

CT imaging for appendicitis - nationwide survey

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Background/introduction

Numerous studies are reporting increasing radiation exposure from medical imaging, in adults as well as in children who are more sensitive to radiation induced cancer (1,2). In developed countries, the average per capita dose is already almost as large as radiation exposure from natural sources. E.g. in Germany, radiation exposure from natural sources is estimated at 2,1 mSv/year/person, whereas exposure from medical imaging is estimated at 1,8 mSv/year/person (3). In Switzerland, exposure from medical imaging has been estimated at 1,4 mSv/Year/person in 2013, of which approximately two thirds are resulting from computed tomography (CT) (4).

This is resulting from many factors, as defensive medicine and development and refinement of new indications for CT, e.g. cardiac imaging.

Alternative imaging methods without ionizing radiation, namely ultrasound (US) and Magnetic Resonance Imaging (MRI), although also increasing in frequency, have not been able to substitute the increase of CT imaging (5).

Also, in contrast to US examinations, CT examinations are relatively easy to standardize and therefore are the most often transmitted imaging modality in the framework of teleradiology, the use of which is increasing worldwide (6,7). In Austria, radiation protection law limits the application of teleradiology to trauma imaging, certain dislocated emergency medicine outpatient wards or for providing a night and weekend service.

A frequent indication for emergency imaging is appendicitis. As the sensitivity and specificity of only clinical and laboratory testing is suboptimal, diagnostic imaging for confirmation or ruling out appendicitis has been established as a standard preoperatively (8). Therefore, graded compression ultrasound is recommended as a first line method especially in younger patients. However, because of its somewhat superior accuracy, CT is used in unclear cases. The use of CT versus ultrasound depends also on the level of expertise in ultrasound available, and therefore, children are much more likely to undergo a CT scan if they are treated in a community hospital compared with a pediatric hospital (9).

The rate of CT examinations for preoperative imaging in suspected appendicitis in Austria has not yet been determined. Our concern was, that with the nationwide saturation with CT equipment, an increasing shortage of radiologists (who are - although not exclusively - a group of medical professionals with relatively high expertise in US diagnosis of appendicitis), and political pressure to reduce costs of health services, there might be a tendency to replace ultrasound with CT examinations.

Description of activity and work performed

Research questions:

1. How high is the rate of patients in which a CT has been performed before appendectomy, dependent on the year of discharge from hospital (2009 - 2016) and age group?
2. Does the probability of undergoing a CT as part of an hospital stay for appendectomy change with the number of FTE held in the hospital by specialists in radiology?

Methods:

The Austrian Federal Ministry of Labour, Social Affairs, Health and Consumer Protection commands a database for documentation of diagnoses and services of the austrian hospitals. From this database we retrieved all patients who had an open or laparoscopic appendectomy in an austrian public hospital and werde discharged from their hospital stay during the years 2009 to 2016.

These patients were stratified according to their sex, age group and if they had a CT examination of the abdominal region. It was taken into consideration, if the CT examination was performed before, on the day of the appendectomy or on the day after the appendectomy.

We attempted to correlate these results with the number of radiologists available in the hospitals where the appendectomies were performed. This was extracted from the cost unit statistics of the Austrian hospitals for the years 2009-2016. The number of radiologists was expressed as full-time employment equivalents (FTE).

Results:

- During the study period between 2009 and 2016, the number of appendectomies in Austria has fallen by approximately 15%, representing a general tendency for a somewhat more conservative therapeutic approach to appendicitis (Figure 1).
- Over all age groups, the fraction of patients who received a preoperative CT before appendectomy has increased from approximately 12% in 2009 to 16% in 2016 (Figure 1).
- The increasing rate of CT examinations during the study period pertains only to patients from 20 years onward, whereas in younger patients it has remained at constant low levels (Figure 2,3).

- Averaged over the study period, in children and adolescents under the age of 15 years, the rate of CT examinations was only 1,1 - 1,2%, increasing to 3.4% for the age group of 15-19 years. In patients aged 40 years and more, the average rate of CT examinations was 40,6% (Figure 4).
- There was some - although no significant - tendency for lower CT rates in hospitals with a higher number of radiologists available (Figure 5, 6).

