

# Bergen Campus Biomedical Research Cooperation Analysis using a CERIF-CRIS

Dag W Aksnes<sup>a</sup>, Anne Asserson<sup>a</sup>, Reidar Thorstensen<sup>b</sup>, Bernt Olav Økland<sup>b</sup>

<sup>a</sup>University Library, University of Bergen, Norway

<sup>b</sup>Department for Research and Development, Haukeland University Hospital, Norway

## Summary

In this study we have analysed research cooperation between a Norwegian university and its affiliated university hospital using contextual metadata based on the CERIF (Common European Research Information Format) model on co-authored publications. The purpose is to analyse the extent and nature of cooperation between the institutions. The study functions as an example of how advanced metadata may be used for monitoring the research activity at institutions, their research output and cooperation links. Such information is important for research management purposes and we will show how the results have been applied in such contexts.

## 1 Introduction

There are two main contributing actors to biomedical research: medical faculties at universities and hospitals. These are often localised together in campus areas. We have carried out a case study of one such campus in Norway: The medical faculty at the University of Bergen and Haukeland University Hospital. The focus is on the research output and links in terms of publications between the two organisations.

The study has two main purposes (Thorstensen et al., 2011). From a management and research administration perspective it is interesting and useful to have a complete overview of the research activities and output at the two closely integrated organisations which nevertheless are belonging to different research sectors. Included in the analyses are co-operation patterns between the two organisations based on co-authored publications, internal and external national and international collaboration. Secondly, it is interesting to investigate how contextual publication metadata can be used as a source and shed light on these issues.

The medical research community in Bergen is an integrated research cluster with a geographic co-location on the hospital site, often referred to as *Campus Haukeland*. In this study we have for the first time been able to show the exact level of cooperation between to two institutions in the cluster. Never before has data at this level of detail and quality been available.

## 1.1 Background

The Norwegian research system has traditionally been divided in three sectors of performers: the industry sector, the institute sector, and the higher education sector. Although the hospitals are major contributors to the national research, they have not been included in a separate sector. The university hospitals have been classified within the Higher Education sector, while other hospitals have been classified in the institute sector. During the recent decade, the public funding of the research institutions has undergone major reforms by the introduction of a performance-based funding system. According to The Ministry of Education and Research, quality “in education and research are best safeguarded by means of a financing system that emphasizes the results attained” (Ministry of Education and Research, 2001). The rationale underlying the model is in addition that society has the right to expect results from the substantial public funding allocated to research and higher education (Aksnes, Følch, Slipersæter, 2008).

The performance-based funding model is partially based on the measurement of their scientific and scholarly publishing (cf. Sivertsen, 2010). Both the higher education institutions and public hospitals are funded in this way, although the formula applied differs somewhat between the two types of institutions. In this system, the publication channels are divided into two levels. The highest level (level 2) is given extra weight and includes only the leading and most selective international journals and publishers (accounts for about 20% of the world’s publications). Publication data from the Norwegian CRIS-system, CRISTin (Current Research Information System in Norway), is used as data source for this funding system. CRISTin contains complete and verified bibliographic records where all co-authors and their institutional affiliations are registered. Both the University of Bergen and Haukeland University Hospital are now using this system. Publication points are calculated based on a formula where the publication level, publication channel and numbers of authors are taken into account.

Several years ago the health sector was reorganized through a major health reform. As a result of the reform, there was a significant increase in responsibility for research and education for the public hospital trusts. The responsibility is statutory. An important argument and justification for implementing a joint cross sector wide research documentation system based on the CERIF model, CRISTin, was to enable national comparable data between the higher education institutions and the hospitals in order to be able to monitor the performance based on indicators.

CRISTin is an application developed in Norway by USIT and is owned by the Ministry of Education and Research. From 2012 CRISTin will be used by all the research performing institutions with public support. From 2012 there will be 170 organisations and about thirty thousand users. CRISTin has already about 900 thousands records spanning over 20 years. The application supports documentation of a Person, Organisation, Project, CV and the interlinking between them. CRISTin, previously FRIDA, is based on an early CERIF model and has an extensive use of master files to secure the quality of the input. As an example can be mentioned that all persons are uniquely identified by their national identification number, the journals are linked to a master file of journal names where all the information is held, to avoid random input. The same holds for organisational units, publishers, series, etc.

