

# Case Based e-Learning in Occupational Medicine—A European Approach

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**Objective:** *The main aim of the European Union project NetWoRM (Net-based training for Work-Related Medicine) is an international case-based e-learning curriculum for occupational medicine (OM).* **Methods:** *To improve teaching in OM, web-based cases have been created and implemented at the University of Munich since 1999. In the last 5 years, the project has been further developed with a view to implement the methods internationally.* **Results:** *Overall, 26 cases were developed in a standard English version and 10 cases each were made available for several national European curricula. The evaluation of cases showed easiness in accepting the cases and high level of interest in working with them.* **Conclusions:** *Case-based e-learning on an international platform is a unique tool, which supports the quality improvement of education and training in OM throughout Europe in the longer term.* (J Occup Environ Med. 2009;51:647–653)

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Occupational health is a global issue. More than 2 million people die from occupational accidents or work-related diseases every year. Furthermore, about 270 million occupational accidents and 160 million cases of occupational diseases occur annually.<sup>1</sup> The numbers vary enormously among countries and economic sectors. Although the number of deaths and injuries continue to decline in industrialized countries, it continues to be high in developing nations; hazardous work practices are still prevalent and work safety issues are often neglected.<sup>2</sup>

Prevention and identification of occupational and work-related diseases is vital to the improvement of this situation. In this context, it is of crucial importance that physicians and medical students are made aware of the potential causal relationships between work and disease, as well as the basic legal aspects of occupational medicine (OM). Worldwide, the implementation of OM learning in the undergraduate medical curriculum and postgraduate education vary considerably. In addition to countries with a curriculum that incorporates mandatory education in OM, like most in Europe, there are some countries that offer this on a voluntary base only; in other countries, OM education programs are not available at all. For these reasons, it would be important to integrate OM in the undergraduate and postgraduate training of physicians worldwide.

However, there are several aspects that complicate teaching of OM. On one hand, opportunities for medical clerkships and bed-side teaching, which are rated as the most efficient

way of teaching practical aspects,<sup>3</sup> are generally limited in the field of OM. On the other hand, limitations of time are an issue for most medical doctors. Therefore, postgraduate training might be best facilitated from their places of living and/or working. It would therefore be logical that learning resources should be made widely available and accessible without limitations of time or place.

A unique solution could be the implementation of case-based e-learning (CBL) and the World Wide Web (www).<sup>4</sup> CBL has been imple-

mented successfully into teaching in other clinical subjects resulting in a higher motivation of the students to learn.<sup>5,6</sup> Furthermore, a review from Smits et al<sup>7</sup> indicated moderate evidence for a higher level of satisfaction of physicians in postgraduate training by problem-based learning than by traditional teaching. Therefore, web-based cases for OM have been created and implemented at the Institute and Outpatient Clinic of Occupational, Social and Environmental Medicine in Munich since 1999.<sup>8</sup> CBL is used in more than 10 medical faculties in Germany and the stu-

dents enjoy working on e-learning cases as an add-on resource to traditional teaching.<sup>9</sup>

Based on these experiences, the international NetWoRM project (Net-based Training in Work-Related Medicine) was founded in 2003. The aim of NetWoRM is the dissemination and implementation of CBL in order to improve teaching in OM on an international platform. This article presents the results of the first stage of the European NetWoRM project, which was funded by the European Union (EU) for an initial period of 3 years within the MINERVA pro-

**TABLE 1**

Case Overview of All Cases Available in English With or Without Adaptation to a National System