Images for this section:

Hospital stays for appendectomy in Austria, all age groups

Year of discharge from hospital	hospital stays	Hospital stays with CT	% of total
2009	12799	1539	12,0
2010	12456	1539	12,4
2011	12457	1634	13,1
2012	12290	1702	13,8
2013	11278	1636	14,5
2014	11415	1679	14,7
2015	10949	1738	15,9
2016	10952	1780	16,3

Fig. 1: Hospital stays for appendectomy in Austria, all age groups 2009-2016

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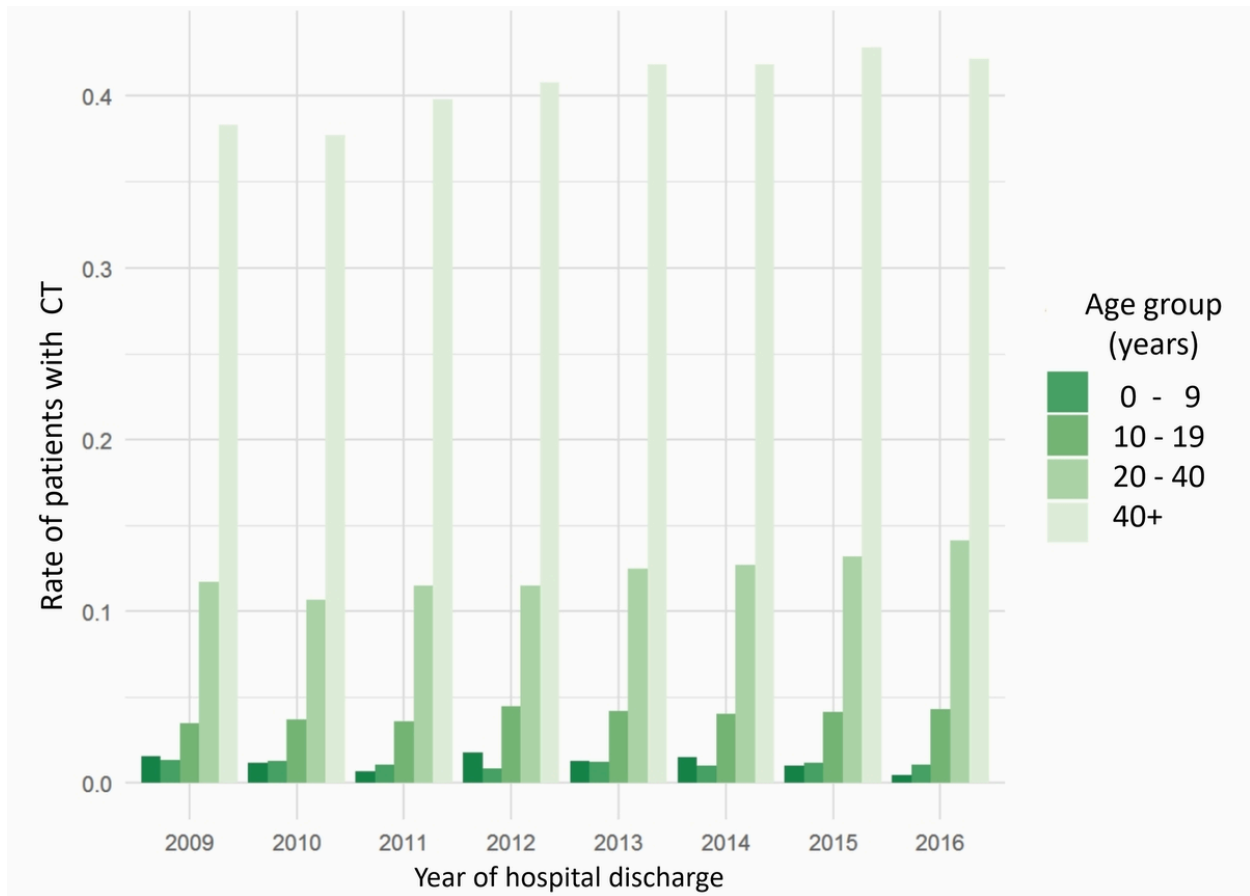