As described above, the hospitals are not considered as a separate research sector in Norway, and this also holds for international statistics such as the R&D statistics of the OECD. The Norwegian health authorities attempt to make the role of hospitals as research institutions more visible both in national and international available statistics. An important motivation for introducing advanced metadata system is to improve the statistics on the research results.

The medical faculties at universities are closely integrated with departments at university hospitals. By the introduction of a common metadata set based on CERIF, we have for the first time the opportunity to analyse the research output in this context.

## 2 Methods

Quantitative studies of scientific publishing (bibliometrics) can offer interesting information on the extent of collaboration (see e.g. Glänzel & Schubert, 2004; Katz & Martin, 1997, Luukkonen et al. 1992, 1993). The fact that researchers from different institutions co-author a scientific publication reflect collaboration and co-authorship may be used as an indicator of such collaboration. Compared to other methodologies, bibliometrics provides unique and systematic insight into the extent and structure of scientific collaboration. For example, very large samples can be analysed, and the technique captures non-formalised types of collaboration that can be difficult to identify with other methodologies (Wendt, Slipersæter, Aksnes, 2003). Computerized databases such as the Web of Science or a local CRIS where the institutional affiliations of the authors are indexed, make it possible to conduct such analyses in a systematic way.

In our study, records were retrieved from CRISTin where authors' published institutional affiliations are to departments at the medical faculty at the University of Bergen or to departments at Haukeland University Hospital. Both institutions have a complete dataset in CRISTin for publications published in 2010, and only data from that year were included in the study. Haukeland University Hospital has some cooperation with other faculties at the university, but these departments are not co-located with the hospital and thus excluded from the study. The dataset is limited to peer-reviewed journal articles, which is the primary publication form for medical and health related research.

A total of 879 records were retrieved, with information on the relational combination of journal articles, authors and institutions. The dataset is complete with bibliometric information including co-authors names and affiliations of all contributing parties. Norwegian authors are identified with national identification numbers (social security numbers) and linked to corresponding records in employers' personnel registers.

In accordance with the Norwegian model for performance-based funding, institutions are credited for publications based on authors published affiliations and not by the authors' current employment situation. This is important as research results often are published years after the research was actually conducted, and researches may have changed employer in the meantime. As a requirement for qualifying for performance-based funding, each journal article is manually checked against the published publication to ensure the quality of the data. Information on completed quality control is registered in CRISTin. Manual quality control is performed by each institution which claims performance-based funding, thus ensuring a fully traceable system and a high quality of the data.

The data from CRISTin was imported into software for statistical analyses, and simple descriptive analysis was performed. The main focus of these analyses was the level of integration and cooperation within the campus, and between the campus and international institutions. To increase the accessibility of the findings in the study we have produced an array of different information visualization, such as Venn diagram, geographic visualization and relationship maps.

There are many repositories and these days it seems that every institution has one. But many of them are not populated with full text, but mainly references. The metadata commonly used in the repositories are Dublin Core (DC) and some has extended this metadata set. The repositories are made searchable via OISTER. However, for the statistics at this complexity, it would not be possible to draw information from a DC metadata set. We need to have uniquely identified persons, gender and age and uniquely institutional units to be able to generate this high quality statistics. We need contextual metadata.

### 3 Selected Results

One of the main findings in this study is that 44% of the total research output is a result of research cooperation between the medical faculty of the University of Bergen and Haukeland University Hospital. The cooperation is especially noteworthy for the university hospital where 74% of the journal articles also have co-authors from the university.

