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Self-directed learning in high-quality antenatal screening

Samokształcenie ważnym elementem utrzymania jakości diagnostyki prenatalnej

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Abstract

Objectives: *To compare first-trimester scan results between audited (AS), according to the Fetal Medicine Foundation criteria, and non-audited sonographers (NAS).*

Material and methods: *Retrospective observational study of N=629 and N=1290 NT and CRL measurements done by AS and NAS, respectively.*

Results: *For similar examined populations (similar CRL and maternal age at examination) NT values were significantly lower in NAS with NT of 1.0 mm or less in 26.9% of measurements taken by NAS (vs. 0.3% in AS). NT differed significantly between NAS and AS in all maternal age groups, except for patients below 24 years of age and in all CRL categories.*

Conclusions: *Training of sonographic skills in fetal medicine needs to be complemented by a regular audit to ensure adequate quality of the measurements.*

Key words: **nuchal translucency** / **first trimester scan** / **fetal scan** / **prenatal diagnosis** /

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Streszczenie

Cel pracy: *Porównanie jakości badań prenatalnych w pierwszym trymestrze ciąży w grupie ultrasonografistów audytowanych (AS) i wykonujących badania bez audytu Fetal Medicine Foundation (NAS).*

Materiał i metody: *Retrospektywna analiza wyników badań i dokonywanych pomiarów w badaniu pierwszego trymestru ciąży w grupie audytowanej N=629 i nieaudytowanej N=1290.*

Wyniki: *Dla porównywalnych populacji w zakresie CRL i wieku ciężarnej wielkości pomiaru NT były znamiennie statystycznie niższe w grupie badań wykonywanych przez nieaudytowanych ultrasonografistów (NAS), wartości poniżej 1,0 mm występowały w 26,9% pomiarów dokonanych przez grupę NAS w porównaniu z grupą AS gdzie ta częstość wyniosła 0,3%.*

Wnioski: *Doskonalenie umiejętności przeprowadzania badań ultrasonograficznych powinno współistnieć z regularnym audytem pozwalającym na samoocenę jakości wykonywanych badań.*

Słowa kluczowe: **badanie w pierwszym trymestrze ciąży** / **przezierność karkowa** / / **diagnostyka prenatalna** /

Introduction

Acquisition and constant development of professional competence is an important element of professionalism in health care. Therefore, lifelong learning is an essential tool for all medical professionals as it helps caregivers to gain knowledge and practical skills essential for everyday professional activity. Also, it is necessary to keep up with constant developments in clinical sciences. Practitioners who do not engage in lifelong learning will very quickly find themselves behind on the current direction of changes in medicine and might put their patients at risk of substandard care.

In 1995, Jean Claude Paye, Secretary General of the Organization for Economic Co-operation and Development (OECD) said: 'Much has been said over the years about lifelong learning but, in truth, it is still a reality only for a tiny segment of the year cycle in which practitioners not only have to be aware of new ideas and developments but also apply them to clinical practice for the well-being of their patients' [1].

Among different tools used for continuing professional development (CPD), self-directed learning plays an important role. According to Hiramanek, self-directed learning is the most effective approach for improving physician performance and patient care outcomes [2]. Therefore, self-directed learning is the necessary basis for continuing medical education.

In 1975, Malcolm Knowles defined self-directed learning as the 'process in which individuals take initiative, with or without the help of others, in diagnosing their own learning needs, formulating goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes' [3]. According to this author, there are several reasons for considering self-directed learning as particularly suitable for continuing professional development. First, participants taking initiative in the learning process are more likely to retain and make use of what they studied than passive trainees. Moreover, taking initiative in learning is more in tune with our natural processes of psychological development [3].

In self-directed learning, learners take responsibility for planning, implementing and evaluating their own progress. Self-directed study can involve various activities and resources. Some learning activities may include formal educational events (lectures, workshops, etc.), however, more informal modes (asking experts, reading, exchange of ideas on the forum or reflective writing activities) are typical.

Some regularly used continuing medical education formats already emphasize learner control: journal clubs, case-based learning, traineeships, practice audit and review, and the use of learning portfolios. All incorporate some or all of the components of self-direction [4].