Name of the Case	Topic	Origin	Language/Adaptation to National Law
<b>Respiratory</b>			
Running nose and breathlessness fits	Baker's asthma	DE	EN, DE, FR, FI, ES, RU, PL
Incidental finding	Claim for compensation	DE	EN, DE
A 59-yr old male with dyspnoea and cough	Asbestosis	DE	EN, DE, ES, PL
The cereal killer	Asthma due to sensitization to thiamine	EN	EN
Nunc terre meteor umbras	Nonspecific interstitial pneumonitis	EN	EN
The car plant worker	Occupational asthma	EN	EN
The Sardinian foundry worker	Silicosis and tuberculosis	EN	EN
The driver in trouble	Sleep apnea in a lorry driver	EN	EN
The retired shop fitter	Pleura mesothelioma	EN	EN, FI, ES
Breathless	Occupational asthma and extrinsic allergic alveolitis	ES	ES, EN, DE
Emaillieurs breath	Silicosis	FR	FR, EN, ES, FI, DE
Patient with chronic dyspnoea needs your help	Hypersensitive pneumonitis	PL	PL, EN, RU, ES, FI
<b>Muskuloskeletal</b>			
Forestry worker with white fingers	White finger syndrome	DE	EN, DE, PL, RO, FI
Sensation of numbness in the finger	Carpal tunnel syndrome	DE	EN, DE
<b>"Classical OM"</b>			
Bright like the sun	Welder with maculopathy	AT	AT, EN, RO
Another long and winding road	Construction worker with skin carcinoma	DE	DE, EN, PL
Stomach cramps and anemia	Lead intoxication	DE	EN, DE, ES, FI, RU
Electroplater	Chromate exposure	DE	EN, DE
They who search will find	Bladder cancer due to aromatic amines	DE	DE, RO, EN
Intoxication	Trichloroethanol intoxication	ES	ES
Weekend rash	Steroid dermatosis	FR	EN, FR, DE
<b>Medical service</b>			
Needle stick injury	Hepatitis B in a medical student	DE	EN, DE, FR, PL, RO, FI, ES, BE
Internship with consequences	Tuberculosis in health service	DE	EN, DE
27-yr old patient with conjunctivitis and rhinitis	Latex allergy in health service	DE	EN, DE
<b>Methods</b>			
Protection of the unborn child	Maternity protection	BE	BE, EN, FI, AT, FR, PL
A statistical thesis?	Occupational epidemiology	DE	DE, EN, ES, FI
Outbreak	SARS Epidemic	DE/EN	EN, DE, ES, PL
An exotic choice	Radiation protection	DE	EN, DE
Flight attendant	Diabetes mellitus and their health effects	DE	EN, DE, PL, RO
Workplace survey	Process of a workplace survey	FI	FI, EN, FR, RO, DE
Workplace accident due to alcohol	Workplace accident due to alcohol	RO	RO, EN, PL

DE indicates Germany; FI, Finland; FR, France; RO, Romania; EN, Great Britain; PL, Poland; ES, Spain; BE, Belgium; AT, Austria.

gram. The design of this project has been published previously.<sup>10</sup>

**Materials and Methods**

**e-Learning Platform CASUS**

CASUS (Instruct AG) is an on-line platform for creating, distributing, and evaluating cases, and it has been used for case-creation since the beginning of the project. It is widely used at universities in Germany and other European countries, the United States, and Canada for undergraduate and postgraduate medical training. CASUS is a linear CBL tool with an underlying didactical concept, which is designed to enhance the differential diagnostic reasoning process. A CASUS case usually presents a story of a real patient history organized in didactic units with findings and therapies. About 5 (short case) to 25 (long case) screen cards form a learning case. Each card represents a variable combination of text ele-

ments with hyperlinks, multimedia material, expert comments for additional information, and most important interactive elements such as different questions types with immediate rating and an detailed answer comment. If enabled by the course instructor, learners can contact the case author via asynchronous communication and discuss questions and problems they encountered while working through the case.<sup>11</sup>

**The European NetWoRM Project**

The European project consists of partner universities and institutions in nine European countries (Austria, Belgium, Finland, France, Germany, United Kingdom, Poland, Romania, and Spain). The aim of the project was to create new learning cases, to translate them into their national languages, and to adapt them to the national medicolegal systems, rather than create disconnected teaching modules for OM in each EU country.

Therefore, the range of OM training in various countries would be broadened by sharing case material from international partners across a wider and varied range of health problems and social environments. This, in turn, would have a positive impact on the overall quality of prevention, recognition, and management of occupational and work-related disorders within Europe.

