Heino Kienapfel
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(Eds.)

The Infected Implant
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Foreword

Infections following joint arthroplasty are a severe complication for each patient with a negative impact on their quality of life. Infections are also a challenge for the surgeons, microbiologists and hospitals involved. Finally, due to their financial impact infections will increasingly be monitored and controlled, as they have a direct influence on how hospitals will be reimbursed; as such, preventing infections has been identified as a source of cost reduction. Furthermore, the issue of infection needs to be a standard part of any outcome measurement – be it based on information obtained from registers or from patient reported outcome studies / questionnaires. The goal of the 2nd International Arthroplasty Symposium – The Infected Implant of November 21–22, 2008 in Potsdam was to provide an expert update on the state of the art, with regard to the basic knowledge on and clinical treatment options for this patient group.

We would like to thank all the presenters for their contributions to this book. Among the topics you will find valuable information on: basic science, epidemiology, microbiology, documentation in orthopaedic surgery and on, surgical as well as local and systemic drug therapy algorithms.

We hope that this book will help us all to further improve the treatment quality and outcome for our patients.

Klaus-Dieter Kühn
Heino Kienapfel
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In surgery, especially in orthopaedic surgery, quality control is one of the main tools to gain feedback of the surgeon’s activity for healthcare professionals. The results from our daily activity, the outcome of the surgical procedures are widely published in the scientific literature and in on-line versions of our peer-reviewed journals. Statistical analysis of the data from the scientific works and meta-analyses created from them are major tools to have information of our surgical activity, or to get knowledge about the quality of orthopaedic devices we are using.

The legal aspect of documentation is nowadays obvious for every practicing surgeon. The accurate documentation of each and every patient who underwent a procedure is essential in legal affairs. Also national healthcare systems use the data of our scientific or statistical databases, that is why the financial impact of documentation is enormous.

Establishing arthroplasty registers in the late 1970’s – the first ever was the Swedish Knee Arthroplasty Register in 1975 – had also the goal to improve quality of orthopaedic surgical activity in order to rule out implants with clinically poor results. The output was that the revision burden of the implants – both hip and knee – decreased significantly. The publication of the results from the Swedish Arthroplasty Register could be widely used in all over the world. Another result of the Swedish model was that other countries, first of all Scandinavian countries followed the Swedish example.

Recent publications of the Swedish Arthroplasty Register report that the cemented technique is the dominating type of fixation throughout Sweden. Infection prophylaxis is achieved in both ways: systemic and local application of antibiotics is widely used. The septic revision rate after total hip arthroplasty (THA) is about 0.6%, which is an enormous improvement compared to the data of the past decade. Furthermore, the colleagues from Sweden report that MRSA is fortunately not yet an issue in Scandinavia.

Norway started its register in 1987, it was a surveillance tool to identify inferior implants as early as possible – as we can read in the Mission Statement of the Norwegian Arthroplasty Register. Colleagues from Norway could detect products like PMMA bone cements with poor survival rates. So the products with high failure rates could be eliminated from the national market. Nowadays the Norwegian group of register professionals has gained the title National Centre of Excellence – 98% of all THA are reported in the Register.

The data from Norway reveal that the number of uncemented THA decreases, while hybrid tech-
1. 

When bone cement without antibiotics disappeared in the last 5 years, local and systemic antibiotic prophylaxis is used in Norway, but systemic antibiotic is administered on a four-times-a-day basis for 24 hours. Increasing number of revisions due to infection are reported in the Norwegian Register, the true causes are being explained.

The financial impact of the Scandinavian registers was that the expenses for the establishment of a national register were compared to those of avoidable revision surgeries. Based upon these findings, further financial support could be achieved by the healthcare systems, as experienced recently in Romania.

The Scandinavian experience made it possible to build up further arthroplasty registers in the European countries. One of the first non-Scandinavian countries was Hungary, which joined the family of national registers in 1998. The success in the funding of a nation-wide register is highly dependent from its strong regulations, compact and effective organisation. The comparability of the national results is achieved by a minimum dataset of arthroplasty registers, which was introduced by the European Arthroplasty Register (EAR).

