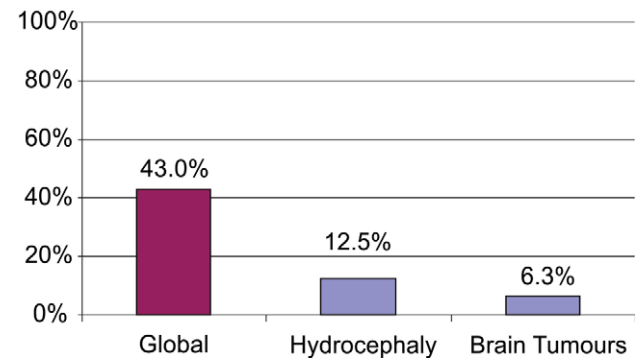
**FIGURE 3.** Distribution of patients according to number of anatomic regions tomographed (group B).

Lesions' detection rate were estimated within the group B. Therefore, a number of 48 out of the 102 tomographed segments have had pathological lesions. These belonged to 46 patients, out of the 90, meaning a global lesional detection rate of 51% (Table 1).

In patients with ICH we found pathological signs in 14 out 32 cases (43%), see table I. Four cases of hydrocephaly and two brain tumors have been diagnosed, the latter ones in advanced states of evolution, with amygdala engagement (Figure 4 a). In patients with loss of consciousness or different stages of coma we detected pathological lesions in 2 out of 14 cases (14%). It was diffuse cerebral edema, one accompanying also a brain tumor.

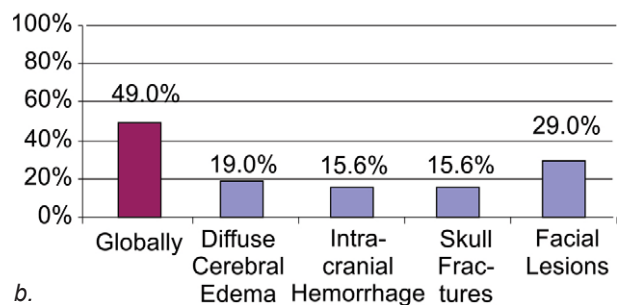
For patients with brain trauma we found lesions in 26/51 cases (50%). For thoracic trauma, the lesions' detection rate was 3/9 cases (33%), and for abdominal trauma 1/4 cases (25%). Results are shown in table I. Types of lesions found in brain trauma are represented in figure 4b. For polytrauma patients, different lesions have been encountered: cranial, thoracic, abdominal, either isolated or associated, in a proportion of 84%. For malformations' suspicions the percent of confirmation was 100%: hydrocephaly (3 cases), dysembryoplastic tumors (1 case), broncho-pulmonary dysplasias (2 cases).

### Lesions found in ICH (n = 32)



a.

### Lesions found in head trauma (n = 51)



b.

**FIGURE 4.** Pathological lesions found by CT examination in ICH (a) and head trauma (b).

## DISCUSSIONS

During the year 2010, the number of visits in ER of the "Emergency Clinical Hospital for Children "MS Curie" Bucharest, associated with a CT scan was 1%, similar with the percent reported by the pediatric Emergency Rooms from the USA, during the year 1995 (1,2%). (1). The percent was significantly lower compared to years 2008 – 5,9% (1) and 2009 – 5,3% (14), or adults – 16.7% in 2007 (14). Main cause for the difference between the percents, between Romania and USA is a carefully evaluation and good selection of cases, especially

**TABLE 1.** Lesions' detection rate by CT scan method, according to clinical indication

1	Age (years)	Total number of patients (group B)	Total Number of CT sections	Indication for CT scan							Lesions' detection rate (%)
				ICH	LOC/coma	Trauma				Malformations	
						Head	Thoracic	Abdominal	Multiple		
2	7.75 ± 5.19 (Limits 0.5-18y)	90	102	32	14	51	9	4	13	6	Total CT exams
		46	48	14	2	26	3	1	11	6	Lesions detected
		<b>51%</b>	<b>47%</b>	<b>43%</b>	<b>14%</b>	<b>50%</b>	<b>33%</b>	<b>25%</b>	<b>84.6%</b>	<b>100%</b>	<b>Rate of lesions' detection (sensitivity)</b>

for indications such as: abdominal pain, dyspnea or minor trauma (9,10,14). We have selected only those patients with altered state of consciousness or clinical signs of shock.