Within the framework of the NetWoRM project, project members from every partner country were trained systematically, enabling them to create and adapt their own cases, and to evaluate the results of their students. The experience and knowledge thus gained helped them further to introduce the NetWoRM project to other international partners and initiate discussions regarding the practical and didactic aspects of the project. In addition, presentations at national and international congresses

**TABLE 2**  
Selection of New Created Cases by Country With the Individual Key Learning Objectives

Country	New Case	Learning Objectives
Austria	Bright like the sun	1) Health risk factors at the welding workplace 2) Combination of different work associated with occupational diseases 3) Eye damage by light
Belgium	Protection of the unborn child	1) Basic knowledge about pregnancy and work 2) Toxicological risks for pregnant workers 3) List and rank the workplace hazards for pregnant women
Finland	Workplace survey	1) Process of workplace survey 2) Legislation concerning workplace surveillance 3) Workplace surveillance
France	Weekend rush	1) Methodology approach 2) Group contribution 3) Problem solving
Germany	Sensation of numbness in the finger	1) Anatomy of the carpal tunnel 2) Pathophysiology of the carpal tunnel syndrome
Great Britain	The retired shop fitter	1) Occupational history 2) Clinical reasoning and common sense 3) The dangers of asbestos exposure
Poland	Patient with chronic dyspnoea needs your help	1) Potential occupational respiratory diseases 2) Differences between respiratory diseases 3) Therapeutical options of occupational respiratory diseases
Romania	Workplace accident due to alcohols	1) An occupational accident 2) The effects of alcohol 3) Consequences of the workplace accident (±rehabilitation)
Spain	Breathless	1) Occupational exposure to organic dust 2) Spirometric results 3) Therapeutical options of occupational respiratory diseases

Learning objective 1: The user should be able to define/enumerate . . . ; Learning objective 2: The user should be able to explain . . . ; Learning objective 3: The user should be able to apply in similar context . . .

enabled generation of interest for further dissemination of the project.

The adapted cases were then implemented in the partner countries in different academic settings. Besides tutorials with hands-on training, the cases were used in independent self-study programs. Only German students had used the CASUS platform before. In most countries, the cases were implemented in undergraduate training; in some countries like Romania, Finland, and Spain, implementation was also done in the post-graduate training curriculum. In the United Kingdom, the learning cases were incorporated only at the post-graduate level.

## Statistical Analysis

For statistical analysis of the cases, a validated on-line questionnaire was implemented in the program. This questionnaire was used in all centers, so that the results could be compared. The results are presented as mean with 95% confidence interval.

## Results

Overall, 13 new cases have been created and 26 cases have been developed in a standard English version. Furthermore, 53 cases have been adapted resulting in 6 to 10 cases available for the local curricula in Finland, France, Germany, Great Britain, Poland, Romania, and Spain covering a broad range of topics at the undergraduate and postgraduate level (Table 1). The major learning objectives of the recently developed cases can be seen in Table 2.

The implementation of the cases was very successful. Thirty-five separate courses were conducted in 8 countries with 28 cases in different languages. More than 4500 undergraduate and 397 postgraduate students worked with the cases and evaluated them during a 3-year period. We received 5286 on-line evaluations, most of them from Germany, Romania, Spain, and Finland. Eighty-five percent of all users reported no technical problems while using the cases. On a scale from 1