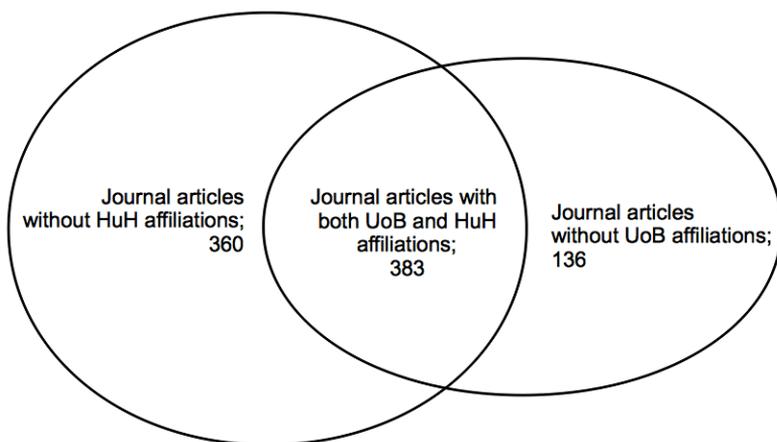


Figure 1: Number of peer-reviewed journal articles in 2010 (n=879); Area proportional venn-diagram of published articles; The Medical Faculty at University of Bergen (UoB) and Haukeland University Hospital (HUH)

Figure 2 shows the number of publishing researchers at the institutions. Only researchers who has authored at least one scientific paper is included in the figure. This way of counting researchers differs from other methods that often rely on employment data. The share of researches that credit both the university and the hospital for their research activities is 30%. The campus consists of 1015 publishing researchers.

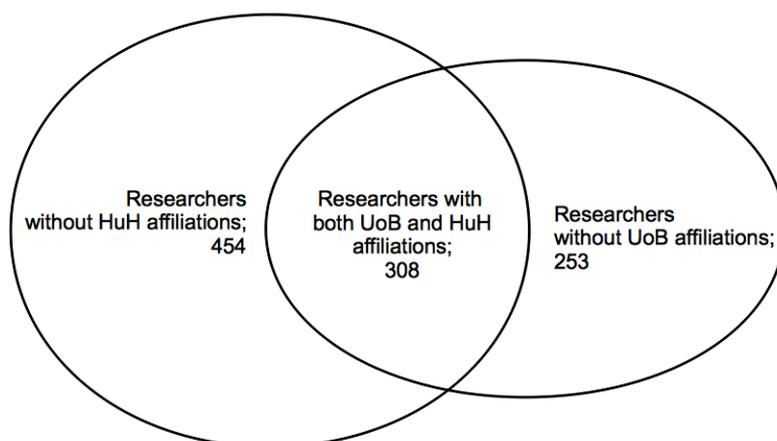


Figure 2: Number of researchers in 2010 ( $n=1015$ ); Area proportional venn-diagram of the affiliations for researchers; The Medical Faculty at University of Bergen (UoB) and Haukeland University Hospital (HUH)

Table 1 is an example of macro indicators for selected departments. The table shows the number of publications points, the numbers of articles the number of researchers and the average publication points per researcher within the department.

Departments	Publication Points	Number of Articles	Number of Researchers	Points on average per researcher
Medicine	36,9	77	66	0,56
Neurology	31,6	64	42	0,75
Heart Disease	21,5	46	44	0,49
[...]				
Radiology	8,8	21	23	0,38
Orthopaedic Surgery	7,9	14	19	0,42
Ophthalmology	3,1	7	7	0,44
[...]				

Table 1: Example of elements implemented into an institutional report; hospital departments

We have also used the data to analyse other aspects of the research performance, for example the gender and age distribution. Figure 3 shows an example of such an analysis. At the Faculty of Medicine, men account for the majority of the publication output in most of the age groups. The main exception is the age group 35-44 years. Moreover, in most of the age groups, men on average produce a higher number of publication points than women.

