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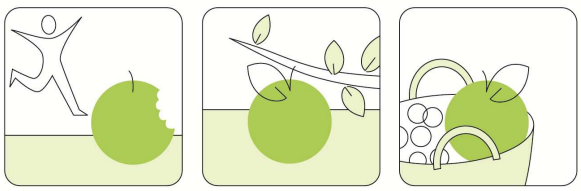

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Executive Summary

General

- To be able to achieve optimum results in medical service for the patients, outcome measurement requires much more detailed and selective basic data than needed for structure and procedure quality measurement.
- The datasets must comply with the requirements of the specific pathology, therefore the options to standardise these datasets are limited.
- With respect to methodology, further standardisation is necessary and possible, with medical devices and pharmaceuticals, as well as surgical interventions and drug therapy having specific individual requirements.

Indicators in Orthopaedics

- From an outcome measurement perspective, the indicators E8 (Revision Rate) and E9 (Revision Burden) from the survey phase are of the greatest relevance.
- Indicator E3 (Inhospital Mortality after Hip Fracture) shows a relevant frequency of mentions in a subgroup pertinent to public health: the therapy of acute fractures.
- Other indicators are only considered in individual cases by physicians. This does not include any statement concerning the relevance of these indicators for other pruposes.
- The indicators collected in the field of orthopaedics during the survey phase focus on structure and procedure quality and, in the majority of cases, can only be used indirectly for outcome measurement.
- The use of inadequate indicators for comparative outcome analyses can have negative effects on the treatment of patients. Measures of improvement in a benchmarking process might lead to imbalanced patient selection resulting in a deterioration in treatment access on an individual level.

Dataset Quality and Outcome Measurement

Outcome registers are a crucial factor in outcome research, as a

- **Core Dataset, and**
- **Source of Reference for further data sources as regards validity.**

Outcome registers for implanted medical devices such as joint arthroplasty are defined as follows:

- Registration of ALL primary and revision operations in a defined area in a central database.
- Follow the implant until it has to be revised, the patient dies or emigrates.
- Definition of Revision (=Failure): at least one part of the implant has to be revised during revision surgery.

The main advantage of registers is their potential to enable systematised longitudinal analyses and a multitude of data linkages which, after expert analysis, may lead to clear recommendations for action.

Analysis and discussion are most efficient when carried out via medical specialist societies. Apart from a democratic decision-making procedure on a high professional level, this ensures
the disclosure of information to physicians and hence the consideration of the results during
the treatment process.

Quality of Datasets

Outcome Measurement

- Sample-based clinical studies exhibit highly relevant and significant bias factors and thus have only very limited usability as a data basis for evaluations and conclusions.
- The data are highly influenced by the authors of the clinical literature as regards the number of cases published. These data constitute a bias factor per se, with varying distributions world-wide though.
- Structured surveys show better compliance with register data, but they are inferior to outcome registers in data quality and organisation.
- Experimental studies show only low correlation with the clinical outcome and are thus no suitable basis for outcome assessment.
- Registers monitor a considerably larger collective under more specified, standardised and comparable conditions and are therefore superior as a data source. Compared to sample-based studies and surveys they allow for statements of considerably higher validity, and they allow robust statements to be made earlier.
- In the context of surgical interventions involving the implantation of medical devices, randomised controlled trials yield no essential improvement in the quality

of statements concerning revision rate as compared to other sample-based study designs.

- At present, the usual categorisation regarding the quality of the literature and bases of evaluations appears to be inadequate for endoprostheses and similar medical devices.

- Therefore, based on the data available, a modification in the classification of data quality should be taken into consideration.

    1. Comprehensive data collections such as registers are to be rated superior.
    2. Randomised controlled trials should be assessed with respect to the endpoint.
        a. In the case of objective endpoints, such as measurement results (e.g. implant migration as an early indicator of loosening), a randomised controlled study is to be regarded as equal according to the relevant guidelines.
        b. In the case of subjective endpoints it has to be checked whether post-operative examinations could possibly break blinding. In such a case, a compromising of results should be assumed.

- To be able to make optimum use of the advantages described, publication procedures and basic data such as implant recording in registers should be standardised.

Market Monitoring and Post-Marketing Surveillance:

- The data currently available from manufacturers and public health authorities are insufficient for the handling of outcome measurement issues, market monitoring, and the detection of serious product deficiencies.
- It would thus make sense to consider arthroplasty registers as an additional tool in market monitoring and post-marketing surveillance.
    - The data should be examined retrospectively with regard to irregularities, such
      as a striking frequency of revision operations with certain medical devices or a cumulation of certain reasons of revision such as implant fracture clearly indicating product failure or requiring measures to be taken with respect to the application guidelines.
    - Manufacturers should be involved in the process, either directly or by means of requesting for statements.
    - Information would be available about patients and departments concerned, for instance, in the case of product recalls, or for vigilance control.
- Information procedures should be improved in detail.

Introduction

During the survey phase of the EUPHORIC project it became evident that the field of orthopaedics, especially arthroplasty and trauma surgery, are particularly well suited for further and in-depth analysis.

As to traumatology, a number of indicators have been collected which are already used in outcome measurement. The involvement of EAR – and the associated accessibility of expertise and data pertaining to the medical scientific field – yielded both the opportunity and the necessity to modify the original objective targeted by the EUPHORIC project in this area.

With respect to the indicators collected in the survey (E1-E7), an initial evaluation from a scientific perspective revealed a relevant discrepancy as regards questions usually addressed by service providers. It was therefore decided to critically review these indicators as regards their usefulness for outcome measurement. Since it is the task of the EUPHORIC project to deal with the specific issues of outcome measurement, the requirements of other areas such as structure and organisation quality have not been considered in detail.

Hence the decision was to perform a subjective evaluation of the indicators from a service provider's point of view on the one hand, and to examine the indicators' relevance by means of a structured literature research of leading international journals for orthopaedic surgery on the other hand. In this process, the consideration of indicators in the study designs and in the subsequent publications was used as an indicator for relevance.

Since no adequate indicators for outcome measurement in the field of arthroplasty had been collected in the survey phase, the EUPHORIC team proposed two additional indicators (E8,E9), which were included when determinating relevance.

Arthroplasty and traumatology differ greatly as regards the datasets available for indicator calculation. In the field of arthroplasty, the first national arthroplasty registers were founded in Scandinavia in the 1980s. Since the year 2000, a marked increase in activities developing similar projects has been observed in the big majority of EU member states, but also world-wide.

Registers are defined by the following criteria:

- Registration of ALL primary and revision operations in a defined area in a central database.
- Follow the implant until it has to be revised, the patient dies or emigrates.
- Definition of Revision (=Failure): at least one part of the implant has to be revised during revision surgery.

Arthroplasty implantations are characterised by several positive aspects with respect to outcome measurement:

1. As a rule, a serious problem of the implant itself or associated with the intervention sooner or later leads to a revision operation. In those situations where this does not apply, for instance, if the patient's severely impaired general condition does no longer allow such a serious operation, one can assume that in comparative analyses (of various THA products, for instance) these cases are roughly evenly distributed in the cohorts.
2. There is no direct interrelation of the event that is to be recorded (revision operation) and unsatisfactory outcome.
3. The endpoint to be recorded is a surgical operation, hence good routine documentation from therapy is available, which, in case of need, can also be recorded and controlled retrospectively.
4. The endpoint to be documented is a largely standardised, objective parameter.

Similar situations are also found in implanted medical products not pertaining to orthopaedics, for instance, in cardiac pacemakers. Within the orthopaedic field, the same positive prerequisites do not apply to every intervention or pathology. For example, the prerequisite of "every serious and unsatisfactory result leads to revision surgery, and every revision operation can per se be rated as a failure" does not apply to spine or traumatological interventions.

Disadvantages and Limits of Registers:

1. Registers are aimed at recording all relevant cases as completely as possible. To achieve this goal, the documentation burden for the clinic staff must be kept at a low level. This either requires clearly structured and short questionnaires, or the use of routinely collected data.
2. Registers are therefore well suited to record clearly structured issues such as the frequency of revision operations, or a rough statement about the reason and the failing component. By contrast, complex issues such as long-term post-operative clinical outcome are less suited due to organisational reasons. However, registers can be used to support the definition of samples or in recording patients concerned, for instance for retrospective analyses or vigilance control.
3. Register collections require well ascertainable entry criteria (e.g. an operation) and a clearly defined and well ascertainable endpoint (e.g. the revision operation). Issues for which these basic requirements do not apply (e.g. adverse effects after drug therapy) can therefore not be recorded using this instruments and should be covered by means of sample-based randomised controlled trials, surveys or incident reporting systems.

Clinical studies and registers have different prerequisites as regards possible applications and organisation:

1. By referencing to the total population, registers are able to exclude or minimise bias factors. This, however, requires strict control of the boundaries of the area monitored. With national registers within the EU this is at present sufficiently ensured by linguistic and administrative barriers. Along with the increasing practical implementation of a common market for medical services, however, adaptations will be necessary, for instance, the exchange of information and the consideration of Europe-wide identification numbers in data collection.
2. As previously described, registers are applicable in the case of clearly defined issues. Modifications of the recorded contents are associated with considerable expense. Thus, registers are capable of serving as a monitoring tool and providing well comparable, valid data for analyses. However, they are not very flexible.
3. Sample-based clinical studies are much more versatile with regard to operating procedures, surgical and nursing standards, general influences through the health care system, as well as the individual objectives of the studies. At the same time, they are considerably more flexible and able to cover individual and detailed issues in study design much more adequately.

When organising an examination, it is essential to use the best tools available. As a basis for further detailed studies, registers are able to provide substantial support, for instance in defining study cohorts.

Since the specific requirements of arthroplasty registers do not apply in the field of traumatology, the foundation of national registers has proved to be much more complex and considerably more difficult. Up to a few years ago, a corresponding project only existed in Sweden. In recent years, similar projects were launched in Norway, for instance, but also in other Scandinavian countries.

Since the indicators E8 and E9 have been one of the most important sources for clinical outcome measurement in the orthopaedic field for many years and had thus already been validated methodologically, the EUPHORIC team decided to dispense with repeating this procedure. Instead, it was decided to evaluate the data base used for indicator calculation in comparative analyses, examine it with regard to bias factors and validate the various data sources as to their reliability for outcome measurement in public health.

This process was divided into work packages and carried out in cooperation with those partners in the EUPHORIC consortium who could make contributions to the individual issues.

These were in detail:

1. WP 5.2.1: Assessment and Summary of the existing Arthroplasty Registers and Related Projects
    a. Comparative Description of the Swedish and Finnish Outcome Measurement Systems:
    The objective is to describe the procedures and internal organisation in two of the most developed public health systems world-wide with regard to outcome measurement, and process this information in such a way that other EU countries will be able to draw conclusions for the development of national systems that can be implemented in practice in consideration of the individual requirements.
    Contributions by: EAR, STAKES, KAR
    b. Summary Description of relevant Arthroplasty Register Projects in Europe:
    The objective is to give a structured overview of existing projects within the European Union and in neighboured countries. Subsequently, the collected information serves to define the prerequisites for successful implementation and compile a manual for project groups planning to develop further national projects.
    Contribution by: EAR
    c. A Tool to Characterise Registers:
    For assessing outcomes from registers by reviews as well as to coordinate and concentrate transnational register activities, the identification and characterisation of registers is important. This contribution is a checklist-like scheme to characterise registers meant to provide an overview and support decisions about further steps of their assessment.
    Contribution by: LBI HTA (Ludwig Boltzmann Institute Health Technology Assessment)

2. WP 5.2.2: Comparison of Clinical Studies and Register Results
    In this process, the following issues were dealt with in detail:
    a. Bias in different datasets
    b. Impact on outcome measurement and monitoring
    c. Impact on licensing procedures for medical devices
    d. Proposal for adjusted, updated procedures

    Contribution by: EAR

3. WP 5.2.3: Quality Control Mechanisms and Quality Control Procedures by Manufacturers
    By way of examples of the past few years, the procedures and the reactions of the parties involved were analysed, and consequently proposals were made for improved procedures with reference to the following issues:
    a. Impact on outcome monitoring
    b. Impact on licensing procedures for risk class III medical devices

    Contribution by: EAR

4. WP 5.2.4: Significance of the Indicators proposed from Medical Expert's point of view
    The indicators in the field of orthopaedics were subjected to critical review from the

service provider's point of view and from the perspective of outcome measurement. On the one hand, a comprehensive literature research of leading scientific journals was performed, on the other hand the indicators were evaluated from a medical perspective with respect to their applicability as indicators in the clinical field and their usability in implementing practical measures.
Contribution by: EAR

5. WP 5.2.5: Public Health-related Data Sources concerning Medical Device Failures, Monitoring and their Linkage
   A comparative analysis of the data available was performed using the example of a clearly defined and unequivocal product failure: the fracture of a total hip arthroplasty component. For this purpose, data from the relevant authorities in charge of product safety and market monitoring in various EU member states should be compared with data from the clinical literature and from registers. It was the objective to evaluate the completeness and validity of the various data sources.
   Contribution by: EAR, STAKES, KAR, CAHTA

6. WP 5.2.6: Summary of Basic Data concerning the Indicators from International Databases
   Data were collected from internationally accessible data sources concerning the proposed indicator of "Revision Burden" for artificial joint implants.
   Contribution by: EAR, ISS, SOFCOT, SAR

In the course of the project two additional topics were included in the workplan:

7. Rationale and Value to link Outcome Data and Economic Data in a Register
   (Subcontract of the Romanian Arthroplasty Register with contribution from Regione Emilia Romagna)

8. Link of Discharge Records with Outcome Register Data
   (Subcontract of the Institute for Biostatistics at the University of Innsbruck)

WP 5.2.1: Assessment and Summary of the existing Arthroplasty Registers and Related Projects:

Comparative Description of the Swedish and Finnish Outcome Measurement Systems

(Reference and background material: Technical Reports #29, #30, #2)

Basics:

- Legal requirements, above all with respect to the protection of personal data, are a major factor in the development of projects on a national level.