The financial support of each national arthroplasty register varies from country to country. There is a wide range between the amounts depending on the engagement of the national healthcare system, ministry of health and other official federal or governmental institutions. There are countries, where the government supports the work of registers, like Austria, Romania, and there are other countries, where the financial support is an obligation of the national orthopaedic society together with manufacturers of orthopaedic implants.

An effective system on a country level is only achieved if all orthopaedic and trauma centres are involved, sufficient financial support is secured, and the healthcare system is highly dedicated to obtain data from the national register.

The European Federation of Orthopaedic and Trauma Surgery (EFORT) started the EAR project in 2002 with the goal to collect data from the national registers in the EU, in order to improve the quality of orthopaedic implants throughout Europe. Co-operation agreements with all national arthroplasty registers make it possible to achieve the highest level of osteoarthritis treatment. The EAR is about to introduce new regulatory requirements for implants in the EU.

The publication raising from the data collected in arthroplasty registers are available in annual reports (Sweden, Norway, Denmark) or in peer-reviewed journals. They are available for everybody in the internet portals of each national register.

Treatment guidelines also belong to the topic of documentation, even though if they suggest a sequence of diagnostic and therapeutic tools. The algorithm of managing periprosthetic infections is very useful in daily practice, even if the orthopaedic surgeon has to deal with highly demanding cases. Standardisation of treatment options in form of a defined algorithm helps to improve the quality of treatment and to avoid failures. The publications in peer-reviewed journals are only recommendations, while nation-wide regulations like treatment guidelines are mandatory for healthcare professionals.

In a well-defined treatment algorithm we can choose the proper option from the different solutions: debridement without exchange, one-stage exchange, two-stage revision with or without antibiotic spacer etc. Recurrence of the infection can be kept on a very low rate (under 5%) when we follow the instructions of the Swiss colleagues (The Liestal Algorithm).

Documentation and to share information in the cases of infected implants are of great importance. The distribution of causative agents, like *Staphylococcus aureus* and *Coagulase-negative Staphylococci*, are highly interesting data for both infectologists and orthopaedic surgeons. Polyresistant strains like MRSE and MRSA are also reported in arthroplasty registers in order to be prepared for the increasing number of cases. The results of local and systemic antibiotic prophylaxis are well known from the annual reports of Sweden and Norway. Publications of novel treatment options, like new drugs in chemotherapy, local application of antibiotics or improved antimicrobial coatings, belong to the topics of documentation, too.
Increasing Incidence of Infected THA in Norway Despite Improved Antibiotic Prophylaxis

Lars B. Engesaeter

Introduction

In orthopaedic implant surgery, infection is rare but devastating for the patient and costly for society. With improved surgical techniques, stricter pre- and perioperative routines and antibiotic prophylaxis, the infection rate after primary total hip arthroplasty (THA) has been reduced from 5–10% in the late 1960s to around 1% today (Lidgren 2001; Lidgren et al. 2003; Zimmerli et al. 2004). In previous papers based on the Norwegian Arthroplasty Register, a lower revision rate of primary THAs was found when antibiotic prophylaxis was given both systemically and in the bone cement compared to systemically only, in bone cement only, or compared to no antibiotic prophylaxis at all (Espehaug et al. 1997; Engesaeter et al. 2006). The importance of systemic antibiotic prophylaxis in primary THA surgery seems to be well accepted; however, the benefits of antibiotic prophylaxis in bone cement remain in question (van de Belt et al. 2001).

Based on the data in the Norwegian Arthroplasty Register (NAR), we report in this paper on the use of antibiotic prophylaxis in primary THA and the incidence of reported revisions for infection after primary THAs in the period 1987–2007.

Methods

The Norwegian Arthroplasty Register is a nationwide registry, established in September 1987. Each THA performed in Norway is reported individually by the surgeon by completing a standard form (Havelin et al. 2000). Information on the form includes the identity of the patient, the date of the operation, indication for surgery, type of prosthesis, type of cement, operation time, type of operating theatre, and, if systemic antibiotic prophylaxis was used, the type, duration and dosage. Revision of the implant is defined as surgical removal or change of the whole or part of the implant. Using the unique identification number assigned to each inhabitant of Norway, the information from the primary THA was linked to any eventual revision in the registry.