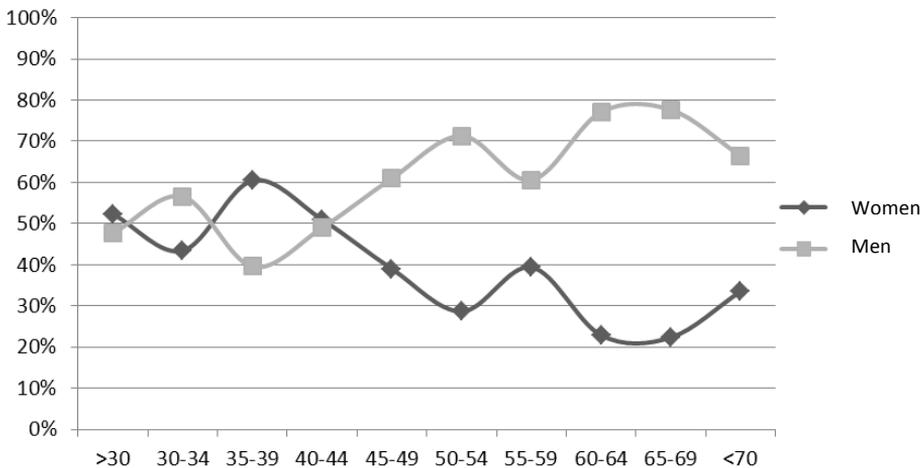


Figure 3: Percentage of publication points by age groups and gender at the Faculty of Medicine, University of Bergen

The data set enables us to analyse the size and performance of the overall inter-institutional performance. We have prepared various illustrations showing the cooperation between different departments within the institutions. Figure 4 gives an example. The figure shows the collaboration between one of the university clinical departments and various hospital departments. The illustration is area proportional. The figures inside the circles are the total number of journal articles authored by hospital and university researchers. The figures by the arrows are the total number of journal articles published in cooperation between the various departments.

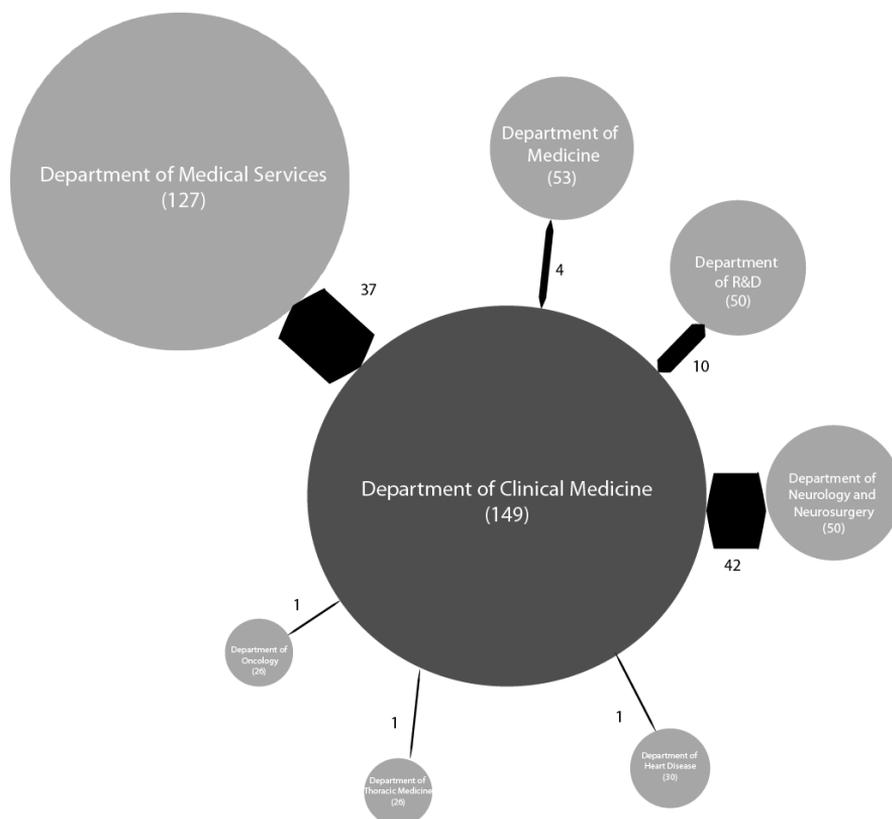


Figure 4: Illustration of cooperation between Department of Clinical Medicine at the University of Bergen and various hospital departments

The data from a CERIF-CRIS structured system allow us to analyse the degree of international cooperation both at the level of publications and individuals. For the university hospital, the proportion of journal articles with international co-authors is 43.7% (Table 2). In total, 49.7% of the researchers at the university hospital have published with co-authors from foreign institutions (Table 3).