There are some studies in the world reporting lesions' detection rate (sensitivity) of CT scan, globally or for different kind of indications (31-40). Being a tertiary pediatric ER, our recommendations for CT scan were similar with those mentioned by Maguire et al. in a study published in 2009 (8). Our lesions' detection rates are though superiors to numbers reported by this meta-analysis, both compared to Europe and Asia (8). It's because we have not exposed cases with minor trauma and we have utilized the transfontanelar US exam as a complement, for infants.

Sensitivity of the method (lesions' detection rate), for head trauma, is similar in our study to others: globally 50% in our study versus 68% in a study from Canada (32), 15% for skull fractures in ours, versus 39% in Utah (33) – this number referring to severe trauma, immediately admitted to operating room and for intracranial hemorrhage – 15% in our study, versus 13% in Utah (33).

For ICH the lesions' detection rate in our study was 43%, while a study from Madrid reports – for general population and with severe trauma – 57% (34). We have included in ICH category also some cases – less severe - with brain tumors and malformations. For patients with loss of consciousness, lesion's detection rate is similar in our study to another study made in California: 13% and 14% respectively (35).

In minor thoracic trauma we have performed an X-Ray exam, firstly. Only for severe trauma we used CT scan. A recent study from Connecticut (USA) reports a lesions' detection rate of 33% (37), which is equivalent to our percentage, 33%. Patients with multiple trauma underwent a pan-CT scan, after X-Ray and US exams have been performed and a careful selection of cases has been made. Our study reports a detection rate of 100%, meanwhile a study published in South Carolina shows only 18%, due to the extensive use of the method. CT scan sensitivity is superior both to X-Ray examination (for thoracic trauma) (37-39) and to ultrasound examination (for abdominal trauma) (40), especially in detecting soft tissue lesions: he-

mo-pneumothorax, parenchymal, vascular or intestinal damage (37-40).

This study seems to be a premiere in our country. It defines the main categories of emergency and clinical indications for undergoing a CT scan examination, in pediatric population. The lesions' detection rates (sensitivity) are similar with those reported in Europe or North-American continent, although utilization rate was five fold lower. This result is showing that selection of cases was more appropriate. Globally, and in Romania also, there is a strong need for standardization of selection criteria for cases that are exposed to a CT exam, in ER (41). This is the main reason why new guidelines, considering the cost/benefit ratio have been published recently (42,43). These guidelines are similar to our usages in the ER of "MS Curie" Hospital.

## CONCLUSIONS

1. Computerized tomography was an investigation carefully prescribed in the Emergency Room, upon the severity of clinical picture at presentation. Thus, a percent of 1% of all calls in ER were associated with a CT scan, meaning 1% of cases considered emergencies.

2. This study shows that main indications for CT scan in ER are: trauma, intracranial hypertension and loss of consciousness.

3. Even though this investigation was less prescribed, compared to other countries, lesion's detection rate was similar to theirs: 50% globally, 49% for brain trauma, 33% for thoracic trauma, 25% for abdominal trauma, 84% for polytrauma and 100% for malformations. For intracranial hypertension, examination's sensitivity was 43% and for loss of consciousness 14%.

4. In cases with head trauma we have identified four types of lesions: diffuse cerebral edema, intracranial hemorrhage, skull fractures and facial lesions. Method's sensitivity is similar to other countries'.

5. Selection of cases undergoing a CT exam and its benefits in establishing a positive diagnosis is due to team's professionalism, composed of highly trained pediatricians and to the fact that the ER from The "Clinical Hospital for Children "M.S. Curie" is a tertiary one.

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