SURGICAL DETERMINANTS, PERIOPERATIVE COURSE AND OUTCOME OF A REPRESENTATIVE PATIENT COHORT WITH ACUTE APPENDICITIS UNDERGOING APPENDECTOMY OVER 3 DECADES

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Acute appendicitis, one of the most frequent emergencies in general surgery, has been repeatedly investigated with regard to specific aspects such as medical history, clinical symptoms, the perioperative management and follow up.

The aim of the study was to investigate relevant and combined determinants for the perioperative management of acute appendicitis a systematic clinical prospective unicenter observational study was conducted. A representative patient cohort was studied (n=9,991; middle Europe) to reflect daily surgical practice through a time period of 27 years divided into 3 separate periods and the frequency of specific categories (e.g., characteristics of the medical history, clinical and intraoperative findings as well as complications), their correlation and relative risk factors for the disease as well as prognosis.

Results. 1. The wound abscess rate was 10.9%. Perforation, surgical intervention in time, acute, gangrenous and chronic appendicitis, age, accompanying diseases such as obesity, arterial hypertension, diabetes mellitus, sex, and missing pathological finding intraoperatively had a significant impact on the postoperative development of a wound abscess. 2. The longer the specific appendicitis-associated medical history was, the more frequent a perforated appendicitis occurred, greater the appendectomy (AE) rate in a non-inflamed appendix and higher the rate of required second interventions. 3. The average hospital stay was 11 days. 4. There was a significantly decreased percentage of patients with no pathological finding intraoperatively at the appendix vermiformis (p<0.001), who underwent AE, in particular, through the last investigation period from 1997 to 2000 onto only 6.8% (1974-1985, 15.5%; 1986-1996, 10.3%). 5. The mortality was 0.6%, with no significant difference comparing male and female patients (p=1), the three investigation periods (p=0.077), or the patients with AE in non-inflamed appendix (0.4%) and AE in acute appendicitis (0.6%; p=0.515).

The study showed a positive, partially significant quality improvement within the presenting clinic with regard to a decreased rate of AE in non-inflamed appendix, wound abscess rate and, in particular, to mortality. Despite this, there is a trendy increase of the perforation rate in the investigated cohort.

Conclusion. Quality control remains indispensable for the assessment of the disease’s surgical treatment. A further significant improval of this control might be achieved by multicenter studies and multifactorial evaluations.

Key words: acute appendicitis, appendectomy, surgical results

* Both authors are equally involved in study evaluation, manuscript draft and final proof-reading; therefore, Drs. Boenigk and Meyer have to be considered first authors.
appendectomy (AE) to reflect daily surgical practice through a time period of almost three decades. In addition to the assessment of relevant prognostic factors and quality control of surgical treatment, changes of various disease-associated perioperative aspects were determined.

MATERIAL AND METHODS

From January 01, 1974, to December 31, 2000 (date of initiated reorganization of departments and clinics in surgical and operative disciplines with the following discontinued data registration), subdivided into three time periods (1974-1985, 1986-1996, and 1997-2000), 9,991 patients who had undergone AE were enrolled in a systematic clinical prospective unicenter observational study at the Department of Surgery, Carl-Thiem Hospital, Cottbus (Teaching Hospital of the Charité at Berlin, East Germany, Middle Europe) and evaluated using a computer-based registry. The only inclusion criterion was the surgical treatment with AE, which was performed in patients with acute appendicitis or unclear signs and symptoms in the right lower abdomen. Exclusion criteria were: Conservatively treated subacute appendicitis and interventions, in which the appendix was simultaneously resected, e.g., in tumor-associated colon resections.

Overall, 12 categories were evaluated, from which 76 items on diagnosis and treatment of appendicitis were derived (tab. 1). These categories were selected from treatment results of an earlier appendicitis-appendectomy registry of the reporting hospital and a time period from 1958 to 1973 (1, 2).

Statistics

The data were registered, evaluated (for descriptive statistics) and statistically tested by the mean of SPSS for Windows. Linear regression was calculated to determine the frequency of acute appendicitis over time. For the comparison of the frequencies, $\chi^2$ test was used whereas $t$ test was used to compare the constant variables as appropriate. To determine correlation or complex association of various factors with such a variable, binary logistic regression was determined to elucidate relevant prognostic factors and their impact on the relative risk of complications and the quality of surgical treatment. A $P$ value < 0.05 was considered to be statistically significant.

