Ultrasound Screening of the Neonatal Hip: Cost-benefit Analysis

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Aim. To explore the economic justification for introducing ultrasound screening for developmental dysplasia of the hip in Croatia.

Methods. The analysis was based on the two formulas: that cost-benefit equals benefit/cost, and that net benefit equals benefit minus cost. Screening costs were expressed as a sum of training costs and fee for ultrasound screening of neonates. The neonatologists’ working hours and utilization of ultrasound instruments were expressed by multiplying the number of infants born per year in Croatia (N=47,792) with the standard time needed for one examination and then dividing the product by the number of employed neonatologists (N=54) and number of ultrasound instruments (N=58). The benefit was expressed as a late case treatment costs and screening costs ratio. Savings, which would have resulted from the reduction in expected treatment costs of patients with hip problems at later age, represent the indirect benefit.

Results. Total hip screening costs would have amounted to US$329,537.80, including the training costs of US$31,035.90. On the average, a neonatologist would spend 71.4 hours screening per year, whereas the instrument utilization would be 64.7 hours. An ultrasound-screening program would save annually US$195,336.50, compared with the existing diagnostic approach. The treatment costs without ultrasound screening were 1.6 times higher than the screening costs. Hospital treatment costs for 165 patients needing endoprosthesis would cover the total screening program in the whole country.

Conclusion. It is economically justified to introduce ultrasound screening for developmental dysplasia of the hip in neonates in Croatia, a country with transitional and developing economy.

Key words: cost-benefit analysis; Croatia; hip dislocation, congenital; infant, newborn; neonatal screening; ultrasonography

Developmental dysplasia of the hip belongs to the group of diseases with public health priority because of its frequency, possibility of secondary prevention and successful treatment, and its impact on an individual’s working capacity and quality of life. Early detection and treatment provide complete normalization of the hip joint and prevent handicaps in infants with the disorder (1-3).

The disadvantages of clinical screening of neonatal hip have resulted in need of introducing ultrasound diagnostics (4,5). Ultrasound diagnostics fulfills the criteria a screening method should have, and developmental dysplasia of the hip may be covered by the screening program, of course, depending on its frequency in a given area (6). Physician training, technical equipment in the maternity hospitals, and cost-benefit analysis are necessary for the introduction of ultrasound screening of the neonatal hip (7).

Cost-benefit analysis is the method applied to health economics and used for health care planning and program-
1996. For cost-benefit analysis of the early detection of developmental dysplasia of the hip, the following basic formulas were used (9):

\[
\text{cost} - \text{benefit} = \text{benefit} - \text{cost},
\]

\[
\text{net benefit} = \text{benefit} - \text{cost}.
\]

### Costs of Introduction of Ultrasound Neonatal Screening

The costs of ultrasound screening were expressed as the necessary investments into the training of physicians who would implement the program and the total sum of fees for ultrasound examinations of the neonates born in a year in the Republic of Croatia. The medical equipment and personnel necessary for the implementation of ultrasound screening of neonatal hip were expressed as the results of a survey carried out in all maternity hospitals in Croatia on December 31, 1995 (11,12). The cost of screening was expressed as the total number of neonates multiplied by the time standard for one hip examination, which was 5 minutes, according to the Croatian Institute for Health Insurance (13). Its value in 1996 was US$6.20. Standard time cost included the labor time and the cost of utilization of ultrasound instruments. Depreciation costs were also included in the time cost. Ultrasound equipment was used for other purposes as well. In the health services in the Republic of Croatia, there are 54 neonatologists and 58 ultrasound instruments, enough to carry out the screening of one entire generation of live births.

Training costs were expressed as organizational costs for the training of one neonatologist and calculated on the basis of costs of a training course held in Zagreb, in January 1998. The course training costs amounted to US$898.50 per participant. Accordingly, if we multiplied the cost per participant by 54 neonatologists working in health services in the Republic of Croatia, the total training costs would amount to US$48,519. This sum should be considered the maximum cost. The actual training costs would amount to US$31,035.90, because some neonatologists have been already trained and do not need a complete training. Training costs include cost of educational administration and longer screening time due to the training of participants.