Fig. 2: CT rate per year and age group

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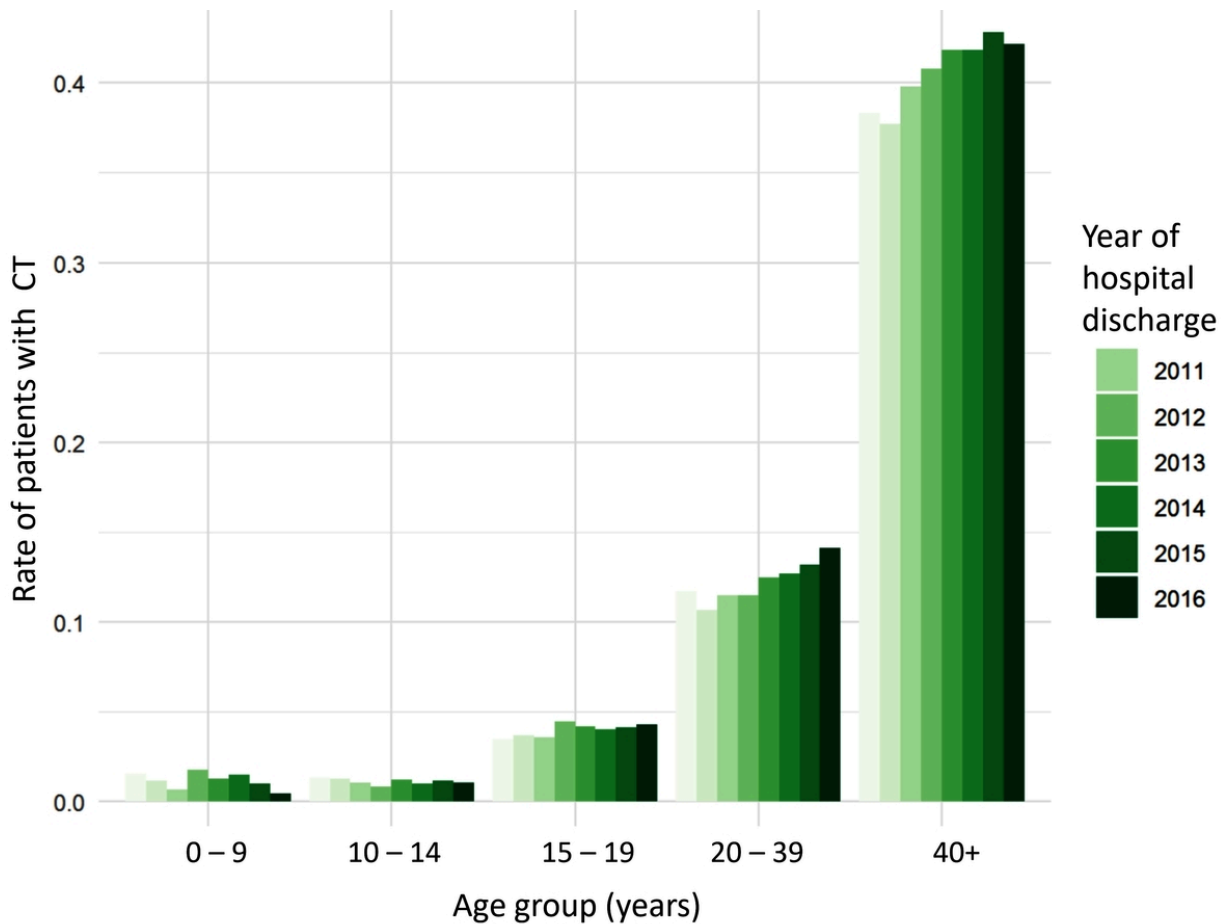


Fig. 3: Evolution of CT rate according to age group, 2009-2016

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Rate of CT according to patient age group

Age group (years)	Hospital stays	Hospital stays with CT	%
00 to 09	7606	91	1,2
10 to 14	16565	189	1,1
15 to 19	18882	746	3,4
20 to 39	30726	3760	12,2
40 +	20817	8461	40,6

Fig. 4: Rate of CT according to patient age group (average 2009-2016)