RESULTS

Multivariate analysis

Overall, 9,991 patients (females, n=5,068; 50.7%), who underwent AE, were enrolled in the study. The number of AE per year decreased from maximally 500 in 1978 to minimally 241 in 2000 with the greatest decrease in subsequent years 1988 and 1989 (n=469 and n=316, respectively), in particular, in patients being 16 to 59 years old (fig. 1).

Table 1 (Part A). Overview of all categories and items, which were evaluated with univariate analysis

<table>
<thead>
<tr>
<th>Categories</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 medical history</td>
<td>typical 72.8%</td>
</tr>
<tr>
<td></td>
<td>atypical 26.5%</td>
</tr>
<tr>
<td></td>
<td>simultaneous intervention 0.7%</td>
</tr>
<tr>
<td>2 duration of medical history</td>
<td>without 0.6%</td>
</tr>
<tr>
<td></td>
<td>to 12 h 23.1%</td>
</tr>
<tr>
<td></td>
<td>to 1 d 42%</td>
</tr>
<tr>
<td></td>
<td>to 2 d 15.5%</td>
</tr>
<tr>
<td></td>
<td>to 3 d 6.7%</td>
</tr>
<tr>
<td></td>
<td>&gt; 3 d 12.1%</td>
</tr>
<tr>
<td>3 finding at admission</td>
<td>65.8% typical</td>
</tr>
<tr>
<td></td>
<td>24.8% appendicitis can not be excluded</td>
</tr>
<tr>
<td></td>
<td>8.7% signs of a peritonitis</td>
</tr>
<tr>
<td></td>
<td>5.6% local signs of peritonitis</td>
</tr>
<tr>
<td></td>
<td>3.1% diffuse signs of peritonitis</td>
</tr>
<tr>
<td></td>
<td>0.5% localized inflammatory infiltrate</td>
</tr>
</tbody>
</table>
## Appendectomies over 3 decades

### Time Point of Surgical Intervention

<table>
<thead>
<tr>
<th>Time Point of Surgical Intervention</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>In time</td>
<td>86.2%</td>
</tr>
<tr>
<td>Delayed by the patient</td>
<td>10.4%</td>
</tr>
<tr>
<td>Delayed by the physician</td>
<td>2.3%</td>
</tr>
<tr>
<td>Delayed by the clinic</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

### Typical Cut at the Abdomen

- Mc Burney laparotomy: 84.2%
- Median laparotomy: 3.6%
- Paramedian cut: 1.4%
- Pararectal cut: 0.2%
- Others: 1%

### Laparoscopy (since 1996)

- Laparoscopically: 3.5%
- Laparoscopically initiated and converted: 0.8%
- Appendectomy in gynecological intervention: 0.1%

### Intraoperative Finding (Macroscopically)

- Appendectomy in acute finding: 80%
- Acutely inflamed: 62%
- Gangrenous: 10.9%
- Perforated with local peritonitis: 9.8%
- Perforated with diffuse peritonitis: 4.6%
- Secundarely inflamed: 0.4%
- Appendectomy in non-inflamed appendix: 11.2%
- Objawy towarzyszące / accompanying findings: 10%
- Lymphadenitis mesenterialis: 5.5%
- Gynecological: 1.4%
- Other diseases: 3.1%

### Surgical Treatment

- Appendectomy: 86.7%
- Appendectomy + drainage: 13.1%
- Abscess drainage: 0.2%

### Overall Results (Univariate Analysis) of All Categories and Items

#### Meckel’s Diverticle

- Not found: 78.3%
- Not searched for: 19.2%
- Found: 2.4%
- Resected: 1.9%
- Left in situ: 0.5%

#### Use of Antibiotics

- None: 81.8%
- Because of local indication: 16.2%
- Because of general indication: 2%

#### Accompanying Diseases

- Without: 92%
- Diabetes mellitus: 1.1%
- Obesity: 2.5%
- Arterial hypertension: 1.8%
- Decompensated cardiac insufficiency: 0.3%
- Pulmonary insufficiency: 0.4%
- Renal insufficiency: 0.3%
- Combined: 2.5%