- There are important differences between medical devices and pharmaceuticals, which has to be considered in the organisation of individual projects.
    - **Pharmaceuticals:**
        - It is of critical importance to track the occurrence of a side-effect or harm because there is a possibility to modify the treatment (e.g. to cease treatment with the specific substance) to stop the undesired effect.
        - To enable physicians or other health care staff to react accordingly, it is basically sufficient to inform about potential incidences to increase attention. It is easier to calculate the correlation between a therapy and the occurrence of a side-effect than to estimate an incidence.
        - The period between the start of the therapy and the occurrence of side-effects is short, confounders due to the aging of the patients and the occurance of diseases are in general neglectable.
        - The calculation of incidences is only essential in specific cases with an objective, irreversible endpoint (i.e. cancer mortality with a certain therapy). A considerable number of outcome registers refer to such situations (cancer, birth, congenital malformations, etc.).
    - **Medical Devices:**
        - Incidences (revision rate, mortality rate, rate of malformations, etc.) are of high importance because direct influence on therapies or the modification of therapies is generally impossible, and they lead to costly treatments highly affecting the quality of life.
        - The periods from the primary intervention to the failure are usually long, and the frequency of complications differ in the course of time.
        - New, unknown complications are rare unless new materials are involved in the medical devices used (coating, cell therapy, etc.).
        - It is therefore essential to access to valid information about the occurrence of complications and their relevance as soon as possible.
        - For these evaluations datasets of superior quality and a more advanced methodology are needed. The questions to be addressed must be more specific, and so must the questionnaires.
          Datasets collected for other purposes (administrative, economic)

may be useful in the evaluations, but are basically not qualified to serve as core data for outcome measurement and monitoring.

Methodology:

A survey in Sweden and Finland has been carried ot by the national partners, KAR and STAKES. Relevant project have been indetified and assessed according to a structured questionaire. In addition not structured personal communication was taken into consideration when preparing the report. In several internal meetings the activities, the structure of the report and findings were discussed and reviewed in the working group.

Limitations:

The compliance by reference persons was sometimes limited. Not all contact persons had sufficient knowledge in english language to complete the forms in proper way. Every persons, who expressed this received assistance by the staff of the EUPHORIC partners.

Findings applicable to both countries:

- Reports are available in English only for a part of the projects.
- In both countries there are no major sponsors potentially pursuing their own interests (manufacturers), which could compromise the results as is observed in scientific sample-based literature.
- The more content is documented in a questionnaire and the more time is needed to complete it, the lower the compliance seems to be.
- The total amount of documentation for the hospital staff seem to be a relevant factor to achieve compliance. Technical solutions to reduce redundant documentation might increase the quality of documentation.
- The data collection often provides several options. This might increase the compliance rate, which is the main goal to achieve for an outcome register.
- Networking and cooperation between outcome registers is useful and creates added value.
- The questionnaires should address the main endpoints and outcome indicators of the pathology. By this reason global questionnaires or content in the database might be a disadvantage.
- Budgets are difficult to compare, but seem to be fairly equal in total

Advantages of the Swedish approach of decentralised outcome registers:

- Sweden has more pathologies and topics covered by outcome registers, also including the measurement of the correlation of expensive treatments (like chemotherapy at rectal cancer) and outcome, which is bound to increase the cost efficacy of the treatment. The precondition for these evaluations is detailed information on tumor staging and therapy regimes.

- The data are used intensively resulting in a democratic and wide-spread dissemination and discussion. This might support reaping benefits.

- There are many scientific publications from the Swedish outcome registers, which might be considered as an indicator for the importance of these data and results on a scientific level worldwide.

- The budgets of the individual registers appear relatively low compared to the benefit.

- The public health sector is mainly involved in the supervision, monitoring and strategic guidance of the entire system relocating the budgets in a central structure (SALAR, Centre of Epidemiology) having access to all results and findings.
  By this procedure the public health sector is able to run the system at low central expenses for overhead costs.

- The coordination and know-how transfer in the system by consultation (like Eyenet) might imply easy access and effective procedures, but standardisation might be more complex in view of such an autonomous approach – especially when it comes to increased complexity in large scale countries.

Advantages of the Finnish approach of centralised outcome registers:

- The involvement of strong organisations might be able to guarantee a higher degree of continuity in staff and know-how. Some Swedish registers seem to be dependent on one person or a very small group of persons running a complex procedure.

- The procedures seem to have a more formal character (guides published), which leads to higher transparency and standardisation.

- Centralisation might facilitate the access to other datasets located in the central institution as well as interchange between individual datasets on a standardised, regular basis.

- The Finnish system with its location of registers in the public health system and long experience in public health evaluations is able to calculate EUPHORIC indicators to a larger extent. The basic philosophy seems to influence evaluation procedures depending on the registers' standardisation.
  Requirements from a public health and scientific point of view seem to differ.

- In Finland publications are increasing with the involvement of research groups, which are mainly realised in national special registers.

Findings in Finland:

- The key staff in statutory registers is relatively small. This might limit the possibilities for dissemination and direct access for communication to health care providers.
  This has an effect on the realisation of benefits by improvement of quality.

- The effect of comparable projects, the Arthroplasty Registers, referring to reduction or complications is obvious.

Proposals:

- To get access to data on regular basis, the translation of reports is essential.
  To identify valid datasets, surveys including national institutions should be considered.

- Outcome registers have their main advantage in topics where
  - incidences are essential to achieve better outcome and the simple information about the possibility that a certain side effect or complication may occur is not sufficient for the health care suppliers;
  - the periods between primary intervention and complications are long or the reason for harm is past (malformations), so the possibilities to influence an unsatisfying situation are limited;
  - delays in the tracking of complications lead to harm for citizens, patients or the health system.

- The organisation of an outcome register is highly influenced by the organisation of the public health system and legal requirements. Since an outcome register shall act as an integral part of the health system, a standardised methodology on the EU level and general guidelines are not feasible.

- Some general aspects should be respected:
  - Outcome registers should be funded by public budgets.
  - There should be a certain degree of coordination between the projects and supervision by public health institutions.
  - The documentation burden for the staff of the health care providers should be as low as possible.
  - The questionnaires should address the main endpoints and outcome indicators of the pathology. By this reason a variety in questionnaires and questions addressed according to the pathologies under observation should be expected.

- A common methodology and basic standardisation are essential for common evaluations including several datasets. ECHI or similar projects might cover this aspect in special task forces for outcome measurement. The definition is more complex and requires highly professional input since the indicators, datasets and

questionnaires should be assessed as a package with respect to professional expertise in the specific pathology.

- The involvement of scientific experts and societies considerably increases the efficacy of outcome projects. Not only by contribution of expertise and shipping in manpower. Scientific societies and their access to physicians is a key player when it comes to modifications of professional procedures and reaping benefits based on valid outcome register results.

Summary Description of the Arthroplasty Register Projects in Europe:

Reference and background material: Technical Report #2

Historical Overview:

Arthroplasty registers were first founded in Scandinavia (1975: Swedish Knee Register; 1979: Swedish Hip Register; 1980: Finnish Arthroplasty Register; 1987: Norwegian Arthroplasty Register), when a hip implant in this regions, the Christiansen hip prosthesis, after more than 10,000 patients treated had shown results that were significantly below the benchmark at that time. Until the turn of the millennium, the Scandinavian national registers were recognised data sources of excellent quality world-wide. In Sweden, for instance, they accounted for a nearly 50-percent reduction in revision rate, and considerable economies were proved in public health due to the avoidance of revision interventions. Nevertheless, all attempts to transfer this model to other European countries failed.

Since the turn of the millennium, however, a considerable increase of successful register foundations has been observed. In Europe, this development can also be traced to the commitment of the European Federation of National Associations of Orthopaedics and Traumatology, EFORT (www.efort.org), a number of national orthopaedic associations, and the European Arthroplasty Register (EAR) project. Among others, EFORT aims to foster the development on a national scale by means of know-how transfer and the coordination of cooperation within a network. After the failure of centralistic attempts this path has proved to be a promising approach.

Basic Principles of a Successful Organisation on a European Level and Rationale behind the Decision to recommend a Network based on Subsidiarity instead on Centralistic Organisation:

1. National legal regulations, particularly in data protection, must be observed.
2. Arthroplasty registers should be organised as a cooperation of public health authorities and medical specialist associations, and should form an integral part of the national public health system.
3. Within the EU, health agendas are primarily a national or regional responsibility. The establishment of a monitoring and outcome measurement project should allow for the quickest possible information of decision-makers and close cooperation in order to ensure optimum results. Therefore, the outcome measurement and monitoring tools applied should consider the structure in health care.
4. The attempt to implement a centralised organisation would imply a high degree of complexity, frictional losses and reduced efficiency.
5. In their data, national registers reflect the conditions of the national health care system, surgical procedures, and local priorities. Direct supranational data collection on an EU level would render direct conclusions or the comparison of national solutions impossible. Due to their direct connection with the prevailing

circumstances, national datasets are thus always to be considered superior for the national use. However, supranational evaluation of national datasets on the basis of standardised procedures yields additional information for supranational issues and questions where national datasets reach their limits for lack of size.

World-wide, the following relevant projects are active as per 31 December 2008:

National data collection with adequate coverage:
Sweden, Norway, Finland, Denmark, Romania, Slovakia, Great Britain, Australia, New Zealand, Canada

Regional data collection with adequate coverage:
Lombardia, Emilia Romagna (Italy), Tyrol (Austria)

National projects at advanced stage (pilot project completed, start of national data collections to be expected in foreseeable period of time):
Austria, Netherlands, Switzerland, Portugal, Lithuania, Hungary

Countries which, due to the strongly national structure in health care, have decided to establish regional registers that can be combined to a national dataset in a later step, which will lead to a a sequential project progression:
Italy, Spain

Advanced projects on a national level, however not having completed the pilot project, and not running active data collection or with at least one essential prerequisite still to be created:
Germany, France, Czech Republic, Bulgaria, Turkey, Israel, Croatia

Countries with projects at other stages of development:
Poland, Luxembourg, Slovenia, USA

Technical Report #2 gives a structured overview and introduction of those projects in Europe whose current activities promise relevant contributions for further development.

In summary, it can be stated that active projects either have already been established or have reached a concrete stage of development in all relevant EU markets.

The existing projects allow for deriving a methodology for organisation and evaluation; the present report is a first step in this direction.

On a world-wide scale, Europe is leading in this area, but also outside of Europe there are serious activities for developing arthroplasty registers.

Methodology:

A structured review based on a standardised questionaire of the national projects have been conducted. Due to the fact that a high number of complex issues were assessed when possible and useful this has been carried out by a personal visit at the register centre, particulary in the countries, which have not published about the project in high amount.

Limitations:

The situation during the year 2008 have been assessed. Since there is a rapid development of the projects in some countries the content will become out of date.

A Tool to Characterise Registers:

Reference and background material: Technical Report #28, “Characterising Registries for Reviewing Purposes” by LBI HTA

Medical registers throughout the world present themselves remarkably heterogenic. To assess outcomes from registers for reviews, and to coordinate and concentrate transnational register activities, the identification and characterisation of registers is important. Registers have different scopes, objectives, designs and present their results in different ways. Some registers give a broad overview of a population’s state of health, others choose a specific clinical question as their topic. An important design criterion is whether the data have been collected specifically for the focussed topic or for another purpose (see the proposal for a description of register databases in section 5.2.2). This criterion divides data sources into primary and secondary data sources. It is known that secondary data sources sometimes are biased (for instance, some hospital administrative databases are known to underreport secondary diagnoses). This distinction is important for the assessment of registers. For that reason and to consider other aspects of registers, a scheme to characterise registers is needed prior to a more in-depth assessment.

In a sub-project by the Ludwig Boltzmann Institute Health Technology Assessment a scheme was developed based on technical literature about the work and experience from registers. The resulting technical document includes a characterisation scheme to assess the scope, design and results from a register. Each of these parts includes three characteristics that can be evaluated by guiding questions and links to good practice strategies from the technical literature on registers. Good practice strategies have previously been extracted from 23 technical documents describing experiences from the work with registers. The 37 strategies are completely listed in Technical Report #28, which is part of the appendix of the present document. The characterisation scheme helps to obtain a general view on a certain register and supports decisions about further steps of their assessment.

Project Specifics and Summarising Conclusions:

- There is a high degree of standardisation concerning basic definitions and the contents collected – the basic requirement for overarching evaluations.
- Apart from the calculation of incidences and probabilities, the EUPHORIC Indicators E8 (Revision Rate) and E9 (Revision Burden) are the most important indicators in the evaluations. Since Indicator E9 primarily makes sense in supranational comparisons, it is mostly not explicitly mentioned but can be deduced from the data published.
- Data are usually collected specifically for the purpose of outcome measurement.
- Data collections have a common core, corresponding to the EFORT Minimal Dataset, from which Indicators E8 and E9 can be derived.
- Moreover, additional data which are specific for the respective country are collected in most of the projects. After adjustment and in consideration of the restrictions mentioned above, it would be possible to apply this additional information also to other countries.
- In a medium-sized country and under favourable conditions, the time frame for establishing an outcome register (from the resolution until a functioning unit is able to make useful data available) should be set at five years. In the process, the most time-consuming step is setting up a structure for data collection and the integration of all clinics.
- The organisation of successful projects is usually marked by a cooperation of the respective medical societies and public health institutions in which each partner can cover certain key issues depending on their particular expertise.
- As a rule, public health institutions have access to reference datasets such as discharge records or registration office data/mortality records, which are essential for the operation of registers.
- Scientific societies have two primary key competencies:
    - Interpretation of the data requires broad expertise and a detailed knowledge of the common surgical techniques and prerequisites in the area covered in order to draw correct conclusions. Recourse to the pooled experience of a multitude of physicians can provide essential contributions.
    - To tap the potentials for improvement identified through register results comprehensive discussion within the networks of service providers is essential. Scientific societies provide an ideal forum for this process.
- At present the cooperation between public health institutions and scientific societies is institutionalised in most countries. In the scientific field, register results are acknowledged valuable sources of data. Cooperation takes place at various levels, on an EU scale within the EAR, as well as in Scandinavia within the Northern Arthroplasty Register Association (NARA; members: Sweden, Norway, Denmark, http://www.nordicarthroplasty.org).
  At EU level, no public health institutions currently participate in these data, structured cooperation would make sense and should be aspired.

- Outcome registers which are primarily sponsored by scientific institutions usually lack adequate and long-term funding. Since the public health sector is the main beneficiary of such projects, it would be sensible to examine projects with regard to their long-term contribution to quality assurance and market monitoring and, in case of positive assessment, ensure long-term and sufficient funding. During this process public health authorities should, of course, also define and safeguard their interests.
- As a rule, the reports are compiled by expert committees consisting of representatives from public health authorities and physicians delegated by the medical societies. In the course of an open discussion within the scientific societies and at particular events, the results are discussed with reference to valid outcome data. Measures are usually implemented autonomously by the clinical departments responsible. Direct intervention by health authorities is normally not required, they confine themselves to accompanying control and the use of the data with regard to structure quality decisions. By this procedure no major additional costs are caused to the public health sector.
- The most cost-effective way of organising outcome registers is within national institutions dealing with outcome measurement, or scientific institutions.
- It is safe to assume that outcome registers effect medium- and long-term cost savings in the public health system. Their correct use can considerably reduce the frequency of complications, resulting in a relative decrease of consequential costs caused by revision operations and a simultaneous increase in treatment quality. In Sweden an estimate has shown that, without consideration of macro-economic costs, cost savings in the clinical field are 30 times higher than the budget of a register.
- Departmental reports are very inhomogeneous, their structure strongly depends on the issues and interests pursued by the Steering Boards.
- Basically, however, the same indicators based on the same data are used as in the Annual Reports. In part, more details are given, but these can only be used sensibly as a feedback for the departments concerned.
- It may be reasonable to define standardised reporting procedures from a public health perspective; this should, however, be disconnected from departmental reports. Moreover, these reports should remain strictly confidential.