	Number of journal articles	In %
The Faculty of Medicine, University of Bergen	367	49.4%
Haukeland University Hospital	227	43.7%

Table 2: Number of journal articles with international co-authors

	Number of researchers	In %
The Faculty of Medicine, University of Bergen	440	57.7%
Haukeland University Hospital	273	49.7%

Table 3: Number of researchers with an international cooperation at the individual level

To illustrate the level international cooperation, we have generated a geographic visualization. The current CERIF model does not include any geospatial coordinate, therefore we have geocoded every address and plotted the results on a map (Figure 5). This was done by using the Google Maps application programming interface (API).



Figure 5: Institutions that have published one or more journal articles in cooperation with Haukeland University Hospital during 2010

## 4 Discussion

In Norway, as in many other countries, clinical research and education of physicians and other health professionals is conducted in close cooperation between a university and a university hospital. However, until now, it has not been possible to get high quality comparable data on research output. By applying and comparing publication data from CRISTin based on the CERIF model we can now derive much information about the size, performance and collaboration at an overall inter-institutional level. This information has been highly appreciated at various management levels.

The objectives and priorities concerning the research do not always coincide among the institutions. Higher education institutions often have a more basic research profile, and undertake long-term and sometimes “higher-risk” research activities, in order to compete at the research frontier internationally. On the other hand, university hospitals tend to have a more applied research profile where research which might improve the health services has priority. Another important aim of university hospitals is to insure that the full extent of different disciplines within the organisation is covered in order to extend the knowledge base and expertise of employees. This often

means that relevance is prioritised side by side with scientific quality when research funds and other resources are allocated.

The tight integration and collaboration in research and education between a university and a university hospital makes it important to have high quality performance data as a basis for making policy decisions. In order to raise research quality and support the development of research in strategically important areas, it is believed that this kind of close integration will bring out synergies.

Historically, Haukeland University Hospital has counted researchers based on employment positions and academic degree. Integration between the hospital and the university has been measured in number of academic staff which is employed in combined positions at the institutions. This information has often been difficult to extract from the financial and/or human resources systems, especially at the hospital, where researchers seldom are full-time researchers, but do research in addition to a clinical position. By counting actively publishing researchers and their author affiliations we have gained a much better picture of the level of integration between the institutions. The proportion of researchers affiliated with both institutions is larger than expected. Previously, we estimated about 200 researchers which had mutual affiliation, while our findings show 308 actively publishing researchers. The differences are mainly due to PhD students and postdoctoral fellows who are mutually affiliated, but only employed by one of the institutions.

For future work we will explore two other closely integrated organisations which have some overlap in co-authoring of publications. This includes Uni Research, which is the University of Bergen's strategic research partner and carries out research projects in all the university's scientific areas, including health research. Little is known of the co-authorship links between the academic staff at University of Bergen and Uni Research.

In addition to being a reporting system for research performance and results-based financing, the CERIF system CRISin can be used as a research management system at all levels of the organizations. What we have been able to document is that there are research activity in all hospital departments. This fact has been of strategic importance to hospital management.

Historically, the research community has been dominated by men. An aim of the national governance policies is to balance these gender differences. In addition to counting the number of male and female researchers, data from CRISin allow us to look at the differences in research output at the levels of gender.

The Norwegian model for performance based funding has differences depending on sector. For instances, the hospitals obtain extra publication points for publication involving international co-authorship. The rationale underlying this is that international cooperation is regarded as important and should be stimulated as it might increase the quality of the research. For the institutional management, indicators on scientific collaboration are interesting because they show the proportion of the researchers who have international contacts.

By geocoding the data from the CERIF-system CRISin we were able to create several geographic visualization utilizing different techniques. In the result section of this paper we illustrated the extent of international cooperation on a world map. In order to do this we had to geocode and plot every institution, since the current CERIF model does not include any geospatial coordinates. The CERIF Task Group of euroCRIS recently included geospatial coordinates in the next CERIF specification. This will make it easier to use geographic information in future studies.

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## Contact Information

Dag W Aksnes  
University of Bergen  
University Library  
N-5020 Bergen  
Norway  
[Dag.Aksnes@ub.uib.no](mailto:Dag.Aksnes@ub.uib.no)