#### Pregnancy

- 0.9% of female patients

#### Local Postoperative Complications / Wound Healing

- Primary healing: 87%
- Abscess of the abdominal wall: 10.9%
- Intraabdominal abscess: 1.6%
- Abscess within the Douglas’ space: 0.5%
- Subphrenic abscess: 0.1%
- Not specifically characterized intraabdominal abscess: 1%
- Diffuse peritonitis: 0.4%
- Ileus: 0.4%
- Enteral fistula: 0.1%
- Postoperative bleeding: 0.2%

#### General Postoperative Complications

- Second intervention: 2.5%
- Not otherwise specified: 1.6%
- Bronchitis: 0.4%
- Pneumonia: 0.4%
- Superficial thrombosis: 0.1%
- Deep thrombosis: 0.1%
- Pulmonary embolism: 0.2%
- Patients died: 0.6%
The sex ratio did not change through the study period and was almost equal with 1.01: 1 (male:female; group of patients 15 years old, 1.04:1; group of patient 15-60 years old, 1.03:1), but with the epidemiologically typical changes in the group of patients > 60 years old (1:0.37). Through the whole investigation period, 87.7% of cases were intraoperatively confirmed as acute appendicitis; the remaining 12.3% of AE did not show a pathological finding. The mean of the “false-positive” AE (i.e., in non-inflamed appendix) decreased significantly from 15.5% (1974–1985) to 6.8% (1997–2000; 1986–1996, 10.3%) (p<0.001). Interestingly, females predominated in the group of patients with no detectable acute appendicitis intraoperatively (male:female, 30.3%; 69.5%). This is, in particular, the case in patients between the 15th and 55th year of age with an increase through the time periods: 1974-1985, 68.3%; 1997-2000, 74.7%.

After a preinterventional course of more than 48 hours, the following observations were made: The longer the disease-associated medical history lasted, the greater the rate of AE with non-inflamed appendix was (p<0.001); e.g., < 3 d, 15.4%; > 3 d, 39.7%. In addition, the rate of AE with detectable appendicitis was the highest if there were typical clinical symptoms (95.3%; highest rate in the group with clinical signs of peritonitis: local, 97%; diffuse, 98.3%).

Specific aspects

Perforated appendicitis (general frequency: overall, 13%; males, 15%; females, 11.3%)

There was a significantly higher rate in the youngest and oldest group of patients: Age 0-1 year, 33.3%; 2-5 years, 30.5%; 86-95 years, 50%. Surprisingly, the perforation rate was not significantly higher in cases with typical compared with atypical medical history of acute appendicitis. Through the three subsequent investigation periods, there was only a tendency of an increasing perforation rate: 12.9%; 13.1% and 14%, respectively (p=0.094). While the multivariate analysis did not reveal any significant prognostic factor (out of the spectrum comprising age, sex, perforation, surgical intervention in time, intraoperative finding at the appendix, obesity, and accompanying disease), the univariate analysis showed a 1.69-fold and 1.44-fold increased risk, respectively, for the occurrence of a perforation, which depended on the duration of medical history and age (specificity, 82.1%; sensitivity, 37.2%; overall probability of prediction, 80.2%).

Wound abscess

There was a significantly higher rate in females (p<0.001), who developed this type of postoperative complication (mean, 10.9%) and, in addition, a significantly increased frequency in the age range between 46 and 95 years (p<0.001) (highest rate in patients 66 to 75 years old of 33% as well as 0 and 1 year of 27.8%; p<0.001). Perforation, surgical intervention in time, acute, gangrenous and chronic appendicitis, age, obesity, accompanying diseases, sex, and no detectable inflammation at the appendix intraoperatively showed a significant impact on the postoperative development of a wound abscess. Independent factors were as follows: 1) Perforation, 14.9-fold increased risk; 2) gangrenous appendicitis, 4.3-fold increased risk; 3) Obesity (4.13-fold); 4) Age, and 5) sex (4 & 5 less fold than 1, 2, & 3).

In this context, there was a significant increase of antibiotic use:
– for the local finding of 59.4% (1974-1985); 54.7% (1986-1996) to 71.7% (1997-2000), and
– for the suspicious generalized peritonitis up to 24.7% between 1997 and 2000 (previous two investigation periods, 2.2% and 1.7%, respectively).
Appendectomies over 3 decades

Relevant risk factors and treatment-dependent items (tab. 2)

Obesity

Obesity was registered with a frequency of 2.5% (mean) with no statistically significant difference comparing males (2.8%) and females (2.2%) and through the three subsequent investigation periods (p=0.46 and p=0.262, respectively). The obesity rate in patients with no postoperative wound complication was only 1.7% whereas in case of a wound abscess, this rate was significantly higher (8.9%; p<0.001).