Potential Benefit for the European Union by Implementing Arthroplasty Registers:

- Due to the development of a multitude of national projects and the longtime experience with registers as an instrument it has become possible to establish a standardised outcome measurement tool on an EU scale. Since many projects are currently being developed, there is a window of opportunity to establish a standardised procedure over the coming years.
- Structured comparison of different public health systems and their effects on the quality of treatment will become possible.
- By means of longitudinal analyses it will be possible to conclude how changes of procedures affect the quality of treatment – an aspect that, in view of increasing efforts for cost-efficiency, will be given rising attention in the future.
- Structured market monitoring will be possible, not only with respect to the outcome of implants and surgical techniques, but also with regard to the use of non CE certified products and falsifications.
- Registers can provide valuable support in vigilance control. By blanket coverage via registers, for instance, it is possible to centrally identify patients affected by a product recall or deficient products and make the lists available to the competent authorities.
- Valid outcome data can be included in licensing procedures.

Recommended Actions Necessary for Reaping the Benefits:

- A methodology should be worked out to create a reporting standard for reports on an EU level considering the requirements of the EU Commission.
- The EU Commission or its authorities should be integrated into the existing networks as an active partner. The publication of results in scientific journals leads to delays in the access of important information for public health authorities *(Technical Report #19, Boneloc)*.
- A Europe-wide medical devices product database should be established in line with the actual licensing conditions. At present, registers do not use common standards for product designation on a national level. When medical products are marketed by distributors, sometimes the distributor's product numbers are recorded, leading to discrepancies in national codes used in the tracking of individual implants.

WP 5.2.2: Comparison of Clinical Studies and Register Results

Methodology:

A methodology, which allows the direct comparison of different datasets adjusted for cases included in the study cohorts and follow up periode, has been developed. It is based on the indicator "Revisions per 100 observed component years" invented by the Australian Arthroplasty Register, a variant of the EUPHORIC indicator E8 (revision rate).
A structured literature review based on electronic libraries like MEDLINE and manual literature search has been conducted. Conventional Metanalyses of peer reviewed journel publications in english and german language was done. The pooled results were stratified for potential influence factors like the region of origin or if the inventor of the implant was part of the study team. These results were compared to data from worldwide arthroplasty register reports. Statistical analyses were performed by calculation of confidence intervals. To refer to potential confounders like the impact of the surgeon or surgical techniques a cut point for relevance was defined. A difference factor up to 3 (e.g. one dataset has 3 times higher revision rates than the control group) between the datasets was considered to be explicable by individual expertise, circumstances in the individual hospital and other potential confounders. The maximum difference in the performance between hospitals in countries, which publish such data, and the performance of the same implant (SP II) in different national registers is between 2 and 3.
For rating as an outlier positive results had to be found in both categories, statistically significant differences by non overlapping of confidence intervalls and relevance by exceeding a difference factor of 3 between the datasets.

Limitations:

Based on the methodology a sample of implants and surgical techniques were tested. Samples in general suffer from a certain degree of uncertainness. To increase the quality of statements the enlargement of the sample heading to a complete coverage of all implants with sufficient data for a structured and direct comparison would be recommended.

Results:

- In the clinical literature the data display a high influence by the authors as regards the number of cases published.
  (Reference and background material: Technical Reports #3, #4, #5, #6, #7, #8)

Region	Number of Articles	Number of Articles by Author	Number of Independent Articles	% Author's Publications	Number of Cases	Number of Cases – Author	Number of Cases – Independent	% Author	CI
EU – continental	72	12	60	16.67	12,408	908	11,500	7.32	6.78 - 7.79
GB	30	11	19	36.67	3,974	2,140	1,834	53.85	52.30 - 55.40
USA	34	16	18	47.06	3,235	1,373	1,862	42.44	40.75 - 44.15
Total	136	39	97	26.05	35,999	7,469	28,530	20.75	20.33 - 21.17

This influence is even greater in studies from the USA and Great Britain than it is in studies from continental Europe. This might be due to the different structures in scientific and public health procedures.

- Authors per se show a relevant bias in outcome:
  (Reference and background material: Technical Reports #4, #5, #6)
  - Of the 13 implants investigated in the project, eight had a clearly identifiable individual author or a developing institution.
  - Four (= 50%) of these developers have published results showing a statistically significant difference in outcome as compared to comprehensive, non sample based register data.
  - Two of the four remaining implants not showing statistically significant differences are rarely used, which implies that the evaluations are based on small numbers. The inventors publish revision rates which are more than two times lower than those shown in register datasets; it is therefore likely that the small overlap of the confidence intervals would lead to statistically significant data with an increasing numbers of implants under observation. Both implants do not exceed the factor of 3 as limit for explanation of the differences by potential confounders from the surgical intervention.
  - Implant developers have very special expertise and can make use of other particularly favourable conditions potentially resulting in the fact that their results are not representative for the performance that can be expected.
    - Developers usually deal with a subject matter intensely and in detail so that one can presume the clinic's high expertise and their fundamental understanding of the product and its handling.
    - Developers might be highly motivated themselves to thoroughly examine potential outcome-relevant failures in the entire course of therapy and take the appropriate steps.
    - The final result of an arthroplasty implantation depends on a variety of factors, such as product, instrumentation, surgical approach, patient selection, etc. Since product development is always based on a specific background and pool of experience, a product might reflect the particular consideration of factors prevailing in the developing clinic.
    - Implant designers and associated manufacturers pursue their own economic interests which may have an influence on the communication of results.
  - Even taking the aspects into consideration, which might lead to superior outcome of the intervention by highly specialised experts compared to the average surgeon some of the inventors published data with differences, which are difficult to explain with superior surgical knowledge and competence. The most impressive examples are located in the USA.

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Implant	Statistically significant	Factor	Region of origin
Pappas-Büchel	+	14.31	USA
Taperloc	+	8.19	USA
STAR	+	4.63	EU (DK)
Oxford Uni	+	4.37	EU (GB)
Agility	-	2.43	USA
Avon	-	2.17	EU (GB)
Lubinus SP II	-	0.98	EU (D)
Alloclassic SL	-	0.76	EU (A)

  - In summary, it has been found that the majority of clinical studies published by the developers of an implant do not allow drawing adequate conclusions or making predictions as to the average performance of an implant.

- The clinical literature shows a high degree of statistically significant differences as opposed to non sample-based register datasets.
  (Reference and background material: Technical Reports #4, #5, #6, #9, #10, #11, #12)

  - Excluding low volume implants, eight systems are available for assessment of an individual author's bias and its impact on aggregated literature assessments.
  - In four examples the bias by the author has a significant impact on aggregated data, consequently this bias leads to a significant bias of the entire dataset.
  - In two of eight examples even independent studies have shown statistically significant bias. Both datasets were produced in the USA.
  - All four implants with a significant author's bias are represented in this evaluation, two designers' publications are not compromised with a bias, for two implants no individual inventor can be identified.

Implant	Significant Bias of aggregated, sample-based publications	Author's Bias	Author's Bias leading to Bias in the aggregated assessment
Accolade/Trident	+	n.a.	n.a.
Alloclassic SL	-	-	-
Duraloc	-	n.a.	n.a.
Lubinus SP II	-	-	-
Taperloc	-	+	+
Oxford Uni	-	+	+
STAR	-	+	+
Pappas-Büchel	+	+	+

  - When applying the usual assessment procedures based on sample-based clinical studies without taking recourse to comprehensive reference data, one must thus expect a high percentage of results deviating significantly from the actual situation of the population.

- Structured surveys show better agreement with register data, but are inferior to outcome registers in data quality and organisation.
  (Reference and background material: Technical Reports #4, #12)

    - Structured surveys are only found in single cases. All examples available for the issues under examination stem from the US. Even though they are more consistent with world-wide reference data from registers, detailed analysis has shown that they are also susceptible to misjudgement.
        - In a survey conducted in California regarding the revision probability in total ankle arthroplasty the benchmark of world-wide register results was underestimated by a factor of 1.9. The difference is statistically significant.
        - In a survey recording implant fractures comparable results were shown for the frequency of cup and head fractures; the reference values of the stem fracture rate, however, has been found to deviate by a factor of 26.

- Experimental studies show a low correlation with the clinical outcome.

  Conclusions regarding the prognosis of future outcome should not be drawn without support by sufficient clinical outcome data *(Reference and background material: Technical Reports #9, #16, #18)*. Since experimental studies are frequently conducted at the beginning of new developments, this information is often also applied in licensing procedures and marketing activities when new products are brought onto the market.

- Publications based on randomised controlled trials do not show essential improvement in the quality of the studies *(Reference / background material: Technical Report #11)*.

  The usual categorisation appears to be inadequate for endoprostheses and comparable medical devices.

  Randomised Controlled Trials (RCT) are the valid gold standard in clinical research. In the analysis of literature on endoprostheses it is noticeable that such study designs are very rare. That such studies are largely missing in the context of outcome in arthroplasty must also be seen under the aspect that the basic prerequisites for medical devices and pharmaceuticals differ to a relevant extent. In his PhD thesis Prof. Leif Ivar Havelin demonstrated in 1995 that an RCT comparing two implants would require as many as 13,474 patients in order to identifiy a 1% difference in revision rate in compliance with the usual requirements for power analysis. These are more patients than are treated with THA in a country like Sweden per year. Hence such studies encounter organisational limits. Since a minimum of five, typically 10 years follow up are required for clinical studies, the results of such studies would only be available after a long delay while in the meantime a large number of patients would be exposed to a high individual risk and the public health sector would have to bear considerable financial risks.

  However, randomised controlled trials are used for clarification of surgical technical issues and for migration analyses. Within the scope of the present project the question was explored whether or not patella resurfacing should be performed simultaneously with primary TKA implantation – a topic that has been a matter of

controversial discussion for years. The reason for choosing this subject was the observation that the majority of medical recommendations are in favour of patella resurfacing, whereas register datasets from Scandinavia (besides offering epidemiological information about the application of surgical techniques) have been showing a clear trend for over 10 years to go without patella resurfacing.

Comparative clinical studies of various designs were collated with register data. In this process a significant bias became apparent in sample-based clinical trials.

Patients not having received initial patella resurfacing were subjected to revision surgery twice to three times more often than those patients who had already been treated with this implant in their primary operation. Hence the recommendations in favour of performing primary patella replacement appear to be justified.

However, these data from sample-based studies could not be reproduced in the reference dataset from world-wide registers, which does not show any major difference between the two treatment groups, the revision rate being close to the values received in clinical studies dealing with primary patella resurfacing.

The bias is largely independent of the study design with RCTs showing a similar distribution as conventional studies. In review papers the bias is rather reinforced.

From these data one must conclude that randomised controlled trials do not necessarily protect against bias and are not superior to conventional, non-randomised study designs.

These findings could be interpreted as follows:

- The methodology of RCTs was originally developed for clinical studies in the pharmaceutical area. For organisational reasons, comprehensive monitoring as exercised by arthroplasty registers is not possible in this field.
- It is the objective of RCT procedures to exclude the well documented bias through individual valuations on the part of the patient and the examiner by means of blinding with regard to the therapy (or a placebo therapy) administered.
- The result of this procedure should be the determination of a preferably unbiased endpoint. These endpoints often represent subjective assessments. However, the procedure considerably improves the objectivity of comparative analysis.
- If medical devices are concerned, like in the present case, the endpoint is also a subjectively influenced decision: to perform revision surgery.
- However, a critical factor in this decision, the physician indicating the revision operation, is no longer blinded even if the formal requirements are thoroughly observed. For deciding on and planning an intervention, radiological findings are usually required from which the previous therapy can clearly be derived.
- Also on the occasion of routine follow-up examinations after TKA implantation x-ray images are usually taken, during which the patient could obtain information about his/her therapy.
- Hence, if the formal RCT requirements are fulfilled (e.g. by identical appearance and packing of the drug) and careful data management provided, one can assume in pharmaceutical studies that secondary

deblinding can be avoided. However, these basic requirements are not definitely guaranteed in the case of medical devices such as endoprostheses even if all formal requirements are thoroughly met.

- In the case of endoprostheses, the formal guidelines of study design do thus not ensure that the expected gain in objectivity is actually obtained.

Based on the data available, a modification of the classification of data quality should therefore be taken into consideration.

1. Comprehensive data collections such as registers are to be rated as superior.
2. Randomised controlled trials should be evaluated with respect to the endpoint.
    i. In case of objective endpoints such as measurement results (e.g. migration of implants as an early indicator of loosening) a randomised controlled study is to be considered equal to the applicable guidelines.
    ii. In case of subjective endpoints it has to be checked whether blinding could be broken by postoperative examinations. In this case it should be assumed that the results are compromised.

- The authors' assessment regarding the quality of a product or a recommendation in favour or against its use basically correlate well with the revision rate indicator. However, there is an overlap area where the evaluation turns out to vary in retrospective analysis. Most commonly, this is encountered in a range between 1 and 2 Revisions per 100 observed component years, where the majority of those products rank that show inferior performance as compared to competitive products but do not have catastrophic deficiencies. It is in this very range where controversial discussion is also observed in marketing, and where there is ample need for selective and comparable analyses. *(Reference and background material: Technical Reports #15, #19, #19a)*

  In this issue, the subjective evaluations of study authors should not be regarded and used as a reliable parameter for recommendations. Standardised evaluations of the basic data could increase the discriminative power.