Survival analyses were performed using the Kaplan-Meier method and the Cox regression model. Relative revision risks (RR) are presented with adjustment for differences among groups in gender, age, cement brand, type of systemic antibiotic prophylaxis, prosthesis type, type of operating theatre, and duration of the operation. The risk for revision due to deep infection was calculated with time stratified into four 5-year periods. Patients who died or emigrated during the follow-up pe-
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period were identified from files provided by Statistics Norway. The follow-up time for the prostheses in these patients were censored at the date of death or emigration.

Results

Since the start of the Register in September 1987 to the end of December 2007, 110,985 primary THAs have been reported to the NAR. In 1987, 82.8% of patients with primary THA received systemic antibiotic prophylaxis, and 99.5% in 2007. Antibiotics in the cement were used in 36% of the operations in 1987 and in 100% in 2007. We have previously shown that the lowest revision risk was found when antibiotic prophylaxis was given both systemically and in the cement (Engesaeter et al. 2003). Compared to this combined regime, patients who received antibiotic prophylaxis only systemically had a revision rate 1.4 times higher with all reasons for revision as endpoint (p = 0.001), 1.3 times higher with aseptic loosening (p = 0.02) and 1.8 times higher with infection as endpoint in the analyses (p = 0.01) (Fig. 2.1).

For the combined antibiotic regime (antibiotic both systemically and in cement), the results were better if antibiotics were administered four times on the day of surgery compared to once (p < 0.001), twice (p < 0.001) or three times (p = 0.02) (Fig. 2.2). In 2007, systemic antibiotic prophylaxis was given four times on the day of surgery in 77% of the primary THAs compared to 30% for the whole period.

For the whole period 1987–2007, 110,882 primary THAs were reported of which 706 were revised due to infection. This number of primary revisions due to infection is increasing. Compared to the primary THAs implanted in 1987–1992, the risk for revision due to infection was 1.3 times higher for those implanted in 1993–1997 (p = 0.05), 1.4 times higher for 1998–2002 (p = 0.01), and 2.7 times higher for 2003–2007 (p = <0.001). This increase in revisions due to infection was also found when analysing separately for cemented THAs and was even more pronounced for uncemented THAs.

Fig. 2.1a–c. Cox-adjusted survival curves with all reasons for revision (a), aseptic loosening (b) and infection (c) as endpoints for THAs with antibiotic prophylaxis systemically and in cement (SC), systemically only (S), in cement only (C), or no antibiotic prophylaxis (None)
Conclusions

The best results of primary THAs were obtained among those patients who received prophylactic antibiotic both in cement and systemically, and where the systemic antibiotic was given four times on the day of surgery. In the Norwegian Arthroplasty Register the number of reported revisions due to infection after primary THA is, nevertheless, increasing.

However, the explanation for the increase in reported infected THAs to the registry is not straightforward. The possibility that the increase is real can of course not be excluded, a finding also reported by Kurtz et al. (2008). Simultaneous changes in possible confounding factors have occurred, however. For example, in recent years low-grade infections of prostheses have been in focus, both for the orthopaedic surgeon and the microbiologist, with better diagnostics for these infections (Zimmerli and Ochsner 2003). In accordance with this, there has been a decrease in the number of reported aseptic loosenings: it is possible that some infections reported today were earlier reported as aseptic loosenings.

Furthermore, more aggressive surgical treatment of early infected THAs without removal of the implant is now more common. Such revisions without removing or exchanging part of the implants are not reported to the register. With modular prostheses, which have become more common in recent years, easily removable parts are exchanged and accordingly reported to the register. This could also contribute to the increase in reported infections.

It is, however, reassuring for us that our recommendations of four doses of systemic antibiotic prophylaxis on the day of surgery combined with antibiotic in the cement still gives the best survival for primary THAs, with all reasons for revision, with aseptic loosening, and with infection as end-point in the analyses.

Conclusions

In the Norwegian Arthroplasty Register the best results for primary THA are found when antibi-