Diabetes mellitus

The frequency was 1.1% (mean). There was a significant increase of the incidence in patients older than 46 years (peak, 10.7% if the patients were 66-75 years old), but with no difference between males and females (p=0.624) and through the time periods (p=0.128). Diabetes mellitus was significantly more frequent in patients with a wound abscess versus those without this complication: 3% and 0.8%, respectively.

Arterial hypertension

Arterial hypertension was documented in 1.8% of cases with no significant differences between males and females (p=0.879). However, there was a higher incidence in patients older than 46 years (p<0.001) and through the investigation periods (p=0.001): 1% (1974-1985); 3.5% (1997-2000). Furthermore, a significantly higher wound abscess rate in patients with arterial hypertension was found (p<0.001; 4.1% versus 1.5%).

Accompanying diseases

The rate of more than one accompanying disease was 2.5% (mean). It was not surprising that more such diseases occurred if the patients were older than 46 years (p<0.001) with a continuous increase of this rate depending on older age (peak, 41.7% within the age group from 86 to 95 years). There was no difference comparing males and females (2.3% / 2.6%; p=0.334), but with an increase through the investigation periods from 1.7% (1974-1985) to 5.6% (1997-2000). The occurrence of more than one accompanying disease led to a significantly higher wound abscess rate: 6.4% versus 2% (p<0.001).

Appendectomy-associated second interventions (in total, 2.6%)

Comparing the various age groups, second interventions were significantly more frequent (p<0.001) in the age groups from 0-1 year, 2-5 years, and older than 55 years with no predominating occurrence in males or females (p=0.54; males, 2.8% / females, 2.2%). While the second interventions were more frequent from 1986-1996 (3.7%) versus the investigation

Table 2. Overview of the relevant risk factors

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Frequency mean</th>
<th>Age</th>
<th>Sex ratio</th>
<th>Changes through the time periods</th>
<th>Alterations of wound healing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obesity</td>
<td>2.5%</td>
<td>highest incidence 9% (age group 56-65 years)</td>
<td>no difference (p=0.46)</td>
<td>none</td>
<td>increase from 1.7 to 8.9% (p&lt;0.0001)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1.1%</td>
<td>highest incidence &gt; 46 years (p&lt;0.0001)</td>
<td>no difference (p=0.624)</td>
<td>no difference (p=0.128)</td>
<td>tendency of an increase from 0.9 to 1.6% (p&lt;0.0001)</td>
</tr>
<tr>
<td>Arterial hypertension</td>
<td>1.8%</td>
<td>highest incidence &gt; 46 years (p&lt;0.0001)</td>
<td>no difference (p=0.879)</td>
<td>increase (p&lt;0.0001)</td>
<td>from 1.0 to 3.5% (time period 1997-2000) (p&lt;0.0001)</td>
</tr>
<tr>
<td>Combined accompanying diseases</td>
<td>2.5%</td>
<td>highest incidence &gt; 46 years (p&lt;0.0001)</td>
<td>no difference (p=0.334)</td>
<td>increase (p&lt;0.0001)</td>
<td>from 1.7 to 5.6% (time period 1997-2000) (p&lt;0.0001)</td>
</tr>
</tbody>
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appendicitis, 41.8% developed a wound abscess and 36.4% underwent a second intervention after previous AE.

A specific aspect of this investigation was to study age-related incidence of acute appendicitis for the city of Cottbus and the Cottbus area, which has become possible since the Municipal Hospital has been the only hospital of the area.

In the Cottbus area, there has been a considerable migration: In 1955, 64,508 inhabitants had lived in Cottbus, whereas through the following 20 years, the number of citizens increased by 32,436 up to 96,944 in 1975 continuing until 1989 to greatest number of 128,943. From 1989 – 2000, the number decreased by 20,702 down to 108,241 (fig. 2).

In particular, number and profile of the Cottbus population was found in the age group > 14 years old. The number of people of this age increased by 16,483 up to 28,555 in 1989. After that, the number was cut in half down to 13,483 within 10 years only (2000). The proportion of the whole population decreased from 22.1% (1989) to 12.6% in 2000. In addition, also the age group 15-60 decreased. However, the retirees has steadily increased from 11,699 (1955) to 20,410 (2000; 18.9% of the whole population).