- Registers monitor considerably larger collectives under better described, standardised and comparable conditions and therefore outvalue clinical studies as a data source. *(Reference / background material: Technical Reports #4, #6, #8, #9, #10, #13, #14, #15)*

- Registers yield valid results much more rapidly than sample-based clinical studies and surveys and are thus able to considerably reduce the periods of time until robust statements can be made concerning the outcome of a medical device or a surgical approach. This refers to periods of several years.
  (Ref. / background material: Technical Reports #3, #4, #6, #8, #9, #10, #13, #15, #16)

- To be able to make optimum use of such advantages, the publication procedures of registers should be standardised.
  (Reference and background material: Technical Reports #6, #7, #8, #10, #11, #14, #16)

For the performance presentation of medical devices it would therefore make sense to proceed as follows:

- In the general report on a national level and in supranational reports implant components should be represented separately because the statements have a more general character as well. Evaluations referring to a striking frequency of unusual revision interventions with certain combinations would be a highly targeted approach to be integrated in the annual report, but should only be presented in detail in case of positive results.
- The procedures for confidential departmental reports should not be standardised. In these reports, the additional presentation of particular component combinations –as usual in the Australian Register Report, for instance– could be advantageous.

- There are big differences in the use of implants in the various countries and, by implication, in registers as well. To obtain a comprehensive overview of the products used in the common market of the EU, a supranational evaluation of national results based on a standardised methodology is required.
  (Reference and background material: Technical Reports #3, #4)

- At present, there is no standardised designation of the implants recorded in the various national register projects. On the part of the producers no current efforts are made to standardise product designation either. Referencing to the product number can clearly identify the product on a national, but not on a EU level. Since product numbers are also used in administrative processes such as orderings, it may occur in a national register that medical devices are recorded differently in different projects on the users' level or due to recording via specific distributors' numbers instead of using the original manufacturer's numbers.

  The maintenance of product databases is one of the most complex tasks of an arthroplasty register. Europe-wide standardisation by means of a unitary reference database would economise the operation of registers and lead to an increase in quality. At the same time, however, it is a prerequisite for efficient reporting on EU level.
  (Reference and background material: Technical Reports #7, #15)

- Influence of national circumstances on the outcome of implants:

  Even if register data in general have proved superior when compared with other data sources available, some particularities must be considered in the valuation of results.

  Arthroplasty registers reflect the conditions prevailing in the regions they cover. This relates, for instance, to the experience with particular medical devices, to surgical approaches, but also to the influence the public health system has on the outcome of a therapy, allows for comparative analyses and facilitates controlling the effect of modifications. However, this aspect should be taken into account in the comparative evaluation of national register results, and the results should be checked with regard to potential local influence. This should be ensured by involving representatives of the national registers in the evaluation procedure.
  (Reference and background material: Technical Reports #7, #11, #16)

In case of comparable circumstances, however, register results are highly consistent. *(Reference and background material: Technical Reports #5, #8, #16)*

- Without registers it is mostly impossible in an independent analysis to deduce the decisions which have lead to a decrease in the use of particular implants or a product recall from the results published in scientific publications *(Ref. #9, #15, #17, #18, #19, #19a*). This is usually decided autonomously by manufacturers and physicians in non public discussions, or by means of a decision-making process at a scientific level. External control or monitoring by public health institutions is thus impossible. The mere access to register data would allow for sufficient control and open up the opportunity of autonomous decisions.

- In the organisation of studies and surveys objective endpoints are essential. As a rule, subjective endpoints entail subjectively biased decisions and results which, without reference sources, may lead to misinterpretations in meta analyses.
  (Reference and background material: Technical Reports #11, #19, #19a)

- A combination of register data and migration analyses is the most promising basis for valuating the implant outcomes to be expected.
  (Reference and background material: Technical Reports #9, #15, #19, #19a)

  Migration analyses based on relatively small numbers of cases can provide reliable predictive statements with reference to long-term loosening rates of an implant within a period of about two years. They can thus be integrated in the usual licensing studies and considerably increase the quality of the evaluation of future risks.

  Registers can provide statements about a potential inferior outcome and revision rates much more rapidly than any other data source. Contrary to migration analyses they also can detect relevant faults in the production process or in surgical practices.

- In combination with registers, patient self-assessment quality of life-questionnaires can contribute to further improve the quality of statements and reliability of predictions. First projects are currently being developed by national registers.
  (Reference: Technical Report #4, Annual Reports of the Swedish National Hip Register)

- The publication frequency in peer reviewed scientific journals decreases considerably after a product has been taken from the market or replaced by a succeeding variant. Thus the possibility is lost to detect structural problems of the medical device. This would be particularly important with durable, implanted medical devices such as endoprostheses which mostly fail only after many years. Since the follow-up of implants can obviously not be sufficiently ensured by the publication of clinical studies, this aspect should be covered by means of registers. By this instrument, this is possible at modest additional expense.

Proposal for a description of register datasets regarding their quality and validity as a basis of decision-making:

Comprehensive data collections such as outcome registers or discharge records differ with

respect to their validity for particular purposes. A crucial point is to achieve the best possible agreement between the purpose of data collection and the issue in question. Another essential dimension is data collection completeness. The assessment of the validity of a dataset thus depends on its internal consistence and its suitability for the issue to be clarified.

Proposal for the structured assessment of data sources for outcome research and structure and process quality issues:

Aim / Purpose	**Outcome (A)**	**Process (B)**	**Structure (C)**
Conformity between aim of data collection and aim of evaluation	Data collection performed for the specific purpose of evaluation (1)	Data collection not performed for the specific purpose of evaluation (2)	
Coverage	Nationwide (1)	Regional (2)	Local (3)
Data collection	Comprehensive (1)	Incomprehensive (2)	Sample-based (3)
Conformity dataset for assessment	Representative (1)	Not representative (2)	

The results would be summarised as follows:

1. the purpose of the data collection in a letter code (A,B,C);
2. internal dataset quality in a descending 3-stage numerical code.

Related Proposals

Proposal for Future Outcome Measurement Procedures for Arthroplasty and similar Medical Devices:

- Arthroplasty registers should be included as an additional tool in outcome measurement.
- Activities should primarily focus on:
    - Longitudinal analyses based on the indicators Revision Rate and Revision Burden
    - Market surveillance
    - Early warning
    - Outcome quality improvement
    - Comparative analyses regarding the performance of public health systems and the effects of modifications
    - Reference data for the assessment of results from other data sources
- The methodology used in the evaluation of the quality of studies and data should be modified.

Proposal for the Future Organisation of an Advanced Outcome Monitoring System:

1. The development of Arthroplasty Registers should be supported in all EU member states.

2. Outcome Registers should be organised as a cooperation of public health institutions and scientific societies in the respective field of activity.

3. Continuous quality improvement projects based on comprehensive register data collections should be initiated on a regular basis.

4. At the EU level these data should be used for comparative analyses and discussed with the respective authorities at the national level. To this end a standard procedure for supranational reporting should be developed with the registers being included in this system as data sources and a pool of expertise.

5. Registers should be employed in market monitoring.

6. In cases of product recalls or similar events in connection with inferior medical devices Arthroplasty Registers can provide information on patients who have been treated with a specific implant and thus support vigilance control.

WP 5.2.3: Quality Control Mechanisms and Quality Control Procedures by Manufacturers

(Reference and background material: Technical Reports #12, #20, #21)

Methodology:

A set of recent incidents have been identified and decided to be evaluated in detail concerning the access to data and organisation of the procedure. The manufacturers have been contacted and available documents were assessed.
The available information were summarised and analysed in order to identify lack of sufficient information, workflow, capabilities of stakeholders to detect the incidents and to extract proposals for improvement.
As additional reference material a structured literature review with comparison to register data concerning fracture of total hip implants was used. The attempt to include data from public health institutions responsible for market monitoring failed due to insufficiant published information.

Limitations:

Frequently the manufacturers are reluctant in giving access to the entire information, so the decision to select a certain incident was dependent on compliance by the manufacturer (Falcon and Link) or published documents. This way of decision might lead to limitations in generalisation of the findings. Since examples were evaluated in general no conclusive statements can be done, only starting points for discussion in order to improve procedures and to identify problems are possible.

Basics and Background:

- Increased revision rates and implant failures can basically have various reasons:
    - Failure of the medical device itself, either due to normal wear, premature breakdown, or product deficiencies;
    - Due to incorrect handling during implantation or use;
    - Due to employment in situations overstraining the product in terms of stability, fixation within the body, or with respect to other essential characteristics.

  The causes of failure can thus be multifactorial and, for the most part, are not clearly attributable in a superficial evaluation.

- Product deficiencies of significantly increased revision rates causing extensive harm to very many patients are fortunately relatively rare in view of the actual number of interventions. Nevertheless they are a relevant problem.

- These circumstances lead to considerable difficulties in the evaluation of individual incidents by a physician or other persons involved. It should also be taken into account that every group affected by product deficiencies and their consequences may suffer individual disadvantages, which in turn may influence individual decisions.

The subject-matter was treated from various perspectives.

1. A structured literature research was performed with regard to the incidence and revision rate of a clearly defined product failure, the fracture of a THA component, and the results obtained from diverse, publicly accessible data sources were compared. The data sources examined comprised publications by public health institutions in charge of market monitoring and the recording of product failure, scientific publications and arthroplasty registers.

2. The processes and available data were evaluated by the example of three recent incidences of product failure:

    - Megasystem C, Implant fracture or conus dislocation, 2006+2007
    - Varicon, Implant fracture, 2004-2007
    - Durom, Suspected high rates of short-term loosening, 2007

In summary, it cannot be assumed that the data available from the present sources are sufficient.

The present form of market monitoring -be it on the part of the producers according to the Medical Device Directive or on the part of the relevant public health authorities- is not adequate to guarantee sufficient monitoring procedures and ensure safe detection of inferior products.

These are the findings in detail:

Quality of the data available:

- Considerable differences became evident regarding the incidences of product failure between registers and scientific publications.

- Scientific literature on the basis of sample-based studies is almost exclusively focused on case reports and therefore is of limited validity in a global evaluation.

- With regard to the validity of statements, structured surveys are superior to clinical publications but inferior to registers. Also due to organisational reasons, registers should be given preference to surveys if there are both options.

- A leading manufacturer of ceramic heads has published incidences of ceramic fractures that were five times below the reference dataset value from registers. The implant manufacturer himself assumes that the numbers recorded only represent a third of the actual numbers of cases.

- The basic data received from market surveillance by the manufacturers seem to be insufficient. The sample of monitored implants is too small and possibly subject to a selection bias.

- In the examined example of the Durom cup a structured follow-up study by the manufacturer yielded the 11-fold revision frequency as compared to the initial value

tracked through the regular procedures. However, such measures are only possible in case of substantial reasons for intervention. Yet the results correspond well with reference data from a national register that would have already been available six months before the mentioned survey was initiated due to the complaints of a prominent surgeon in the USA.

- No comparable data were obtainable from institutions pertaining to the public health sector. Data that would be useful for comparable evaluations are not published on their websites or in reports.

- Since the manufacturers' reports represent a main source of information in these institutions, one must assume that the authorities face similar difficulties with regard to basic data as the manufacturers.

Course of Action in case of the Detection of Inferior Products or High Revision Rates:

- In all cases incidences were initially reported by individual users. Due to the specifics of durable implants, however, this is only possible to a user in exceptional cases and when failure patterns are defined quite clearly. It must be assumed that the estimated number of undetected or unreported cases of inferior outcome increases in less spectacular incidents.

- The assessment of observations is restricted due to the lack of comprehensive reference data and subjected to subjective judging. In retrospective evaluations supported by more qualified basic data not all decisions turned out to have served the purpose. This was also true for the passing on of data to central bodies, entailing belated reactions on their part. As a result, the course of action was delayed several times without giving cause for accusing individual decisions of gross carelessness.

- Reporting to the health authorities was handled by the manufacturers. From the part of the users, public health institutions received only insufficient information even though this group is also legally obliged to notify the authorities.

- The present report deals with relatively clear events of damage, which the respective manufacturer and authorities have already recognised accordingly. In less evident incidents, a certain number of belatedly or undetected product deficiencies must be expected.

- In all cases examined, the manufacturers reacted very quickly and in compliance with the relevant regulations.

- In terms of quality, the basic data available for decision-making to both the manufacturer and the health authorities do not always correspond to requirements.

- In all cases examined the stakeholder primarily active in analysis and reasoning was the manufacturer.

- Under these circumstances it is hardly possible to conduct valid and comprehensive risk assessments.

- Due to legal restrictions (data protection) manufacturers are not in a position to collect and administer comprehensive datasets for the individual follow-up of implants or patients as is standard practice in arthroplasty registers. Usually only public health authorities or institutions having a corresponding mandate are entitled to do so.

- Comprehensive analysis would require regular interaction of the various stakeholders (health authorities, manufacturers, physicians) in due consideration of their respective competence and responsibilities.

Related Proposals

Proposal for a Future Procedure regarding the Course of Action with respect to the Development and Market Launch of New Medical Devices:

- The standardisation of processes within the scope of the development of medical products should be improved. In addition to the present proceedings the following measures should be introduced:
    - Comprehensive obligation of users involved in development to report undesired events. The notification should be primarily addressed to the manufacturer and also include a commitment by the surgeon to save and return retrievals.
    - The findings of the investigation should be summarised in a report and be linked to the case that is to be reported to the competent authorities for further investigation.
    - In analogy to the regulations for pharmaceuticals, licensing studies should be centrally recorded and the findings be circulated even if they are not published or the development is discontinued.

- After licensing revision operations should be recorded via registers; these data should be made accessible to those legally responsible (manufacturers and authorities).

- In the case of substantial irregularities detailed retrospective analyses of the incidents in question should be provided for. Registers can provide access to basic information such as patients concerned and sources for further information such as X-ray images and patient records. This information can also be used to support potentially required activities in the context of vigilance control or product recalls.

- Reports and evaluations should be interchanged among the stakeholders (registers, manufacturers, authorities, users represented by scientific societies), and the opportunity to comment should be provided for in case of publication.

- The EU should increasingly include autonomous and comprehensive datasets such as arthroplasty registers in accompanying market monitoring, risk analyses, and

the handling of damage events. At present a multitude of projects do already exist or are in their developing stage.

- It would make sense to standardise reporting and data supply to authorised bodies in public health. This would require the establishment of supranational coordination.

- To cover risks and handle them as efficiently as possible, it would be reasonable to install standing committees ensuring continuity and professionalism.
  The following parties should be involved:
  - Public health authorities on a national and EU level;
  - Experts from arthroplasty outcome registers;
  - Manufacturers.

- Increased connectivity between authorities and experts would be sensible to allow for autonomous data evaluation and the option of acting independently on the part of the respective authorities.

- Due to the efficient communication network of these institutions, scientific societies can support the quick circulation of relevant information, its expert assessment and the speedy implementation of measures (e.g. the temporarily restricted use of individual products until an investigation is finished and a final decision has been made).

- The information of physicians and other parties should be improved. Among other things, this could include the special labelling of mail containing important information and summarising information on websites. This could also have positive effects on patient information.