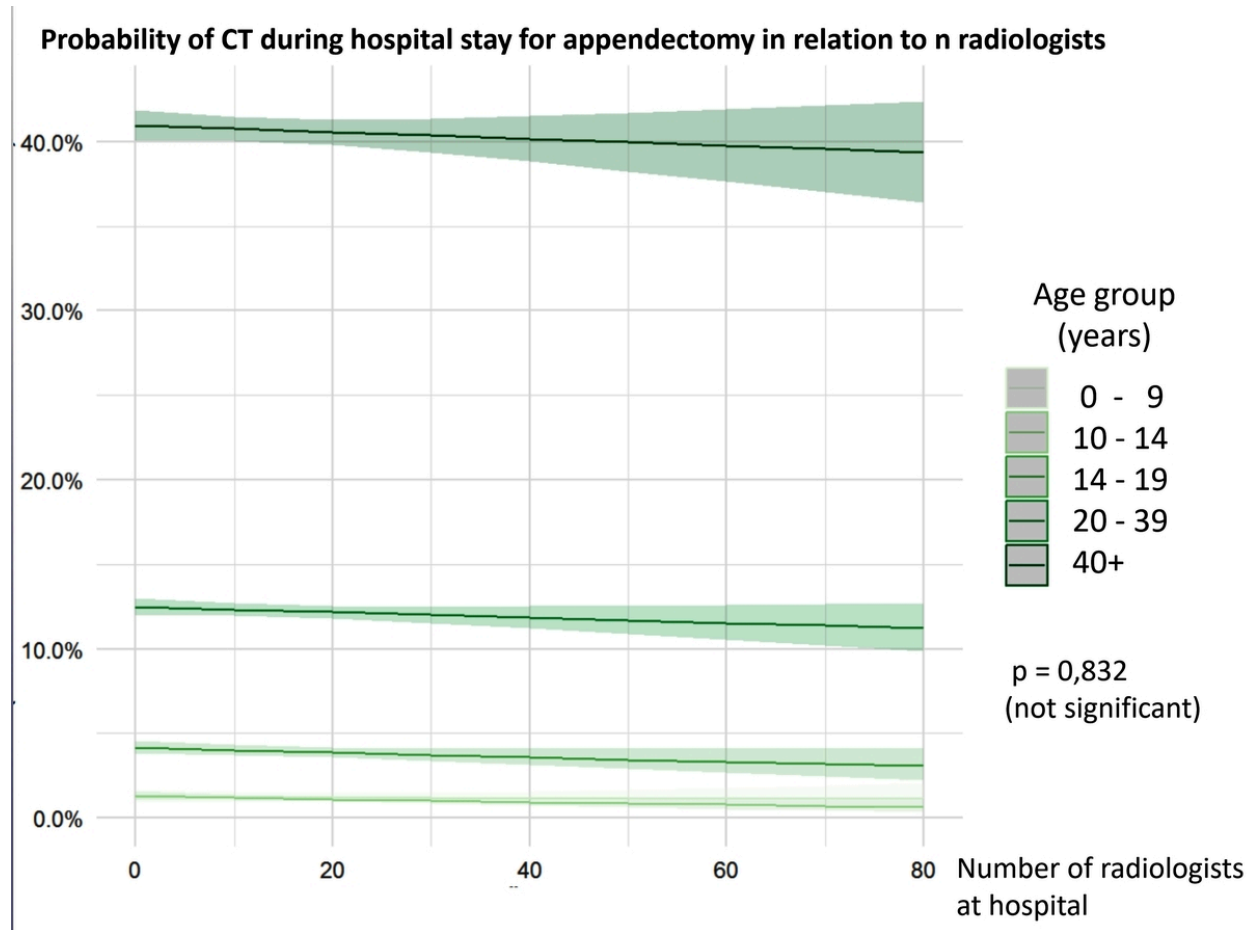


Fig. 5: Probability of CT during hospital stay for appendectomy in relation to n radiologists