Within the investigation period, there was an overall decreasing tendency in the incidence of acute appendicitis, in particular, in the children and teenagers as well as in the age group older than 60 years. In the group of retirees, incidence has not changed since 1990 except fluctuation by coincidence (fig. 3).

Appendectomy-related death (in total, 0.6%)

There was a continuous increase of mortality from the younger to the older age groups (p<0.001) but with a considerably higher percentage in patients, who were older than 75 years (9.2%) (age group from 86-95 years, 25%). In addition, there was no difference of mortality, comparing 1) males and females (p=1),
2) investigation periods (p=0.077), and
3) patients with acute inflammation and those with non-inflamed appendix (p<0.515).

Patients with more than one accompanying disease died significantly more frequent (10.6% versus 0.2%; p<0.001) after AE. In patients with a second intervention, there was a significantly higher mortality (p<0.0001). Out of the 55 death cases, 65.4% showed a perforated appendicitis, 41.8% developed a wound abscess and 36.4% underwent a second intervention after previous AE.

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Appendectomies over 3 decades

Table 3. Overview of the relevant items with regard to second intervention and death

<table>
<thead>
<tr>
<th>Item</th>
<th>Frequency</th>
<th>Age</th>
<th>Sex ratio</th>
<th>Time periods</th>
<th>Rate of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second intervention</td>
<td>2.5%</td>
<td>male 2.8%;</td>
<td>no difference</td>
<td>increase</td>
<td>increase</td>
</tr>
<tr>
<td></td>
<td></td>
<td>female 2.2%;</td>
<td></td>
<td>time period,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>age group 0-1; 2-5; (p&lt;0.001)</td>
<td></td>
<td>1986-1996; 1988/89</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;55 years</td>
<td></td>
<td>increase</td>
<td>increase</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>from 2.4 do</td>
<td>from 2.1 to 5.8%</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(p=0.53)</td>
<td>(p&lt;0.001)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>increase</td>
<td>increase</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.5% (p&lt;0.001)</td>
<td>(p=0.000)</td>
</tr>
<tr>
<td>Mortality</td>
<td>0.6%</td>
<td>male 0.6%;</td>
<td>no difference</td>
<td>increase</td>
<td>increase</td>
</tr>
<tr>
<td></td>
<td></td>
<td>female 0.5%;</td>
<td></td>
<td>from 0.3 to</td>
<td>from 2.3 to 36%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>group, &gt; 75 years</td>
<td></td>
<td>10.6% (p&lt;0.001)</td>
<td>(p=0.515)</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>

ns – not significantly different

DISCUSSION

There is a number of investigations to assess outcome and quality of surgical treatment such as AE in appendicitis. But overall, there are predominatingly retrospective studies (3-18) if the incidence of the appendicitis or the AE rate are investigated versus the less frequent prospective studies (19-23). However, there were no comparable studies through such a long time period of 27 years, which were prospectively conducted. The high number of complete data collections enables the competent analysis of relevant disease-specific characteristics. This new quality includes the option to investigate more complex study aims and aspects such as quality control and identification of clinical variables for the correctness of diagnosis and treatment course after AE versus a retrospective study based only on diagnosis code numbers (3, 5, 6, 8, 9, 10, 12, 23), medical documents (4, 13, 18, 24), or reports on the surgical interventions (14-17, 19, 20, 21, 24, 25).

In addition, prospective multicenter studies on the acute appendicitis as that of the East German Study Group led by Lippert et Gastinger (20, 22, 26, 27, 28) are available and were used as established study results for reference (29).

Comparison of AE in acute versus non-acute intraoperative finding at the appendix

The relative decrease of cases with intraoperatively non-inflamed appendix is confirmed in the literature but with considerable varia-

“Non-inflamed appendix” intraoperatively more frequent in women

Andersson et al. found that, with no specific reasons, the rate of non-inflamed appendix intraoperatively is 2-fold higher in women of...
fertile age than in men of the same age (5). It is likely that unexplored gynecological causes play a substantial role since this rate is also higher in further female age groups than in men (3, 23, 31) and did not decrease through the investigation period (6). Gastinger et Eckhardt reported also on the highest rate of 70% of AE with non-inflamed appendix intraoperatively in women with chronic symptoms in the lower abdomen in their multicenter study (26). Lauschke’s (32) and de Dombal’s (33) demands from the eighties that a precise medical history and an appropriate clinical exam should provide a rate of diagnostic error lower than 10% as had been achieved for the patients at that time in the Cottbus area and has distinctly fallen below this value with the help of the diagnostic advances in the Cottbus area during the last investigation period (6.8%). A further significant decrease can not be expected, in particular, if considering the sex ratio; approximately 70% of the AE with non-inflamed appendix were female patients with a stable sex ratio overall.