### Benefit of Ultrasound Neonatal Screening of Developmental Dysplasia of the Hip

With the existing diagnostic procedure, 44% of the registered cases per year started the therapy at age 3 to 5 months (10). The ultrasound screening allows reaching the diagnosis in early neonatal age, which consequently makes the treatment simpler and cheaper. The benefit of the early detection of the developmental dysplasia of the hip was expressed as the ratio between treatment costs of late cases (diagnosed between 3 and 11 months of age) and ultrasound screening costs. The costs saved by the ultrasound screening were expressed as a difference between the treatment costs for children aged 1 and 4 months.

The average frequency of the outpatient and hospital care and duration of therapy, which depends on the age when the therapy started, were calculated from the medical files of 490 children with developmental dysplasia of the hip treated at the Department of Pediatric Orthopedics of the Zagreb University Children’s Hospital, in 1996. Calculations were performed in a similar way:

- **Cost of initial hospital care**: US$25.70
- **Cost of further routine hospital care**: US$20.40
- **Reposition**: US$7.50
- **Cost of ultrasound or X-ray examination**: US$11.00
- **Average cost of orthosis**: US$31.30
- **Outpatient follow-up**: US$4.50
- **Ultrasound or X-ray follow-up**: US$5.50
- **Average cost of orthosis**: US$31.30
- **Outpatient follow-up**: US$4.50
- **Ultrasound or X-ray follow-up**: US$5.50
- **Average cost of hospital stays**: US$18.10
- **Cost of educational administration**: US$898.50
- **Depreciation costs**: US$329,537.80
- **Training of all existing neonatologists**: US$31,035.90
- **Ultrasound examination of the hip**: US$298,501.90

According to the calculations based on standardized procedures (13), a neonatologist would need 71.4 working hours per year for implementing the ultrasound screening of neonatal hip, whereas the existing ultrasound instruments in the maternity hospitals in Croatia would be utilized 64.7 hours per instrument per year.

The results of the study of 490 medical records of children treated during 1996 at the Department of Pediatric Orthopedics of the Zagreb University Children’s Hospital showed that the proportion of children treated in hospitals increased with the age (Fig. 1). The duration of hospital treatment showed statistically significant correlation with children’s age at the start of therapy (r=0.98, p<0.001, Fig. 2).

Assuming that the treatment for 1,046 children with the developmental dysplasia of the hip registered in Croatia in 1996 started at age of 1 month, the total cost would be US$338,241. If the treatment started at age of 4 months, the total cost would amount to US$333,578. The difference between costs of the therapy started at age of 1 month and 4 months, presents saved treatment costs and would amount to US$195,337. Late case treatment costs (622 cases diagnosed after age of 3 months in Croatia in 1966) were 1.6 times higher than the screening costs would have been if all the livebirths that year had been screened by ultrasound in the maternity hospitals, including the physician training.

### Results

In 1996, 1,046 children with of the developmental dysplasia of the hip were registered in the Republic of Croatia. By the existing diagnostic procedures, the diagnosis was set in 24% of the infants at the age 0 to 2 months, in 44% at 3 to 5 months, in 16% at 6 to 11 months, in 4.5% at 1 to 3 years, and in 1.9% s at the age 4 to 6 years. In the maternity hospitals, developmental dysplasia of the hip was recognized in 94 neonates (9% of the registered children) (10).

The costs of ultrasound screening of the hip for 47,792 neonates in the maternity hospitals in Croatia, in 1996, would have amounted to:

- **Ultrasound examination of the hip**: US$298,501.90
- **Training of all existing neonatologists**: US$31,035.90
- **Total**: US$329,537.80

According to the Croatian Institute for Health Insurance price system (as of January 1, 1998) (13), the costs of outpatient treatment for each age group were expressed as a sum of:

- **Average cost of orthosis**: US$31.30
- **Outpatient follow-up**: US$4.50
- **Ultrasound or X-ray follow-up**: US$5.50

The daily costs of hospital treatment were expressed in a similar way:

- **Average cost of hospital stays**: US$18.10
- **Cost of initial hospital care**: US$25.70
- **Cost of further routine hospital care**: US$20.40
- **Reposition**: US$7.50
- **Cost of ultrasound or X-ray examination**: US$11.00

The costs of hip endoprosthesis alone would cover the total screening program. The cost of that treatment should be added to the total cost of the problem. Average hospital treatment costs for one patient with hip endoprosthesis amounted to US$1,663.30 (15). This means that 34% of hospital treatment costs for 165 patients with hip endoprosthesis alone would cover the total screening program in the whole country.