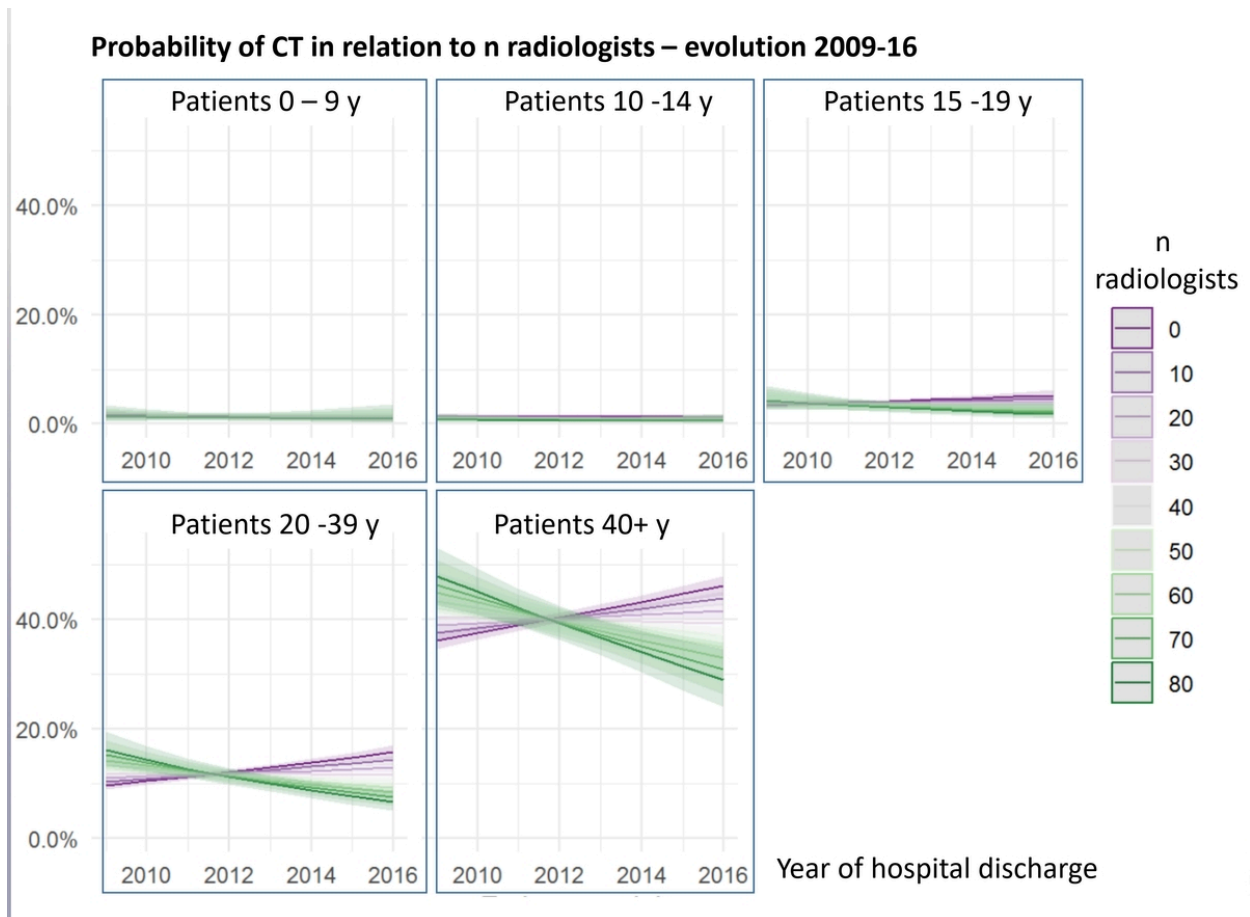


Fig. 6: Probability of CT in relation to n radiologists - evolution 2009-16

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Conclusion and recommendations

Within the study period between 2009 and 2016, the rate of preoperative CT examinations in patients undergoing appendectomy in Austria has been strongly dependent on the patient age.

Children up to 14 years had a CT examination only in 1,1 - 1,2% of cases.

This low rate of CT has remained unchanged in the study period, probably representing a high level of radiation protection consciousness in Austria, and the availability of alternative imaging methods without ionizing radiation, namely ultrasound.

In adult patients the rate of CT for diagnosis of appendicitis has moderately increased during the study period, probably representing a general tendency for increasing use of radiologic imaging.

Factors influencing the choice and frequency of imaging methods should be evaluated more thoroughly and constantly, in order to maintain a well balanced approach to imaging decisions in regard of radiation protection.

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