Sex ratio

The data on the overall sex ratio differ considerably in the literature including the concordant opinion that in case of a balanced sex ratio, a critical indication for the AE can be assumed. Many authors consider the sex ratio as control for finding such a “balanced indication”. For instance, Styrud et al. presented their ratio of 1:1.09 as balanced (17), closed to which the data of our presented study can be considered. In a broader indication for AE, females predominate (34). In contrast, Primastesta et al. found a sex ratio of 1.8:1 not favoring the females in Great Britain (15); the multicenter study in East German districts reported a ratio of 1:1.5 (20).

However, there are also contrary reports describing a higher percentage of male than female patients: Addis et al. in the U.S.A., 1.4:1 (3), Gastinger et al. in East Germany 1.3:1 (19), Kang in Great Britain, 1.2:1 (10), Wen in Canada, 1.17:1 (23), Körner in Norway, 1.12:1 (21) as well as Noer and Bakken in Norway, 1.09:1 and 1.03:1, respectively (6, 14). The latter one can be considered stable (tab. 4).

In the studies mentioned above, there was no change over time, e.g., in Norway, equal percentages of males and females were observed from the earliest time periods investigated: Noer (1943-1972) (14) to Bakken (2001) (6) and Körner (21). The extreme reversion of the sex ratio in Great Britain from 1:1.8 (1970-1986) to 1:2.1 (1999-2000) can only be explained with pursuing a very adequate indication for an AE though Hontschick reported in 1989 that the sex ratio could be reduced from 1:2 to 1:1 by a more strict indication (35).

Perforated appendicitis (36)

The mean perforation rate was 13.1%. Gastinger et al. reported on 8.3% of the overall perforation rate in their multicenter study (former East Germany in 1988/1989) (19). In 1996/97, this rate decreased down to 5.8% (20) the lowest value ever achieved. Below the rate found for the Cottbus area, there was only the rate described by Primastesta et al. in Sweden: 9.3% (1970-1986) (15). Similar rates of a perforated appendicitis were reported by Noer (15.2% in 1972) and Bakken (14.8% from 1990 to 2001) at hospitals in Norway (6, 14). Higher rates were observed by Styrud (21%) from Sweden (1986-1993) (17), Addis (19.2%) from the U.S.A. (1979-1984) (3), Körner (20%; 1989-1998) (21) and Blomqvist (15.2%; 1989-1993) (8).

An increase as also reported in the presented study was also found in the U.S.A. (3) from 13.6% (1964) to 31.4% (1984) (16) as well as in Norway by Bakken et al. (6) from 12.9% in 1990 to 21% in 2001. Stable rates were described by Noer (1943, 15.5%; 1972, 15.2%) (14) and Styrud: 1986-1993, 21% (17). Only one study detected a decrease of the perforation rate: 1989, 41.4%; 1993, 22.1% (8). It can be assumed that there is an association of the increased perforation rate to the increased portion of an older population but this was not investigated in detail.

Age-related perforation rate

Simultaneously as in the presented study, Lau et al. found a significantly higher perforation rate in patients older than 70 years (85.6%) (37) and children 0 to 4 years old with a perforation rate of 27% (8% in patients 10 to 14 years old) (38). A higher rate in the group of patients younger than 10 years was also...
Table 4. Study overview on appendicitis/AE worldwide. Data specifies on quality control: Sex ratio (M:W), median of age, general and specific incidence, rate of AE with detectable appendicitis and with non-inflamed appendix, respectively, perforation rate, wound infection, mortality.