### Treatment and rehabilitation of patients with hip problems at later age can also be the result of non-effective screening program. The cost of that treatment should be added to the total cost of the problem. Average hospital treatment costs for one patient with hip endoprosthesis amounted to US$1,663.30 (15). This means that 34% of hospital treatment costs for 165 patients with hip endoprosthesis alone would cover the total screening program in the whole country.
sound diagnostics enables early therapy, which is more appropriate for treatment monitoring (24). Ultra-screening program (21). On the other hand, ultrasound (20-23). The Graf method is recommended for the dysplasia of the hip as early as immediately after birth for early detection of all types of developmental dysplasia of the hip in the Republic of Croatia, compared to other countries. This may be because Croatia belongs to the group of countries with the highest frequency of this deformation, and because it is a middle-income country with transitional economy.

Since its cause has not been completely understood, early detection of the developmental dysplasia of the hip is of utmost importance for a successful treatment (1,17). Clinical screening of the neonatal hip is a subjective diagnostic method of low sensitivity and has not resulted in the expected decrease in surgical treatments of late cases (16,18,19). Ultrasound diagnostics is a method of choice for early detection of all types of developmental dysplasia of the hip as early as immediately after birth (20-23). The Graf method is recommended for the screening program (21). On the other hand, ultrasound diagnostics based on the assessment of hip stability is more appropriate for treatment monitoring (24). Ultrasound diagnostics enables early therapy, which is simpler, shorter, and cheaper, and at the same time decreases the need for surgery and the number of aseptic necroses of the femoral head (25-27).

The results of cost-benefit analysis for ultrasound screening of neonatal hip have rarely been published (28-31). Tredwel (28) has proved the economic justification of neonatal screening for developmental dysplasia of the hip based on the difference between the screening and late cases treatment costs. At the frequency of 2.6 per 5,000 live births, Geitung et al (29) have considered the nonselective screening of neonatal hip in Norway economically unjustified, explaining the fact that a great number of maternity hospitals with less than 300 deliveries per year would yield considerable educational costs for a great number of physicians with a small number of examinations. They have recommended ultrasound screening only for the neonates at high risk and in large hospitals. At the same time, they suggested further study of the reduced quality of life at adult age for those not screened at the early age and not treated at all (29).

In Austria, the 1985 governmental decree included ultrasound screening of the neonatal hip in the general health preventive program (32).

Dilemma on whether to implement selective or nonselective ultrasound screening greatly depends on the frequency of developmental dysplasia of the hip and the economic justification of ultrasound screening (6). Taking into account the frequency of developmental dysplasia of the hip and the results of cost-benefit analysis, the nonselective screening of neonatal hip is economically justified in the Republic of Croatia. Because Croatia belongs to the group of middle-income developing countries with transitional economy and health care system (33), we could assume that nonselective screening of neonatal hip could be recommended to other countries with a similar situation. The implementation of ultrasound diagnostics in the maternity hospitals in the Republic of Croatia would allow early detection of developmental dysplasia of the hip, thus saving US$195,336.50, which is 59.2% of the annual nonselective ultrasound screening costs.

This analysis explored the prerequisites for the introduction of ultrasound screening of neonatal hip and found that the only investment necessary is in physician education, by which the screening program effectiveness would be permanent and level of technical equipment in the maternity hospitals appropriate, with a better organization of work. The introduction of ultrasound screening of neonatal hip would result in the early detection and hence cheaper treatment of developmental dysplasia of the hip. Consequently, it would reduce the need for hip endoprostheses, which is presently the most common surgical procedure at the orthopedics departments (34).

Discussion

The results of this study confirmed the economic justification for introducing nonselective ultrasound screening for the developmental dysplasia of the hip, presuming that the late-cases treatment costs were 1.6 times higher than the screening costs. We performed this study because of late diagnosis of developmental dysplasia of the hip in the Republic of Croatia, compared to other countries. This may be because Croatia belongs to the group of countries with the highest frequency of this deformation, and because it is a middle-income country with transitional economy.

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References

32 Grill F, Müller D. Results of hip ultrasonographic screening in Austria [in German]. Orthopädie 1997;26:25-32.