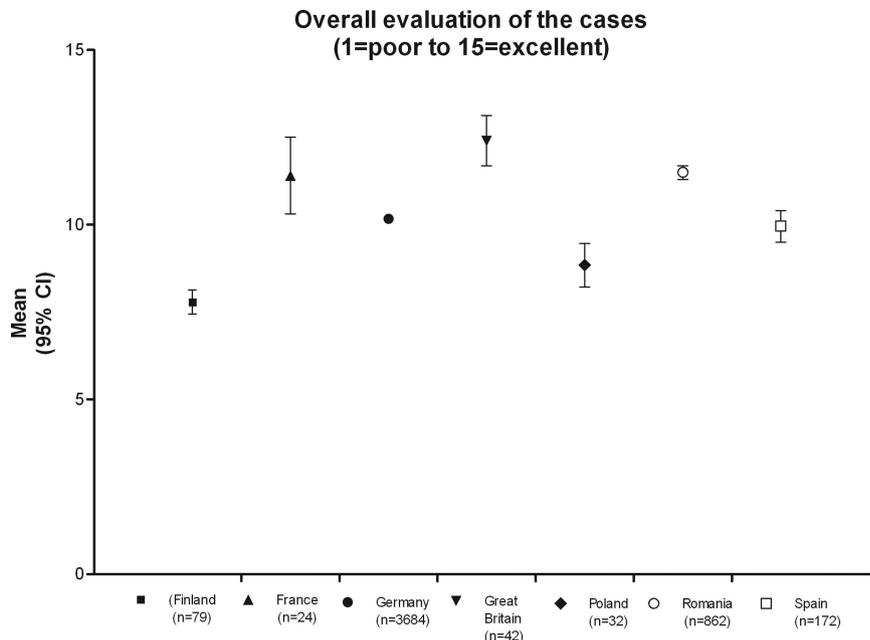


Fig. 1. Overall evaluation of the cases. In Finland, a different scale from 1 to 10 was used so that no direct comparison could be made.

(poor) to 15 (excellent), the users evaluated the cases giving a mean score of 10.4 (95% confidence interval [CI]: 10.3 to 10.5) (attachment, Fig. 1); except in Poland, where the cases were rated significantly worse with a mean of 8.8 (95% CI: 8.2 to 9.6). In all centers, the users rated the cases as relevant for their career (mean: 2.3; 95% CI: 2.3 to 2.4; scale 1 [= excellent] to 6 [= poor]). Most of the users recorded that the cases were fun to work with (mean: 2.4; 95% CI: 2.4 to 2.5; scale 1 to 6) and rated the experience as efficient (mean: 2.5; 95% CI: 2.4 to 2.5; scale 1 to 6) (Table 3).

When the results were stratified separately as undergraduate and postgraduate levels, several differences could be seen (Table 3). Although the question concerning "Handling the case was fun" showed similar results, the other questions differed significantly between the undergraduate and postgraduate level. Postgraduates rated the cases higher than undergraduates except on the question "There was a critical dispute with the topic."

Evaluation results stratified by country are presented in Table 3, too.

In Finland and the United Kingdom, the question "the cases provided a new approach to the subject" was rated significantly better (Finland mean: 2.3; 95% CI: 2.0 to 2.6; GB mean: 2.1; 95% CI: 1.7 to 2.5) than the mean result of all participating centers.

## Discussion

### Evaluation Results

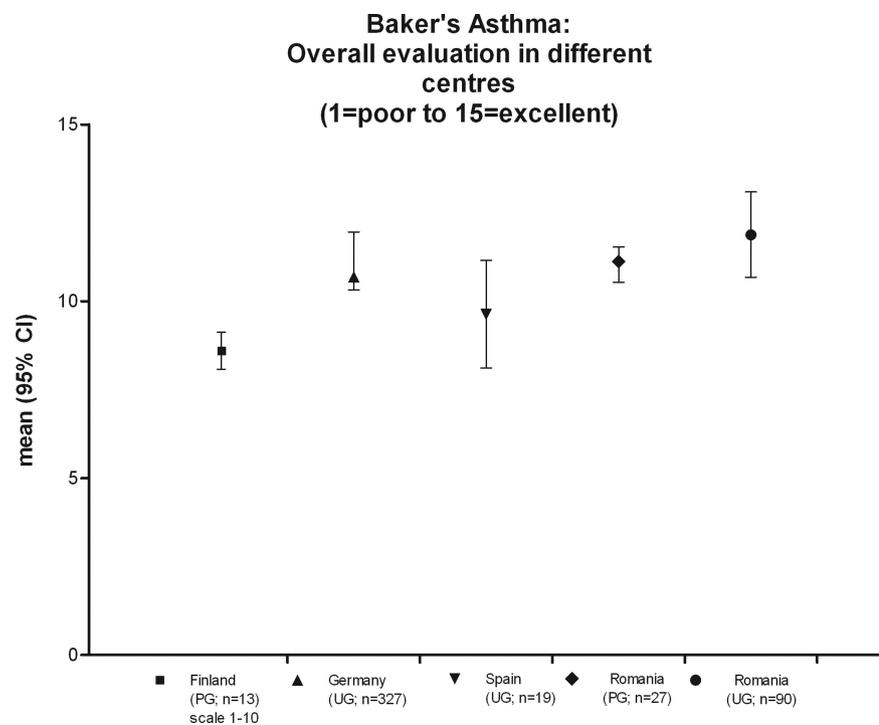
Given the large number of available cases in different languages created within the NetWoRM project, we have shown that the translation and adaptation of cases to other medicolegal systems is feasible. The evaluation of the cases by the students showed that it was easy for them to work with the cases, that they accepted the cases easily, and that they were interested in working with them. Most of the participants stated that the cases provided a new approach to the subject and supported their learning process. However, differences in level of knowledge and setting of the case use had to be taken into account; eg, as in Finland, only postgraduates worked with the baker's asthma case (Fig. 2).