- Cooperation with DG Enterprises and other authorities responsible for licensing should be considered. The data collected for outcome measurement and market monitoring could potentially also used for re-licensing procedures of risk class III medical devices providing worthwile additional information in the assessment of the future risks, safety and reproducibility of medical services.

Proposal concerning a Future Organisation of a Modified Licensing Procedure and an Advanced Quality Monitoring System:

1. Technical evaluation of the products by notified bodies (according to the present regular guidelines).

2. Mandatory clinical studies based on appropriate samples.

3. Specific recommendations for the clinical studies should be negotiated, like the obligation of surgeons/hospitals/manufacturers to report any revision operation or major complication in a standardised way and subsequently collect and analyse retrievals.
   Even though there are major differences between medical devices and pharaceuticals, an adjusted model based on the guidelines used in pharmaceutical phase 1-3 studies could be useful. In drawing up this specific set of guidelines, the main emphasis should be put on risk adjustment procedures and adverse event evaluation.
   Regular reporting to notified bodies or public health institutions might also be included.

4. Inclusion of migration analyses as an essential part in the clinical studies mentioned.
   There are procedures and systems of migration analyses already available, like RSA, EBRA or MBRSA. Technical systems should be validated prior to being accepted scientifically. Notified bodies should be included in the process of formal licensing of the tool.
   Scientifically speaking, it can be considered as proven that migration analyses are proper tools to significantly increase the predictability of long-term revision rates. These evaluations can easily be introduced into the CE licensing process.

5. Standardised requirements for these studies should be decided in expert meetings including public health authorities, notified bodies and medical experts in the field of migration analyses and outcome measurement of artificial joint implants.

6. For every re-licensing procedure, an evaluation of the available National Arthroplasty Register data should be made regarding the indicator of “Revision Rate” and used to assess the performance of a medical device in the human body. This procedure should be applied in addition to the clinical studies used at present, in order to benefit from having independent, comprehensive, non sample-based data as a reference. The data should be adjusted for confounders (failure mechanisms not related with the implant) in cooperation with experts from Arthroplasty Registers (where the implants are tracked, EFORT-EAR might support by coordination), including scientific assessment and benchmarking.

7. For failure mechanisms exclusively related to the implant (e.g. implant fracture), regular reporting to the public health institutions responsible for quality monitoring of medical devices on a national and EU-level should be taken into consideration in order to provide these institutions with comprehensive information for their evaluations.

8. In cases of product recalls or similar actions on inferior medical devices Arthroplasty Registers can provide information on patients treated with a specific implant as well as on the hospitals involved, and support vigilance control by this service.

WP 5.2.4: Significance of the Indicators Proposed from a Medical Expert's Point of View

(Reference and background material: Technical Reports #22, #23)

Rational:

Indicators should support improvement by feedback to persons in charge for individual decisions in a certain process. Persons involved in public health institutions have to consider all 3 main dimensions of quality (structure, process, outcome) and focus on the issue by their competence to organise the health system.
Physicians have a different view on the subject since they are a key player concerning outcome, but have limited influence on structure and process quality. Outcome is the main point of interest from their perspective.
Since physicians in their role as service provider should be a target for information based on outcome indicators to omprove the quality in health service it might be interesting to take the individual point of view of this group of stakeholders into consideration.
Since public health experts and physicians have just limited contact on scientific level it might be reasonable to adjust reporting procedures to the requirements of this group.

Methodology:

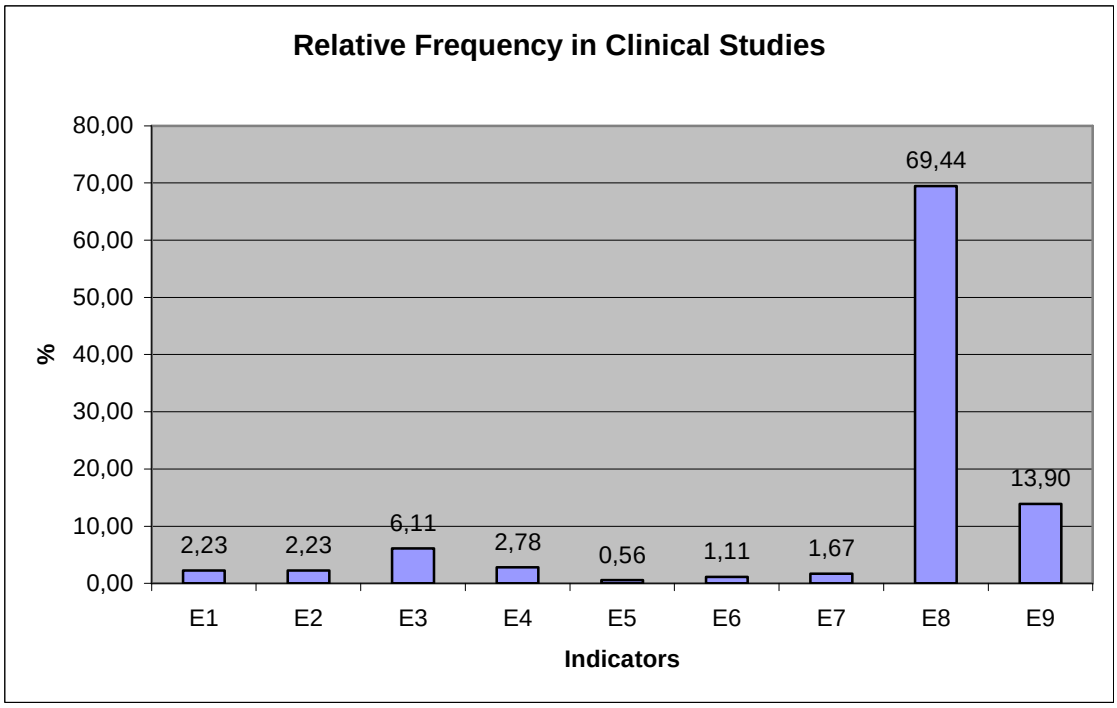
A structured literature review in high level scientific orthopaedic journals have been conducted. Main endpoint was the citation of orthopaedic indicators included in the EUPHORIC. The frequency of citations was used as a surrogate parameter for relevance in the individual point of view of physicians.

Limitations:

The findings are focused on the individual aspects of one group of stakeholders with limited cooperation in the public health forum. Statements do not refer to a general perspective or judge the general quality of indicators.

Results:

- Comprehensive literature analysis revealed that the indicators E8 (Revision Rate) and E9 (Revision Burden) are by far most frequently used in scientific publications.
- Indicator E3 (Inhospital Mortality after Hip Fracture) shows a relevant frequency of mentions in a subgroup germane to the public health sector, the therapy of acute fractures.
- Other indicators are only taken into consideration in individual cases.



- There is a relatively low frequency of relevant data sources for these indicators in the literature published and actually is below 2% of the total amount. From the health authorities' perspective, a systematic review of scientific publications therefore makes little sense. It appears more reasonable to involve experts in the field and thus obtain access to aggregate knowledge.

- The indicators E1 to E7, which were collected in the first phase of the project, can be calculated from the datasets available in public health at a relatively moderate expense. However, they only have restricted selectivity and validity in the assessment of outcome measurement issues since non controllable factors such as the patient's condition have a high impact on the result.

- Indicators for outcome measurement should be examined with respect to their usefulness and potential undesirable side effects for each pathology and situation before they are included in comparable benchmarking processes.

- The use of such indicators for comparative outcome analyses can have negative effects on patient treatment. Measures of improvement in a benchmarking process may entail particular patient selection resulting in deterioration in treatment access on an individual level.

- The present paper focuses on the field of study of the EUPHORIC project (outcome measurement). Statements concerning relevance and recommendations therefore exclusively apply to this area.

- Outcome measurement as an instrument to assess the performance of the health system with respect to the patient is an important, but not the only area to be considered. The statements made in this report cannot be applied to the fields of

structure and process quality.

- The use of the indicators E1 to E7 in handling issues pertaining to these areas may be perfectly reasonable.

WP 5.2.5: Public Health-related Data Sources concerning Medical Device Failures and Monitoring and their Linkage

(Reference and background material: Technical Reports #12, #24)

Methodology:

A structured survey among institutions in EU memberstates have been carried out in order to compare the data avialable from this source to other data sources concerning the fracture of artificial hip joint implants.

Limitations:

There were no published data available in a proper form to be used as reference data.

Results:

- As explicated in chapters 5.2.2. and 5.2.3 the individual valuation of the failure of medical devices is subject to special conditions.
- For institutions of the public health sector the access to independent data is difficult and insufficient under the present conditions. On the basis of the information on hand, it is very likely that the basic data available to the public health institutions are incomplete and not reliable.
- Proposals to improve the situation are basically the same as summarised in chapter 5.2.3.
- The investigations of the EUPHORIC project had to rely on the analysis of published material because the time frame was too short to organise analyses on demand. Based on the methodology elaborated in this project and due to the reference data it would be worth considering to examine this issue at national institutions at least in a representative sample. This should also include the question of information sources.
- For autonomous analyses by public health organisations it would be advisable to draw on world-wide data from arthroplasty registers as a source of reference data.
- Registers can also provide valuable additional information for the analyses of reported events of damage of individual implants.
    - This allows for an estimate of whether further, non-reported cases relevant to the investigation have possibly occurred. These cases can then be included in the current analysis.

- The relevance of reports can be rated by recourse to comprehensive documentation. For instance, the number of patients treated with a particular medical device can quite easily be calculated.
- From basic data such as the number of implant bearers, as well as the number of possible evident and potential further cases allows for performing quick and cost-effective risk assessment.
- This can be used to assist efficient focus creation in detailed analyses and thus support the internal organisation of public health institutions.
- In cases of suspected incidents supranational evaluations should be made to adjust the data, for instance, if the national data basis is too small or does not allow for sufficient conclusions.
- Cooperation with national arthroplasty registers also provides access to medical experts with a good knowledge of the underlying methodology and fundamentals of the datasets. As a rule, high-ranking experts delegated from the respective scientific societies are represented in these committees.
- Registers can support further organisational steps after damage event analysis, for instance, with respect to vigilance control. The datasets contain comprehensive information about patients and departments possibly affected by an inferior product.
- Retrospective autonomous analyses in cooperation with a national register would also be possible.

- The findings of such investigations should be available from the existing network of institutions within the European Union and be accessible to all member states.

- Depending on the respective requirements, restricted access to information should also be possible for physicians and patients/citizens in order to support efficient, professional and individual risk assessment, as well as decisions in patient treatment.

Proposal:

It was not possible to carry out a survey requesting evaluations on demand of data available in the institutions in the time frame available for the EUPHORIC project.
It might be considered to focus on this issue in an other project.
Reference data from clinical literature and worldwide arthroplasty registers as well as contact addresses are available from the EUPHORIC project

WP 5.2.6: Summary of Basic Data concerning Indicators from International Databases

Methodology:

Some general statements concerning the use and value of the 2 indicatores submitted to ECHIM are summarised in this section.
Content from worldwide datasets were collected in order to calculate comparisons between countries by the Indicator Revision Burden (E9) and to test the quality of data for such analyses.

Limitations:

The data are collected in 2008, as every cross sectional analyses the value of data decrease by time. Due to limitations in the access to data not all countries could be included. A cooperation with other ongoing projects (e.g. Hospital data project) might realise added value after publication of the results by the project.

Results:

Indicator E8, Revision Rate:

The E8 indicator is a very universally usable indicator that has been in scientific use for decades. It has been used in 9.8% of all papers of the structured literature research of WP 5.2.4.

There are variations of this indicator such as “Revisions per 100 observed component years” where part of the calculation formula is standardised in addition. In this instance, the follow-up period –as is the case with the basic indicator– can be defined freely in accordance with the profile of the study.

Publications considering this indicator in the field of arthroplasty are available from the websites of the various national register projects summarised on the EFORT portal (www.efort.org). The direct link is:
http://www.efort.org/getdoc/1b923b01-41d2-4587-bac2-7ca7a11e613e/Arthoplasty-Registers.aspx

The indicator E8 can be manifoldly used; however, it is mainly focused on the analysis of clinical outcome after the implantation of medical devices.

Indicator E9, Revision Burden:

The indicator E9 rather references to general issues and public health-relevant aspects such as global comparisons of countries and systems.

Within a certain country, the revision burden can also be examined in longitudinal analyses. This allows for a global statement regarding quality development in a particular country.

An essential parameter influencing the result calculated is the development of primary interventions over time. Since revision operations usually occur with a delay of several years, this leads to a decrease in the revision burden in countries with a high increase in the frequency of revision operations; in the rather theoretical case of a decrease in operations frequency the reverse effect would be observed.

In view of an increasingly aging population, a world-wide increase in the numbers of cases is being noticed; however, the dynamics of this process exhibits considerable differences between the various countries. Within the EU, the Western and Central European countries are comparable, where arthroplasty has nearly uniformly developed into a standard intervention since the beginnings of 1960s. For lack of know-how and adequate implants, this development was not possible in the former countries of the Soviet zone of influence. Since the opening of the borders, rapid development is being observed in this region with country-specific differences. For a comparative evaluation of this indicator within the EU adjustment should therefore be based on the development of the number of primary operations.

This indicator can be derived from various data sources. The basic quality of the data and the intended purpose of the collection should be taken into account in direct comparisons.

It is therefore recommended to always indicate the sources of the basic data.

In the following, data available for arthroplasty treatment are represented in tabular form.