<table>
<thead>
<tr>
<th>Author / country</th>
<th>M:W</th>
<th>Age (median)</th>
<th>Incidence</th>
<th>Acute finding</th>
<th>Non-inflamed appendix</th>
<th>Perforation</th>
<th>Wound infection</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastinger I et al. 1991 (26)</td>
<td>1:3.1</td>
<td>median 20 yr</td>
<td>n.d.</td>
<td>70,3%</td>
<td>29,7%</td>
<td>8,3%</td>
<td>0,32%</td>
<td></td>
</tr>
<tr>
<td>Koch A et al. 2002 (20)</td>
<td>1:1,5</td>
<td>median 19 yr</td>
<td>n.d.</td>
<td>75,1%</td>
<td>24,9%</td>
<td>5,8%</td>
<td>0,3%</td>
<td></td>
</tr>
<tr>
<td>Bakken IJ et al. 2003 (6)</td>
<td>1:0,3:1</td>
<td>median 27 yr (50%; 10-29 yr)</td>
<td>117/116 a 225 d (10-29 yr)</td>
<td>81/60% a (1990) 86/71% a (2001) 19/29% a (1990) 14/29% a (2001)</td>
<td>12% 9% a (1991) 21% 7% a (2001)</td>
<td>0,3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luckmann R et al. 1989 (12) / 1991 (32)</td>
<td>n.d.</td>
<td>n.d.</td>
<td>96; 170 d (10-19 yr)</td>
<td>89,1%</td>
<td>10,9%</td>
<td>42,6% (0-91 yr)</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>Andersson R et al. 1994 (4)</td>
<td>1:2,6:1</td>
<td>peak, 10-14 yr</td>
<td>116; 167 appendectomy</td>
<td>256 c (1970) 182 c (1989)</td>
<td>67-73% increase</td>
<td>51%</td>
<td>12-16%</td>
<td></td>
</tr>
<tr>
<td>Noor T et al. 1975 (14)</td>
<td>1:0,9:1</td>
<td>53% &lt; 20 yr</td>
<td>50% b</td>
<td>72,2% c (1943) 74,6% c (1971)</td>
<td>27,8%</td>
<td>15,5% c (1943)</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>Styrud J et al. 1999 (17)</td>
<td>1:1,09</td>
<td>n.d.</td>
<td>stabile population</td>
<td>70,9% c (1986) 87,1% c (1993)</td>
<td>29,1%</td>
<td>21%</td>
<td>7,7% 100% (&gt; 70 yr)</td>
<td></td>
</tr>
<tr>
<td>Addiss DG et al. 1990 (3)</td>
<td>1:4:1</td>
<td>median 21 yr</td>
<td>69% &lt; 30 yr</td>
<td>280</td>
<td>110</td>
<td>49 d (f, 35-44 yr) 19/2/17,8% a 51% (&gt; 65 yr)</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>Blomquist PE et al. 1998 (2)</td>
<td>1:0,1:1</td>
<td>median 23 yr</td>
<td>146 c (1989) 136 c (1993)</td>
<td>78,7% 77% c (1989) 81,6% c (1993)</td>
<td>21,3% 23% 18,4%</td>
<td>15,2% 26/18% a 41,4 c (1989)</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>Primastea P et al. 1994 (15)</td>
<td>1:1,8</td>
<td>peak, 15-19 yr</td>
<td>n.d.</td>
<td>n.d.</td>
<td>n.d.</td>
<td>9,3% 24,8/25,3% a (&gt; 65 yr)</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>Körner H et al. 2001 (21)</td>
<td>1:1,2:1</td>
<td>median 24 yr</td>
<td>84</td>
<td>38% 20%</td>
<td>22% 38% (&lt; 5 yr) 48% (&gt; 65 yr)</td>
<td>n.d.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wen SW et al. 2001 (23)</td>
<td>1:1,7:1</td>
<td>n.d.</td>
<td>n.d.</td>
<td>83,3% 16,7%; 10,5/23,9% a</td>
<td>20,6%</td>
<td>23,1% d (&gt; 45 yr)</td>
<td>n.d.</td>
<td></td>
</tr>
</tbody>
</table>

*a incidence of male/female population, b decrease of the incidence in %, c only the most current time period shown, d peak of the incidence; n.d., no data
observed by Ricci et al. In addition, there was also a delayed transferral of the patients of this age group. They also found out that age and transferral had an impact on the frequency of perforation (16).