**TABLE 3**

Evaluation Results From Seven Different Centers Stratified for Undergraduates and Postgraduates and Stratified for the Different Centers Presented as Mean With 95% CI

Handling the Case . . . (1 = Applicable to 6 = Not Applicable)	Was Fun	Was Efficient (Compared With Private Study)	Advanced My Interest for the Subject	Provided a New Approach to the Subject	The Content of the Case Is Relevant to My Career	There Was a Critical Dispute With the Topic
Total (n = 4848)	2.44 (2.41–2.49)	2.45 (2.42–2.49)	2.74 (2.70–2.78)	2.66 (2.62–2.70)	2.33 (2.30–2.37)	2.69 (2.65–2.73)
Undergraduates (n = 4497)	2.45 (2.41–2.48)	<b>2.50 (2.46–2.54)</b>	<b>2.81 (2.77–2.84)</b>	<b>2.74 (2.70–2.77)</b>	<b>2.37 (2.33–2.41)</b>	<b>2.66 (2.62–2.70)</b>
Postgraduates (n = 371)	2.45 (2.28–2.61)	<b>1.91 (1.77–2.04)</b>	<b>1.93 (1.79–2.06)</b>	<b>1.81 (1.68–1.93)</b>	<b>1.88 (1.74–2.02)</b>	<b>3.05 (2.87–3.24)</b>
Finland (n = 79)	2.34 (2.04–2.64)	2.51 (2.19–2.82)	2.72 (2.41–3.03)	<b>2.27 (1.95–2.60)</b>	2.63 (2.28–2.73)	2.42 (2.11–2.73)
France (n = 24)	2.29 (1.74–2.84)	2.41 (1.86–2.97)	2.54 (1.99–2.89)	2.41 (1.93–2.89)	2.50 (1.86–3.13)	3.69 (2.81–4.59)
Germany (n = 3684)	2.39 (2.35–2.43)	2.47 (2.44–2.51)	2.82 (2.78–2.86)	2.76 (2.72–2.80)	2.29 (2.26–2.33)	2.47 (2.44–2.51)
Great Britain (n = 42)	2.00 (1.61–2.38)	2.25 (1.81–2.64)	2.12 (1.67–2.57)	<b>2.09 (1.66–2.54)</b>	2.14 (1.69–2.59)	4.25 (3.63–4.82)
Poland (n = 32)	2.84 (2.15–3.54)	2.72 (2.04–3.99)	2.75 (2.07–3.43)	2.84 (2.12–3.57)	2.91 (2.32–3.50)	2.62 (1.96–3.29)
Romania (n = 862)	2.58 (2.48–2.69)	2.33 (2.13–2.34)	2.35 (2.26–2.45)	2.21 (2.12–2.31)	2.27 (2.17–2.38)	3.39 (3.28–3.50)
Spain (n = 172)	3.08 (2.88–3.28)	3.05 (2.83–3.26)	3.11 (2.91–3.32)	3.07 (2.85–3.29)	3.11 (2.88–3.36)	3.51 (3.25–3.77)

Seven centers: Finland, France, Germany, Great Britain, Poland, Romania, Spain. Undergraduates and postgraduates: the bold numbers represent significant differences between undergraduates and postgraduates; Finland and Great Britain: the bold italic numbers represent significant differences to the total evaluation.