Hip Arthroplasty:

Country	Register	Implant	Year	Source	Total Number	Primary Operations	Revision Operations	Revision Burden (%)
Sweden	Swedish Hip Arthroplasty Register	Hip	Global	Annual Report 2006	296,015	270,031	25,984	8.78
Sweden	Swedish Hip Arthroplasty Register	Hip	2006	Annual Report 2006	15,679	13,942	1,737	11.08
Denmark	Danish Hip Arthroplasty Register	Hip	1995-2005	Annual Report 2006	71,900	61,506	10,394	14.46
Denmark	Danish Hip Arthroplasty	Hip	2005	Annual Report 2006	8,292	7,244	1,048	12.64

	Register							
Germany		Hip	2007	BQS 2007	218,173	196,391	21,782	9.98
Germany		Hip		DGOOC	215,000	200,000	15,000	6.98
Italy	ISS	Hip	2005	ISS, ICD-9 Codes (primary 81.51, revision 81.53)	64,180	57,055	7,125	11.10
Norway	Norwegian Arthroplasty Register	Hip	1987-2007	Annual Report 2008	129,481	110,985	18,496	14.28
Norway	Norwegian Arthroplasty Register	Hip	2007	Annual Report 2008	7,486	6,443	1,043	13.93
Australia	Australian Orthopaedic Association - National Joint Registry	Hip	2005-2006	Annual Report 2007	34,211	30,440	3,771	11.02
Canada	CJRR	Hip	2003-2006	Annual Report 2007	42,626	39,162	3,464	8.13
Finland	Finnish Arthroplasty Register	Hip	1997-2005	Yearbook 2006	78,175	65,062	13,113	16.77
England and Wales	NJR	Hip	2006	4th Annual Report	65,234	58,962	6,272	9.61
Scotland	SAP	Hip	2007	Annual Report 2008	6,891	6,009	882	12.80
New Zealand	New Zealand Orthopaedic Association - National Joint Registry	Hip	1999-2006	Annual Report 2006	48,804	42,421	6,383	13.08
New Zealand	New Zealand Orthopaedic Association - National Joint Registry	Hip	2006	Annual Report 2006	7,319	6,423	896	12.24
USA		Hip	1990-2002	AAOS Publikation OKU- Hip and Knee Reconstruction 3, ISBN 0-89203-348-7				17.5
USA		Hip	2010	The Future Burden of Hip and Knee Revisions, Kurtz et al, AAOS 2006	301,181	253,367	47,814	15.88
France		Hip (THA + Hemi)	2005	PMSI, French National Institute for Statistics	138,713	120,494	18,219	13.13
France	Fren Arthroplasty Register Pilot			Rapport 2007	2,710	2,332	378	13.95

Switzerland		Hip	2008	Estimation SGO	22,000	19,800	2,200	10.00
Austria	Austrian Health Inst.	Hip Total	2006	Discharge Records	16,352	15,139	1,213	7.42
Austria	Austrian Health Inst.	Hip Partial	2006	Discharge Records	4,532	3,674	858	18.93
Austria	Austrian Health Inst.	All Hip	2006	Discharge Records	20,884	18,813	2,071	9.92
Austria	Austrian Health Inst.	Hip Total	1997-2006	Discharge Records	145,098	133,496	11,602	8.00
Austria	Austrian Health Inst.	Hip Partial	1997-2006	Discharge Records	38,444	32,721	5,723	14.89
Tyrol	Tyrolean Arthroplasty Register	Hip	2004-2007	Annual Report 2007	6,252	5,411	841	13.45
Tyrol	Tyrolean Arthroplasty Register	Hip	2007	Annual Report 2007	1,573	1,363	210	13.35
Spain		Hip	2005	Hospital Discharges (CMBDAH)	22,036	19,015	3,021	13.71
Romania	Romanian Arthroplasty Register	Hip	2007	Online Statistics RNE	7,105	6,759	346	4.87
Slovakia	Slovankian Arthroplasty Register	Hip	2006	Prresentation Cervenanski Days 2007, Activity Report 2006	3,832	3,507	325	8.48

Knee Arthroplasty:

Country	Register	Implant	Year	Source	Total Number	Primary Operations	Revision Operations	Revision Burden (%)
Sweden	Swedish Knee Arthroplasty Register	Knee (TKA)	1996-2005	Annual Report 2007	63,133	60,936	2,197	3.48
Sweden	Swedish Knee Arthroplasty Register	Knee (UKA)	1996-2005	Annual Report 2007	11,535	9,894	1,641	14.23
Sweden	Swedish Knee Arthroplasty Register	Knee	2006	Annual Report 2007	11,149	10,544	605	5.43
Denmark	Danish Knee Arthroplasty Register	Knee	1997-2006	Annual Report 2006	33,681	30,611	3,070	9.11
Denmark	Danish Knee Arthroplasty Register	Knee	2006	Annual Report 2006	5,138	4,659	479	9.32
Germany		Knee	2007	BQS 2008	145,837	136,262	9,575	6.57
Germany		Knee		DGOOC	105,000	100,000	5,000	4.76
Italy	ISS	Knee	2005	ISS, ICD-9 Codes (primary 81.54, revision 81.55)	47,574	45,049	2,525	5.31
Norway	Norwegian Arthroplasty Register	Knee	1994-2007	Annual Report 2008	32,292	29,649	2,643	8.18
Norway	Norwegian Arthroplasty Register	Knee	2007	Annual Report 2008	3,855	3,556	299	7.76
Australia	Australian Orthopaedic Association - National Joint Registry	Knee	2005-2006	Annual Report 2007	36,466	33,737	2,729	7.48
Canada	CJRR	Knee	2005-2006	Annual Report 2007	18,055	17,082	973	5.39
Finland	Finnish Arthroplasty Register	Knee	1997-2005	Yearbook 2006	68,512	63,266	5,246	7.66
England and Wales	NJR	Knee	2006	4th Annual Report	65,425	62,105	3,320	5.07

Scotland	SAP	Knee	2007	Annual Report 2008	6,678	6,291	387	5.80
New Zealand	New Zealand Orthopaedic Association - National Joint Registry	Knee (only TKA)	1999-2006	Annual Report 2006	31,204	28,705	2,499	8.01
New Zealand	New Zealand Orthopaedic Association - National Joint Registry	Knee (only TKA)	2006	Annual Report 2006	5,490	5,140	350	6.38
USA		Knee	1990-2002	AAOS Publikation OKU- Hip and Knee Reconstruction 3, ISBN 0-89203-348-8				
USA		Knee	2010	The Future Burden of Hip and Knee Revisions, Kurtz et al, AAOS 2007	718,257	663,007	55,250	7.69
Switzerland		Knee	2008	Estimation SGO	13,000	11,700	1,300	10.00
Austria	Austrian Health Inst.	UKA	2006	Discharge Records	1,267	1,004	263	20.76
Austria	Austrian Health Inst.	TKA	2006	Discharge Records	14,304	13,387	917	6.41
Austria	Austrian Health Inst.	All Knee	2006	Discharge Records	15,571	14,391	1,180	7.58
Austria	Austrian Health Inst.	UKA	1997-2006	Discharge Records	7,970	6,275	1,695	21.27
Austria	Austrian Health Inst.	TKA	1997-2006	Discharge Records	103,393	97,179	6,214	6.01
Tyrol	Tyrolean Arthroplasty Register	Knee	2004-2007	Annual Report 2007	4,678	4,329	349	7.46
Tyrol	Tyrolean Arthroplasty Register	Knee	2007	Annual Report 2007	1,296	1,184	112	8.64
Spain		Knee	2005	Hospital Discharges (CMBDAH)	34,504	32,076	2,428	7.04
Romania	Romanian Arthroplasty Register	Hip	2007	Online Statistics RNE	1,099	1,074	25	2.27

Other Joint Arthroplasties:

Country	Register	Implant	Year	Source	Total Number	Primary Operations	Revision Operations	Revision Burden (%)
Norway	Norwegian Arthroplasty Register	Ankle	1994-2007	Annual Report 2008	454	380	74	16.30
Norway	Norwegian Arthroplasty Register	Ankle	2007	Annual Report 2008	72	58	14	19.44
Norway	Norwegian Arthroplasty Register	Finger (MCP)	1994-2007	Annual Report 2008	2,946	2,460	486	16.50
Norway	Norwegian Arthroplasty Register	Finger (MCP)	2007	Annual Report 2008	145	89	56	38.62
Norway	Norwegian Arthroplasty Register	Handrot (CMC I)	1994-2007	Annual Report 2008	412	365	47	11.41
Norway	Norwegian Arthroplasty Register	Handrot (CMC I)	2007	Annual Report 2008	27	23	4	14.81
Norway	Norwegian Arthroplasty Register	Handsledd	1994-2007	Annual Report 2008	211	169	42	19.91
Norway	Norwegian Arthroplasty Register	Handsledd	2007	Annual Report 2008	31	16	15	48.39
Norway	Norwegian Arthroplasty Register	Schoulder	1994-2007	Annual Report 2008	2,648	2,425	223	8.42
Norway	Norwegian Arthroplasty Register	Schoulder	2007	Annual Report 2008	341	308	33	9.68
Norway	Norwegian Arthroplasty Register	Schoulder (Hemi)	1994-2007	Annual Report 2008	2,088	1,976	112	5.36
Norway	Norwegian Arthroplasty Register	Schoulder (Hemi)	2007	Annual Report 2008	225	215	10	4.44
Norway	Norwegian Arthroplasty Register	Schoulder (Total)	1994-2007	Annual Report 2008	560	449	111	19.82
Norway	Norwegian Arthroplasty Register	Schoulder (Total)	2007	Annual Report 2008	116	93	23	19.83
Norway	Norwegian Arthroplasty Register	Hallux	1994-2007	Annual Report 2008	1,043	924	119	11.41

Norway	Norwegian Arthroplasty Register	Hallux	2007	Annual Report 2008	67	47	20	29.85
New Zealand	New Zealand Orthopaedic Association - National Joint Registry	Shoulder	1999-2006	Annual Report 2006	1,746	1,641	105	6.01
New Zealand	New Zealand Orthopaedic Association - Nat. Joint Registry	Ankle	1999-2006	Annual Report 2006	317	298	19	5.99
New Zealand	New Zealand Orthopaedic Association - National Joint Registry	Elbow	1999-2006	Annual Report 2006	222	191	31	13.96
New Zealand	New Zealand Orthopaedic Association - Nat. Joint Registry	Knee (TKA + UKA)	2002-2008	Online Statistics (20080818)	41,548	39,881	1,667	4.01
New Zealand	New Zealand Orthopaedic Association - National Joint Registry	Knee (TKA + UKA)	2002-2009	Online Statistics (20080818)	4,405	4,323	82	1.86
New Zealand	New Zealand Orthopaedic Association - National Joint Registry	Knee (TKA + UKA)	2003-2006	Presentation Cervenansky Days 2007	3,832	3,507	325	8.48
New Zealand	New Zealand Orthopaedic Association - National Joint Registry	Knee (TKA + UKA)	2002-2006	Annual Report 2006	34,731	30,067	4,664	13.43

Rationale and Value of Linking Outcome Data and Economic Data in a Register

(Reference and background material: Technical Reports #26, #27)

Methodology:

Projects and experts in this field were identified. Existing projects and statements were summarised in reports.

Limitations:

Reports and statements by definition are subjective and starting points for discussion.

Introduction:

Outcome Measurement is of critical importance, but not sufficient for cost efficacy assessment. To measure cost efficacy data concerning costs AND effect (=outcome) are required.

As demonstrated in other chapters of this report, data from comprehensive outcome registers such as arthroplasty registers are superior to data available from other sources such as discharge records or clinical studies.

Basically, different types of economic data are available from health administration. However, there are just a few projects with access to outcome register data for the exact measurement of outcome. In the context of arthroplasty and EUPHORIC indicators (mainly E8, Revision Rate), evaluations and basic data are available from:

- Romania: at present the only project with direct access to both types of datasets in one structure. More detailed information is given in Technical Report #26.
- Emilia Romagna: is running a regional arthroplasty register (more detailed description in Technical Report #2) and related projects at R.G.T.S. (see Technical report #27).
- In addition, there are scientific publications by Scandinavian registers focused on cost efficacy that are available from the internet (access via National Arhroplasty Register web pages at http://www.efort.org/getdoc/1b923b01-41d2-4587-bac2-7ca7a11e613e/Arthoplasty-Registers.aspx).

It is the aim of the present report to study whether and how the linkage or joint evaluation of outcome data and economic data can create added value based on the experience made so far.

The information collected has been processed in the form of a descriptive feasibility study. The summary report is based on a series of Technical Reports from the sources mentioned. The reports have been compiled independently.

Results:

- For exclusively economic issues sample-based data may suffice; for outcome issues, however, comprehensive data are required. A direct linkage of data based on department level might lead to additional opportunities for evaluations. The more comparable the data are the higher the quality of results will be. Since Outcome Registers are dealing with personal and restricted data the concentration in one centre might be reasonable.

- The prices for products between hospitals, different products in use and classes of implants vary considerably.

- Whether or not these differences are justified, can only be evaluated by directly referencing to outcome data.

- Basically, the costs of the implant are a relatively low in proportion to the entire cost of treatment, but the implant has a high impact on outcome and long-term costs since revision operations are very expensive interventions. For this reason the exclusive focus on implant costs could entail negative macro-economic effects caused by long-term consequential costs.

- The allocation of resources and the access to medical service can be evaluated in longitudinal evaluations (coverage from different sources, e.g. private payment by the patient in Romania). In principle these figures represent a mixed cost coverage since patient services in the hospitals are still based on public money. In this situation overall figures might be useful to control the various contributions to the total budgets.

- Evaluations based on joint datasets are able to support waiting list management and perform more accurate evaluations for investments to reduce the waiting list.

- Resources can be allocated on the basis of objective decisions and guidelines avoiding personal influence, and it is possible to control the compliance with the decisions made.

- The compliance with legal requirements (for instance, as regards the access to health service or cost coverage) can be controlled. Deficits can be detected and relevant authorities even outside the public health sector can be included. Wanting or misdirected resources can be quantified.

- Registers allow for comparative price analyses. In the reports groups of implants are presented, and more detailed evaluations such as the cost of implants or prices in individual departments/hospitals are possible. In addition to cross section analyses, longitudinal evaluations are possible. The effects of decisions or

measures can be monitored this way.

- The example of cervicocephalic implants in Romania (Technical Report #26) clearly demonstrates the positive effect of the linkage of outcome data and economic data in terms of long-term economic effects. Other relevant topics are published by Scandinavian Registers, e.g. concerning unicompartmental and total knee arthroplasty. At any rate, currently there is no continuous system in activities evaluating and monitoring the financial effect of decisions. A regular monitoring system could support cost control taking optimum patient service into account at the same time.

- Clear guidelines for patient service could be developed in cooperation with medical societies and distributed via their networks, which have proved most efficient.

Summary and Proposals:

- As in outcome measurement, registers should be used as a data source and should not act as decision-making authorities. Registers should prepare reports according to the requirements of the competent decision-making authorities and offer support in interpretating the data. Decisions should be achieved in a democratic way including all stakeholders whenever possible. The linkage of outcome data and economic data should aim to provide a more reliable basis for decisions, but should not change the decision-making procedures themselves.

- The linkage of outcome data and economic data is a precondition for cost-efficacy evaluations in health care. In the field of arthroplasty, a reasonable amount of basic data would be available, but currently remains unused.

- This type of evaluations would be very useful for providing decision-makers with objective information
  - for the allocation of resources, and
  - the lack of resources in the health care system on a national and EU level.

- International benchmarking is recommended.

- Indicators and procedures should be defined. This could be done at reasonable expense since the basic methodology is already available. With respect to economic data a consensus in methodology (indicators) is recommended similar to what the EUROMEDSTAT project has worked out for pharmaceuticals. Basics could be adapted from this project. Only the linkage of outcome data and economic data would have to be started from scratch.