Sex ratio related to perforation

The perforation predominated in men versus women (own data, 15%: 11.3%). Bakken et al. found a similar ratio, 12%: 9% in 1991 and 29%: 21% in 2001 (6); in addition, Addis, 19.2%: 17.8% (6); Blomqvist, 26%: 18% (8), and Primatessa, 23%: 22.3% (15). The cause is not clear. Surprisingly, perforated appendicitis was reported to be independent from age and sex in a few studies (4, 12, 39, 40).

Treatment-relevant risk factors

The definition of medical criteria for accompanying diseases has been changed as the surgical treatment for the last 27 years. Arterial hypertension and diabetes mellitus play a major role for morbidity and mortality in Germany and throughout the world. Mann et al. reported on a current prevalence of arterial hypertension with 20% in adults in Germany (2004), and diabetes mellitus with minimally 5-8% (increasing tendency) (40).

Accompanying diseases

The frequency of diabetes mellitus in all patients from the Cottbus area was distinctly lower than in general. This is caused by the fact that acute appendicitis is a disease of younger age (median of age, 23 years). Independently from this, there was a negative impact of the diabetes mellitus on the course after AE in older patients. The ESTHER study (41) in 2004, an epidemiological study for prevention, early detection and optimal treatment of chronic diseases in the older population, revealed a prevalence of diabetes mellitus of 11% in the group of patients 50-74 years old. This is in concordance with data from the Cottbus area showing a prevalence of diabetes mellitus of 10.7% in the group of patients 66-75 years old, of arterial hypertension of 16.1% in patients 76-85 years old but the latter one was distinctly lower than the percentage from the ESTHER study (42%). Similarly, the obesity rate with 8.9% (prevalence, 26.3%) was also much lower (41).

Wound infections

The overall risk of wound infections in normal weight patients has been reported to be 4.7% in abdominal surgery whereas patients with a BMI > 30 kg/m² have a higher risk of 11% (42). A different study (n=3,000 cases of abdominal surgery with a 10-year follow up) revealed a general wound infection rate of 3.53% (43). Gastinger et al. (19) reported a wound infection rate of acute appendicitis in both multicenter studies with 8.3% (1988/89) and only 5.8% (1997/98) ranging considerably from 8 to 75% in various hospitals (1-50% with and without use of antibiotics). There were similar data from Sweden: Mean of wound infection rate, 7.7% (1986-1993) (17); in the presented study, 10.9%. A prospective analysis from the U.S.A. (1991-1999) showed a higher rate (16%) (44). Again, the multicenter study (20) revealed a wound infection rate of 8.7% in AE with a non-inflamed appendix, which was also found in other studies with rates up to 14% (45). This underlies that the discussion on pursuing strictly a correct indication for AE needs to be continued.

Hospital mortality

Compared with the presented study, showing a hospital mortality of 0.6%, there was a similarly low mortality with 0.32% in the multicenter study in 1996/97 (20) and others: 0.21% (17); 0.3% (3); 0.3% (10); 0.2% (6). An exceptional result was reported by a study from the U.S.A. with a mortality of 1.4% (< 60 Jahre, 0.15%; > 80 Jahre, 4.7%) and even 1.8% (44) and a still higher mortality (3.5%) in a study from Central Africa (46).

Taken together, the data suggest that the mortality after AE is not associated with the severity of appendicitis and accompanying diseases. An evidence might be the fact that there is still a residual mortality of 0.4% in AE with non-infamed appendix in the Cottbus area. This indicates that the mortality of AE is distinctly lower than that of other ab-
Appendectomies over 3 decades

dominal surgical interventions, which can be related to the fact that appendicitis is a disease of the younger age, in which there is only a lower frequency of accompanying diseases (27).

CONCLUSIONS

It can be derived from the difference of the age-specific incidence of acute appendicitis that an epidemiological evaluation of data on acute appendicitis and AE is required in future analyses. This recommendation is emphasized by the demographic change in the industrialized countries including the spectrum of age groups. In addition, a competent surgical quality control can be achieved, which is also relevant in the process of changes in the surgical treatment such as inauguration of novel procedures (24, 47-50), use of antibiotics and others. All this provides transparency in important quality criteria of surgical treatment and only this can allow to sufficiently assess and correctly compare the outcome of patients with regard to hospital mortality, frequency of second interventions, perforation rate, or the rate of AE in non-inflamed appendix as well as to follow tendencies in the medical development but not to accept them uncritically.

REFERENCES