**Fig. 2.** Comparison of the evaluation results of the baker's asthma case among different countries and different levels of training (Germany, Finland, Spain, and Romania; postgraduate [PG] and undergraduate [UG]). Overall evaluation (1 = poor to 15 = excellent). In Finland, a different scale from 1 to 10 was used so that no direct comparison could be made.

The level of this case might be considered too high for undergraduates. Therefore, we conclude that the appropriate case selection, strictly divided into undergraduate or postgraduate training, as well as the setting of

the case use is of crucial impact for the success of the implementation.

However, not all partners were able to implement the cases on a regular basis. In some of the partner institutions, the cases were used as a

pilot project and the students took part only during the pilot phase. As the case use was obligatory for these students, a selection bias seems to be unlikely in this context. In contrast, a selection bias could be appeared by completing the evaluation form as not all case users completed an evaluation sheet for each edited case. However, the high number of evaluation sheets indicates that each user completed at least one evaluation form.

In general, we conclude that implementation needs longer periods as the curriculum has to be adapted, and teachers and lecturers have to get used to the new teaching format. These results are concordant with a study from Hege et al<sup>12</sup>, where it was shown, that the concept of integration into a curriculum is indispensable, if one wants students to work on the provided cases. Besides motivation of the students (eg, by credits), the case contents have to fit with the regular lecture programs and the academic infrastructure must facilitate technical integration. A systematic literature review from Childs et al.<sup>13</sup> confirms this result. The integration of e-learning into the curriculum seems to be one of the major steps for the

successful implementation of health context into e-learning.<sup>14</sup>

## European and International Impact

Our project added a new and unique dimension into the teaching of OM on a European platform. NetWoRM represents an attempt to strengthen a pan-European perspective in education at all levels, facilitates wider trans-national access to educational resources in Europe, and seeks to promote equal opportunities in the field of education. Simultaneously, the NetWoRM project exemplifies the cooperation and transferability of resources in the field of education, in particular by encouraging and fostering exchanges between educational institutions and promoting distance learning. Besides the traditional aspects of occupational health, new cases were developed and included hot topics such as vulnerable subgroups and health promotion. As OM covers a wide variety of topics within and across European countries, NetWoRM provides the unique opportunity to get an overview about the range of the subject. It also enhances cultural exchange as each case setting also represents the culture of the country in which the case has been created. Therefore, sharing e-learning cases is not only cost-efficient, but it also gives the opportunity to cover the field of OM more completely and exchange cultural perspectives on health care issues, medical practice, and legal aspects across international borders; this aspect seems to be particularly relevant in the context of the ongoing climate of globalization.

## Implementation and Dissemination

The success of the project stems from excellent cooperation between the partners within this project. However, the dissemination process, especially at an international level appears to be more time consuming than expected. In Germany, the fixed

implementation into the curriculum took about 8 years. In retrospect, the 3-year period of the MINERVA funded NetWoRM project was perhaps insufficient for successful implementation of the cases in all centers. Owing to constraints of time, the implementation process in our partner countries had to be restricted to one or two institutes for OM. In this case, as in other projects,<sup>15</sup> further exploitation and the development of cost-efficient integration strategies appear to be vital to guarantee the sustainability of the project. In the long run, sustainability can only be achieved by reaching a critical mass of users.<sup>16</sup>

## Future Prospects

For further dissemination and sustainability of the project, NetWoRM<sup>3</sup> (Net-based Training for Work-Related Medicine—Sustainability<sup>3</sup>) has started in January 2008 with support of the EU. In the future, we aim to establish an international e-learning curriculum for OM within which the e-learning cases will be an integral part. Overall, the activities of the NetWoRM project have broadened the scope of the e-learning network and now include other research groups and institutions from Europe, North and South America, and India.

## Conclusions

We have shown that CBL is a good way to improve teaching as it might come closer to the practical aspects of OM than traditional teaching methods. Therefore, a modular program for OM has been successfully developed in seven European languages and implemented into the curricula in eight European centers as well as throughout Germany. To guarantee the sustainability of this program, a critical mass of users has to be obtained to make the best use of these results. The NetWoRM initiative will result in an improvement in the quality of education and training in OM throughout Europe in the long run.

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