- The Romanian project can be recommended as a model for other countries. Structural details should be adapted to local circumstances.

- The assessment and interpretation of the basic data is an essential issue. Physicians and scientific societies should be involved in this process. Outcome and long-term costs should be given high priority. Requirements and circumstances related to the implantation of medical devices have a high impact on the effects. For example, to

change an implant or a supplier leads to learning curves and a temporary increase in revision rates (= reduced quality of medical service and increasing long-term costs). Short-term decisions following lowest prices policies lead to frequent exchanges of implants, finally resulting in negative long-term effects.
Since these effects strongly depend on individual situations, consultations with medical experts are highly recommended.

- Too aggressive evaluations might have negative effects on the access to health service. This aspect should be taken into consideration when defining evaluation strategies.

- Democratic decision-making processes based on valid information should be used in the interpretation of data and for drawing consequences. This concept has already proved its efficacy in the Scandinavian Arthroplasty Registers yielding actual improvement in outcomes. It should also be preferentially used in assessments and discussions concerning cost efficacy.

- Data adjustment should be improved to increase the sensitivity of the data.

- The topic of cost efficacy and the linkage of economic data and outcome data via Arthroplasty Registers should be fostered in the future. Added value can be expected in terms of outcome as well as in economic aspects.
The EU Commission should address the issue of standardised evaluation and reporting procedures.
Data collection and evaluation on a national level as well as decisions related to physical patient service should be located at the national and regional level according to the principles of subsidiarity.

- A standardised implant tracking system including a central reference database is a central tool for evaluations on a European level.

Link of Discharge Records with Outcome Register Data

(Reference and background material: Technical Report #25)

Methodology:

Discharge Records are one potential dataset for outcome measurement. Experts working on the interfact between arthroplasty registers and discharge records were invited in a statement concerning the potential use of these datasets and added value by linkage or other ways of cooperation.

Limitations:

Reports and statements by definition are subjective and starting points for discussion.

Introduction:

Outcome-oriented, comprehensive data collecting systems via arthroplasty registers have resulted in considerable increase in the quality of medical treatment during the past decades. In Sweden, for instance, the revision rate could be reduced by half since the national register has been launched while in other countries the outcome has remained nearly unchanged within the same period of time.

In almost all countries discharge records are regularly used for evaluations, i.a. also in outcome-relevant issues.

Results:

Possible evaluations from discharge records for outcome measurement:

- An important factor for evaluation options for outcome measurement is whether longitudinal analysis is possible or not. Discharge records are usually primarily collected for accounting or other organisational purposes and therefore document a code for inpatient stay as the primary case identification. For the chief purpose of recording services, this is an optimum approach. For outcome measurement, however, personal data linkage and evaluation whether an intervention (e.g. primary operation) has led to a defined secondary event (e.g. revision operation) are essential.
  At least in Austria, direct linking is currently not feasible for lack of unerring personal identification, as well as for data privacy reasons. The manual assignment of individual cases based on redundantly stored data may be conceivable but is hardly practicable in daily routine.

- The Annual Reports of the Scottish Arthroplasty Project allow for deriving the following possible calculations:

    - Epidemiological calculations such as incidences and probabilities of diagnoses and complications (however, without direct assignment to important variables such as the implant);
    - Market data regarding the range of services in the medical field;
    - Length of inpatient stay; Where the patients were discharged to; Whether the patient made use of aftercare in some institution; Whether the intervention was performed on an outpatient basis or was connected with an inpatient stay;
    - Longitudinal economic data;
    - Waiting list management and other activities important for the public health sector;
    - Revision burden;
    - Descriptive presentation of patient profiles such as age, sex or indications.

- Apart from personal identification, discharge records sometimes fail to provide important data for outcome measurement:
    - The implant, as one of the most essential factors for the outcome;
    - Information about the therapy with respect to both primary operation and revision; to a relevant extent, the documentation of diagnoses in the ICD system does not suffice to clearly discriminate the medical reason of an intervention. Since the DRG system was originally developed for clearing purposes, interventions involving similar expenditure are occasionally pooled, which leads to a loss in discriminative power in outcome measurement.

- Personal identification in a register presupposes unambiguous assignment to the individual person. Therefore, person-specific codings are required that are unequivocal and stable for a lifetime.

Discharge records have some undeniable advantages for evaluations:

- They are usually complete.
- They are easy to access.
- They are standardised to a high degree, which is helpful in interdiscinplinary evaluations (in an SAP report, for instance, the consideration of anesthesia as an outcome-relevant factor).

For outcome measurement, however, discharge records also have disadvantages:

- The quality of data is often unchecked. A phenomenon observed in large-scale data collections is the inferior quality of data that are not in the focus of the evaluations primarily intended.
- Discharge records are not primarily collected for outcome measurement. Internal data consistency should therefore checked for each data source before including it in evaluations.
- Outcome analyses incorporate a large number of variables depending on the treatments under examination. Missing data or lack of discriminative power of data thus lead to a considerable reduction in final results, since relevant factors influencing the primary endpoint cannot be checked and adjustments can only be made to a limited extent.

- Data fusion on an individual level is a prerequisite for the stratification of groups in the database and for direct comparisons, thus representing one of the essential requirements for the computation of long-term outcome.
- If the outcome of a primary endpoint is calculable on the basis of discharge records (e.g. mortality, infections, etc.), usually no sufficient data is available with regard to specific therapies or procedures. Therefore, inferential statistics or evaluations are not always possible in the quality required.

Differences as compared to register reports:

- Evaluations in national register reports feature a more comprehensive coverage of all relevant information for patient treatment. This enables the physician –or other persons in charge– to obtain a comprehensive overview
  of the respective situation by means of a benchmarking system, and make target-oriented decisions which, in turn, can be checked in their impact in the following years.

- Thus, register reports allow for the efficient implementation of continuous quality monitoring and quality improvement projects.

- Discharge records can also contribute to quality improvement, but have other priorities.
    - Indicators and evaluations based on discharge records are rather focused on structure and process quality.
    - Drawing conclusions from structure and process indicators to outcome is possible to a limited extent.
    - For organisational reasons the questionnaires of outcome registers must be concise. One of the main reasons for this is that the work load for the hospital staff caused by documentation constitutes a critical factor for compliance and hence for the completeness of the register dataset. Discharge records contain information potentially offering essential contributions for outcome analyses, for instance:
        - Comorbidities of patients;
        - Services exceeding the primary intervention;
        - Information about the process of medical service (e.g. waits, follow-up, etc.) that might have a relevant influence on the outcome but cannot be included at present for lack of possibilities of overall analysis;
        - Economic data that could be used in cost-efficiency analyses. At present, this is only feasible to some extent even in well developed register systems such as Sweden or Finland.

Prerequisites for the Linking of Discharge Records and Register Data and Potential Added Value for Outcome Measurement:

- The basic data for case identificaton must be synchronisable. Synchronisation could be performed via a trust centre. Similar aspects have been widely and intensely discussed for years within the scope of the introduction of electronic health records or electronic storage media (e-Card) containing medical basic data.

A trust centre has also been planned in Austria for quite some time now, but has not been implemented yet.

- The introduction of a standardised personal identification (european medical code or national equivalents) as reference data in various datasets would make sense with regard to the additional information gained for quality development in health care. However, clarification is needed concerning data protection in data collection, data processing, and the subsequent procedures.
- Outcome data involve a very complex process with many variables and including factors that are changing rapidly. Selective and detailed information is therefore required allowing for target-oriented decisions in support of quality improvement.
- This process, in turn, requires a core dataset in the form of an outcome register modelled on arthroplasty registers.
- A Link with further data from routine data collections such as discharge records will then allow additional applications and adjustments covering the following topics and respective areas:
    - Influence of structural and procedural changes on the outcome;
    - Linking of outcome data and economic data for further and more detailed cost-benefit analyses than common at present.
    - Influence of comorbidities on outcome and proposals for the adaption of interventions based on individual risk profiles.

Summary and Recommendations:

- Discharge records alone are not comparable in quality with outcome registers specifically designed for this purpose.
- Target-oriented measures require a great wealth of information and detailed evaluations.
- By focusing on specific, central outcome indicators and longitudinal analyses, outcome registers such as arthroplasty registers offer an adequate basis.
- The inclusion of discharge records and other data regularly collected in the health care system in evaluations of outcome registers allows for essential and additional evaluation options.
- A prerequisite for this, however, is to enable dataset assignment at a personal level, which is currently not possible in all EU member states on the basis of a routine procedure since the basic data for personal identification are not congruent or even not accessible at all.
- In this respect, it is also essential to clarify the regulatory framework (data protection) of such procedures. This could be integrated into current efforts for further data networking in health care, electronic health record, etc.
- The consideration of standardised datasets for personal identification, such as the European Medical Code, might substantially simplify technical solutions.

Summary and Conclusions

Indicators in Orthopaedics:

- The indicators E8 (Revision Rate) and E9 (Revision Burden) are by far most frequently used in scientific publications in the area of orthopaedic surgery. From the perspective of the providers, the most important agents for improvements in the outcome, they are to be given top priority.
  The indicators E8 and E9 can be used in both longitudinal service and cross-section analyses. Indicator E8 allows for considerably more accurate statements, but requires specific datasets from registers.
  Indicator E9 rather provides data giving a more general overview, but can also be calculated from data available in almost every country such as discharge records.
  These indicators are most effective when applied in combination: calculations of the revision rate can be used in the adjustment of comparative supranational evaluations of the revision burden.

- Indicator E3 (Inhospital Mortality after Hip Fracture) shows a relevant frequency of mentions in a subgroup pertinent to public health: the therapy of acute fractures.

- Other indicators are only considered in individual cases.

- There is a relatively low frequency of relevant data sources for these indicators in the literature published and actually is below 2% of the total amount. From the health authorities' perspective, a systematic review of scientific publications therefore makes little sense. It appears more reasonable to involve experts in the field and thus obtain access to aggregate knowledge.

- The indicators E1 to E7, which were collected in the first phase of the project, can be calculated from the datasets available in public health at a relatively moderate expense. However, they only have restricted selectivity and validity in the assessment of outcome measurement issues since non controllable factors such as the patient's condition have a high impact on the result.

- Indicators for outcome measurement should be examined with respect to their usefulness and potential undesirable side effects for each pathology and situation before they are included in comparable benchmarking processes.

- The use of such indicators for comparative outcome analyses can have negative effects on patient treatment. Measures of improvement in a benchmarking process may entail particular patient selection resulting in deterioration in treatment access on an individual level.

- The present paper focuses on the field of study of the EUPHORIC project (outcome measurement). Statements concerning relevance and recommendations therefore

exclusively apply to this area.
The indicators E1 to E7 rather focus on structural and process quality, where they can definitely contribute valuable information.

Outcome Registers:

In terms of outcome measurement there is a fundamental difference between pharmaceuticals and medical devices.

As to pharmaceuticals, the initial record of a potentially occurring side effect is sufficient to inform physicians and patients and to allow for corresponding action in the individual case. Most commonly, the adequate reaction is to cease the medication and initiate symptomatical therapy of the side effects. Due to the short periods of time between the intake of the medication and its effects, the retrospective analysis of damage events appears to be reasonable. Rare, severe side effects such as embryonic damage (e.g. Thalidomide/Contergan) are exceptional and should be handled in a similar way as implanted medical products.

With implanted medical products such as endoprostheses this does not suffice. In most cases serious side effects lead to revision operations. Often years pass by between primary surgery and product failure, during which further patients do not receive optimum treatment. It is therefore essential to record the side effect profiles to be expected as soon and as exactly as possible in order to allow for target-oriented reaction in primary implantations. This requires very accurate dataset analyses preferably covering all important factors of influence, which in turn necessitates specific data collections carried out prospectively. In this process, registers have proved a useful tool.

Outcome registers for implanted medical products such as total endoprostheses are defined by the following:

- Registration of ALL primary and revision operations in a defined area in a central database.
- Follow the implant until it has to be revised, the patient dies or emigrates.
- Definition of Revision (= Failure): at least one part of the implant has to be revised during revision surgery.

The main advantage of registers is their potential to enable systematised longitudinal analyses as well as a multitude of data linkages which, after expert analysis, may lead to clear recommendations for action.

Analysis and discussion are most efficient when carried out via medical specialist societies. Apart from a democratic decision-making procedure on a high professional level, this ensures
the disclosure of information to physicians and hence the consideration of the results during the treatment process.

Quality of Datasets:

Outcome Measurement:

- Sample-based clinical studies exhibit highly relevant and significant bias factors and thus have only very limited usability as a data basis for evaluations and conclusions.

- The data are highly influenced by the authors of the clinical literature as regards the number of cases published.

- Publications by implant designers in many cases show a relevant bias in outcome per se, thus leading to a distortion of results. This influence appears to be stronger in publications from the USA than in publications from continental Europe.

- Structured surveys show better compliance with register data, but they are inferior to outcome registers in data quality and organisation.

- Experimental studies show only low correlation with the clinical outcome and are thus no suitable basis for outcome assessment. This also applies to issues such as the licensing of medical devices.

- Registers monitor a considerably larger collective under more specified, standardised and comparable conditions and are therefore superior as a data source.

- Registers yield valid results much more rapidly than sample-based clinical studies and surveys and are thus able to considerably reduce the periods of time until robust statements can be made concerning the outcome of a medical device or a surgical approach. This refers to periods of several years.

- In the context of surgical interventions involving the implantation of medical devices, randomised controlled trials yield no essential improvement in the quality of publications. Compared to pharmaceuticals, medical devices show relevant differences affecting the organisation of studies and their quality. For organisational and methodological reasons outcome registers, which can provide highest-quality data in the area of arthroplasty and similar medical devices, do not make sense for pharmaceuticals. In this field RCTs are still to be regarded as the gold standard.

- At present, the usual categorisation regarding the quality of the literature and bases of evaluations appears to be inadequate for endoprostheses and similar medical devices.

- Therefore, based on the data available, a modification in the classification of data quality should be taken into consideration.
    1. Comprehensive data collections such as registers are to be rated superior.
    2. Randomised controlled trials should be assessed with respect to the endpoint.
        a. In the case of objective endpoints, such as measurement results (e.g. implant migration as an early indicator of loosening), a randomised controlled study is to be regarded as equal according to the relevant guidelines.
        b. In the case of subjective endpoints it has to be checked whether post-operative examinations could possibly break blinding. In such a case, a compromising of results should be assumed.

- To be able to make optimum use of the advantages described, publication procedures and basic data such as implant recording in registers should be standardised.

- There are big differences in the use of implants in the various countries and, by implication, in registers as well. To obtain a comprehensive overview of the products used in the common market of the EU, a supranational evaluation of national results based on a standardised methodology is required. This would necessitate standardised designation of the implants recorded.

- Without registers it is mostly impossible in an independent analysis to deduce the decisions which have lead to a decrease in the use of particular implants or a product recall from the results published. This is usually decided autonomously by the manufacturers and physicians in non public discussions, or by means of a decision-making process at a scientific level. External control or monitoring by public health institutions is thus impossible. The mere access to register data would allow for sufficient control and open up the opportunity of autonomous decisions.

- In the organisation of studies and surveys objective endpoints are essential. As a rule, subjective endpoints entail subjectively biased decisions and results which, without reference sources, may lead to misinterpretations in meta analyses.

Market Monitoring and Post-Marketing Surveillance:

- The data currently available from manufacturers and public health authorities are insufficient for the handling of outcome measurement issues, market monitoring, and the detection of serious product deficiencies according to the material analysed in this project.

- The process is poorly structured and comprises a series of subjective valuations based on insufficient data.

- Public health authorities are highly dependent of the manufacturers' reports, while users only barely meet their legal obligation to report.

- For the user it is difficult to decide whether or not the revision of a product is to be rated as a relevant case, since the assessment of relevance largely depends on the calculation of the frequency of an event with a specific product. This, however, necessitates the access to a comprehensive data collection such as a register.

- Even the manufacturers, who rely on their sales representatives' recordings, are not in a position to guarantee adequate safety. In the cases examined the manufacturers have complied with the legal regulations. However, the decisive step towards improvement, the access to comprehensive data and their retrospective analysis, is made impossible to them for reasons of data protection. This would require a database comprising the personal data of all patients treated with a certain medical device.

- It would thus make sense to consider arthroplasty registers as an additional tool in market monitoring and post-marketing surveillance.
    - The data should be examined retrospectively with regard to irregularities, such
      as a striking frequency of revision operations with certain medical devices or a cumulation of certain reasons of revision such as implant fracture clearly indicating product failure or requiring measures to be taken with respect to the application guidelines.
    - Manufacturers should be involved in the process, either directly or by means of requesting for statements.
    - Information would be available about patients and departments concerned, for instance, in the case of product recalls, or for vigilance control.

- Information procedures should be improved in detail, for instance, by
    - Improved labelling of letters referring to product problems;
    - More precise regulations for products in the trial stage, e.g. by the users' obligation to report revision operations to the manufacturer, including the preservation of retrievals.
    - Improved and standardised access to information, e.g. by setting up respective websites.

Key-findings:

Outcome Registers are the most important factor in Outcome Research, as a

- **Core Dataset**
- **Reference source of other data sources with respect to validity**

Proposals

- **Proposal for a Description of Register Datasets regarding their Quality and Validity as a Basis for Decision-Making:**

  Comprehensive data collections such as outcome registers or discharge records differ with respect to their validity for particular purposes. A crucial point is to achieve the best possible agreement between the purpose of data collection and the issue in question. Another essential dimension is data collection completeness. The assessment of the validity of a dataset thus depends on its internal consistence and its suitability for the issue to be clarified.

  Proposal for the Structured Assessment of Data Sources for Outcome Research and Structure and Process Quality Issues:

Aim / Purpose	Outcome (A)	Process (B)	Structure (C)
Conformity between aim of data collection and aim of evaluation	Data collection performed for the specific purpose of evaluation (1)	Data collection not performed for the specific purpose of evaluation (2)	
Coverage	Nationwide (1)	Regional (2)	Local (3)
Data collection	Comprehensive (1)	Incomprehensive (2)	Sample-based (3)
Conformity dataset for assessment	Representative (1)	Not representative (2)	

The results would be summarised as follows:

1. the purpose of the data collection in a letter code (A,B,C);
2. internal dataset quality in a descending 3-stage numerical code.

Proposal for the Future Organisation of a Modified Licensing Procedure and an Advanced Quality Monitoring System:

1. Technical evaluation of the products by notified bodies (according to the guidelines currently valid).

2. Mandatory clinical studies based on appropriate samples.

3. Specific recommendations for the clinical studies should be negotiated, like the obligation of surgeons/hospitals/manufacturers to report any revision operation or major complication in a standardised way and subsequently collect and analyse retrievals.
   Even though there are major differences between medical devices and pharaceuticals, an adjusted model based on the guidelines used in pharmaceutical phase 1-3 studies could be useful. In drawing up this specific set of guidelines, the main emphasis should be put on risk adjustment procedures and adverse event evaluation.
   Regular reporting to notified bodies or public health institutions might also be included.

4. Inclusion of migration analyses as an essential part in the clinical studies mentioned.
   There are procedures and systems of migration analyses already available, like RSA, EBRA or MBRSA. Technical systems should be validated prior to being accepted scientifically. Notified bodies should be included in the process of formal licensing of the tool.
   Scientifically speaking, it can be considered as proven that migration analyses are proper tools to significantly increase the predictability of long-term revision rates. These evaluations can easily be introduced into the CE licensing process.

   a. Systems or institutions taken into consideration to be included in the licensing process should guarantee the following minimal requirements:
      i. Sensitivity on Migration:
         1. RSA: 0,1 mm
         2. EBRA: 1 mm
         3. MBRSA: 0,15 mm
      ii. Validity of the basic material (X-rays,..) has to be proven by an audit.
      iii. Design Requirements for migration analyses:
         1. Follow Up: 2 years
         2. Examination: Postoperative, 3 months, 1 year, 2 years after surgery
         3. Maximum migration acceptable:
            a. RSA: up to 1 mm in the 1st year, depending on the implant, RSA is able to define specific curves for implant design features
            b. EBRA: 0,5 mm/year
            c. MBRSA: dependent on the implant and technical specifications

         4. Minimum Study samples:

a. RSA: 35 Cases/Implant
b. EBRA: 60 Cases/Implant
c. MBRSA: 20 Cases/Implant

For any implant under observation a proper reference group should be available, preferably in a prospective controlled trial.

The figures presented are based on current scientific standards for standard implants like hip arthroplasty. For implants with a more complex surface or less data available, the required number of cases might be higher.

5. Standardised requirements for these studies should be decided in expert meetings including public health authorities, notified bodies and medical experts in the field of migration analyses and outcome measurement of artificial joint implants.

6. For every re-licensing procedure, an evaluation of the available National Arthroplasty Register data should be made regarding the indicator of “Revision Rate” and used to assess the performance of a medical device in the human body. This procedure should be applied in addition to the clinical studies used at present, in order to benefit from having independent, comprehensive, non sample-based data as a reference. The data should be adjusted for confounders (failure mechanisms not related with the implant) in cooperation with experts from Arthroplasty Registers (where the implants are tracked, EFORT-EAR might support by coordination), including scientific assessment and benchmarking.

7. For failure mechanisms exclusively related to the implant (e.g. implant fracture), regular reporting to the public health institutions responsible for quality monitoring of medical devices on a national and EU-level should be taken into consideration in order to provide these institutions with comprehensive information for their evaluations.

8. In cases of product recalls or similar actions on inferior medical devices Arthroplasty Registers can provide information on patients treated with a specific implant as well as on the hospitals involved, and support vigilance control by this service.

Proposals for future activities to increase quality in outcome measurement and market monitoring:

1. Development of a standardised medical device tracking system.
   The definition of medical devices in National Arthroplasty Register datasets is not standardised. At present the maintenance of article lists consumes a relevant part of the back office expenses of every national project.
   The lack of standardisation of medical devices is a major limitation for reporting on European level.
   A standardised medical device catalogue available for every national Register is a prerequisit for a regular reporting system on European level as well as for market monitoring. If this list would be connected to the list of CE-licensed devices Arthroplasty registers could easely identify not CE-licensed implants on the market and could contribute to ongoing tasks.

2. Development of a standardised evaluation and reporting procedure for EU level.
   At present evaluation and publication procedures on national level differ in the European Union. Since the feedback and dissemination procedures of successful projects should not be modified – this might effect the quality monitoring procedres on national level in a negative way - it would be recommended to define a guideline for a report on EU level referring to aggregated National Register datatsets taking specific interests of the health system on supranational level and ECHI indicators into consideration.

3. Development of advanced statistical methodologies to improve sensitivity and predicatability for outcome measurement based on Registers.
   At present successful national projects are based on direct feedback mechanisms to disseminate findings to stakeholders on national level. This procedure is dependent on personal discussions leading to modifications in daily decisions to improve quality. On EU level the level of complexity is higher since there are additional confounders like the influence of the national public health system on the outcome. On EU-level a more structured evaluation and reporting system independent from large scale consultation processes might be easier to handle in daily practice.
   Evaluations on EU-level comparing national health system procedures and their effect on the outcome might contribute to the increase of quality of health service in the EU. National Arthroplasty Registers can contribute data in sufficient amount even now.

Abbreviations:

- **TAA** Total Ankle Arthroplasty
- **THA** Total Hip Arthroplasty
- **TKA** Total Knee Arthroplasty
- **RCT** Randomised Controlled Trial
- **EFORT** European Federation of National Associations of Orthopaedics and Traumatology
- **EAR** European Arthroplasty Register, an EFORT-affiliated, non-profit scientific society focused on outcome research in arthroplasty and Arthroplasty Registers

Annex:

- Technical Report #1: Left to be used for the main document in the EUPHORIC general Report, if requested by the leading partner
- Technical Report #2: Assessment and Summary Report of National Outcome Registers concerning Arthroplasty in Europe
- Technical Report #3: Avon Retropatellar Replacement
- Technical Report #4: Total Ankle Arthroplasty
- Technical Report #5: Oxford Unicompartmental Replacement
- Technical Report #6: Taperloc Hip Stem Implant
- Technical Report #7: Zweymüller Prosthesis
- Technical Report #8: Lubinus SP II
- Technical Report #9: Boneloc Cement
- Technical Report #10: Accolade stem implant /Trident cup implant
- Technical Report #11: Patella Replacement in TKA
- Technical Report #12: Component Fractures in Total Hip Arthroplasty
- Technical Report #13: Austin Moore Cervicocephalic Hip Implant
- Technical Report #14: Duraloc Cup
- Technical Report #15: Omnifit Cup
- Technical Report #16: Advance Medical Pivot Total Knee Arthroplasty System
- Technical Report #17: Poly Two
- Technical Report #18: Summary Hylamer
- Technical Report #19: Cemented Titanium Stems: 3M Capital Hip
- Technical Report #19a: Titanium Stem for Cemented Fixation
- Technical Report #20: Manufacturers Procedures – Quality control and Market Monitoring
- Technical Report #21: Summary available data concerning the Indicator E9, Revision Burden
- Technical Report #22: Indicators E1-E7 from a Medical Expert's Point of View
- Technical Report #23: Evaluation of Public Health Indicators in the Relevant Orthopaedic Traumatological Peer Reviewed Literature
- Technical Report #24: Data Sources of National Public Health Authorities concerning Medical device Failure
- Technical Report #25: Potential Use of Discharge Records in Outcome Measurement and Link with Data from Outcome Registers based on the example of Arthroplasty
- Technical Report #26: Register-based Documentation of Economic and Administrative Data and Linkage to Outcome measurement – Report by the Romanian National Arthroplasty Register
- Technical Report #27: Economic data concerning Arthroplasty and Register data from Emilia Romagna
- Technical Report #28: Characterising Registries for Reviewing Purposes
- Technical Report #29: Quality Registers in Sweden
- Technical Report #30: Quality Registers in Finland
- Technical Report #31: Data Mining and Arthroplasty Register datasets

Reference and Literature:

This list is designed in order to present key publications. It is not the aim to present the entire material available.

National Arthroplasty Register webpages are summarised at the EFORT-Portal. http://www.efort.org/getdoc/1b923b01-41d2-4587-bac2-7ca7a11e613e/Arthoplasty-Registers.aspx

Annual Reports, contact information and publications (in some countries like Norway in full text when possible due to copyright) are available in updated versions in userfriedly way.

Information concerning the use of indicators and background information are available in Annual Reports from Sweden, Norway, Denmark, Australia and Canada

Some recommended journal publications concerning validation of datasets, value od datasets and Indicators:

1. **O. Robertsson**. Knee Arthroplasty Registers. *J Bone Joint Surg* 2007; 89-B: 1-4
2. **Herberts P, Malchau H.** Long-term registration has improved the quality of hip replacement: a review of the Swedish THR Register comparing 160,000 cases.

   Acta Orthop Scand. 2000;71-2:111-21.
3. **Herberts P, Malchau H.** How outcome studies have changed Total Hip Arthroplasty Practices in Sweden. *Clin Orthop*. 1997;344 : 44-60.
4. **Malchau H., Garrellick G., Eisler T., Karrholm J., Herberts P.**

   Presidential guest address: the Swedish Hip Registry: increasing the sensitivity by patient outcome data. *Clin Orthop*. 2005 ;441:19-29.
5. **Havelin LI, Engesaeter LB, Espehaug B, Furnes O, Lie SA, Vollset SE.** The Norwegian Arthroplasty Register: 11 years and 73,000 arthroplasties. *Acta Orthop Scand* 2000;71-4:337-53.
6. **Robertsson O, Dunbar MJ, Knutson K, Lewold S, Lidgren L.** The Swedish Knee Arthroplasty Register. 25 years experience. *Bull Hosp Jt Dis* 1999;58-3:133-8.
7. **Lucht U.** The Danish Hip Arthroplasty Register. *Acta Orthop Scand 2000;*71-5:433-9.
8. **Puolakka TJ, Pajamaki KJ, Halonen PJ, Pulkinen PO, Paavolainen P, Nebelainen JK.** The Finnish Arthroplasty Register: report of the hip register.

   Acta Orthop Scand. 2001 Oct;72(5):433-41

9. **Furnes A, Lie SA, Havelin LI, Engesæter LB, Vollset SE.** The economic impact of failures in total hip replacement surgery. The Norwegian Arthroplasty Register 1987-1993. *Acta Orthop Scand.* 1996;67:115-21.
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11. **Espehaug B., Havelin L.I., Engesaeter L., Vollset S.**
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A review of 39,505 primary total hip replacements reported to the Norwegian Arthroplasty Register, 1988-1996. *Acta Orthop. Scand.* 1999; 70(1): 12-18
12. **Pedersen AB, Johnsen SP, Overgaard S, Soballe K, Sorensen HT, Lucht U.** Registration in the Danish Hip Arthroplasty Registry: completeness of total hip arthroplasties and positive predictive value of registered diagnosis and postoperative complications. *Acta Orthop Scand* 2004;75-4:434-41.
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