In self-directed learning of medical staff, self-evaluation is particularly important. Norman et al., supposed that traditional methods, which rely on individual self-assessment, are inadequate. Instead, these authors suggest some possible strategies to identify learning needs, such as periodic internal audits by using electronic office records, individualized audit results against current practice guidelines, or individualized audit results plotted against exemplary peers (benchmarking), single issue audit tools developed by local academic units for continuing medical education, or facilitated note keeping and reflection around sentinel patients [5].

According to Himestra R., self-directed learning does not necessarily mean that the whole process will take place in isolation from others [6]. Sometimes doctors who engage in self-directed learning need support from other people or institutions, for example in the form of an audit of their knowledge and skills [7].

Following the rapid progress of medical knowledge, continuing development is essential for medical professionals. It became mandatory in most European countries and structured modules are constantly being developed for many specialties, different levels of professional experience, and different purposes.

Medical professionals from Central European countries which joined EU during the last decade, had also to find their way within the network of training and certification developed by the 'old' members of EU, particularly the UK. As this process develops rapidly, we continue to witness various approaches to structured self-learning and auditing at the international level.

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Therefore, we designed a study to investigate whether participation in an audit and submission of scans for a periodic assessment improves the quality of fetal measurements comparing to a theoretical training without any auditing. We hypothesized that quality of measurements differed between the audited and the non-audited sonographers.

Material and methods

In order to test our hypothesis, we designed a retrospective observational study to compare fetal measurements taken by examiners who did not undergo a regular audit of the quality of their performance (non-audited examiners) to measurements taken by examiners audited once every year in accordance with the requirements of the Fetal Medicine Foundation (audited examiners), as stated below. In the assessment of fetal nuchal translucency (NT), the ultrasound machine should be of high resolution with a video-loop function and calipers that provide measurements to one decimal point. Only the fetal head and the upper thorax should be included in the image for the measurement of NT. Magnification should be as large as possible to ensure that each slight movement of the calipers produces only a 0.1 mm change in the measurement. As for the fetal crown–rump length (CRL), a good sagittal section of the fetus should be obtained and NT should be measured with the fetus in the neutral position. The maximum thickness of the subcutaneous translucency between the skin and the soft tissue overlying the cervical spine should be measured. The calipers should be placed on the lines that define the NT thickness – the crossbar of the caliper should be hardly visible as it merges with the white line of the border and not in the nuchal fluid. During the scan, more than one measurement must be taken and the maximum one should be recorded. The umbilical cord may be around the fetal neck in 5–10% of the cases and this finding may produce a falsely increased NT. In such cases, the measurements of NT above and below the cord are different and, in the calculation of risk, it is more appropriate to use the average of the two measurements. All sonographers were obstetricians theoretically familiarized with the recommendations as they were available in several publications and national guidelines on the first-trimester ultrasonic scan.

The study was conducted from December 2005 to December 2011 among 1919 pregnant women, between 11-14 weeks of gestation, admitted to the referral outpatient clinic for further ultrasound examination, due to a number of indications, to establish the final diagnosis. Only patients with complete scanning data were included in the study. The study protocol was reviewed and approved by the Local Bioethics Committee.

Our study group was divided into two subgroups: women referred to our clinic following an examination performed by a non-audited examiner (N=1290), and those referred to the clinic following a fetal scan performed by an audited examiner (N=629). NT and CRL measurements were performed and collected for further analysis. NT MoM (NT multiple of median) was calculated according to the regression equation: NT (MoM) = NT / (- 2.058007 + 0.099864*CRL – 0.000645*CRL 2) by Kublickas[7]. Other data such as age and weight were determined to compare the groups. In a subsequent analysis, group comparison was performed in subpopulations divided by age groups that were 5 years apart. Calculations were performed with nonparametric analysis and descriptive statistics, using Statistica software. Statistical hypotheses were verified and differences were considered as statistically significant at $p<0.05$.

Results

In our study group, 97.0% of the fetuses came from singleton and 3.0% from twin pregnancies. Audited sonographers have seen a statistically larger number of twin pregnancies (2.17 vs 4.77%, *p*=0.0018). When divided into Non-Audited (NA) and Audited (A), 28 (1.46% of total 1919 cases), and 30 (1.56% of total 1919 cases) fetuses respectively belonged to the twin count. Chi-square (df=1) 9.74 p=0.0018. The analysis of the age variable showed similar distribution in both subgroups. However, mean and mode of age differed between the groups: 33.2 years in NA vs. 34.5 years in the A subgroup (Figure 1). There was a statistically significant difference between medians (p=0.005; Z=2.80).

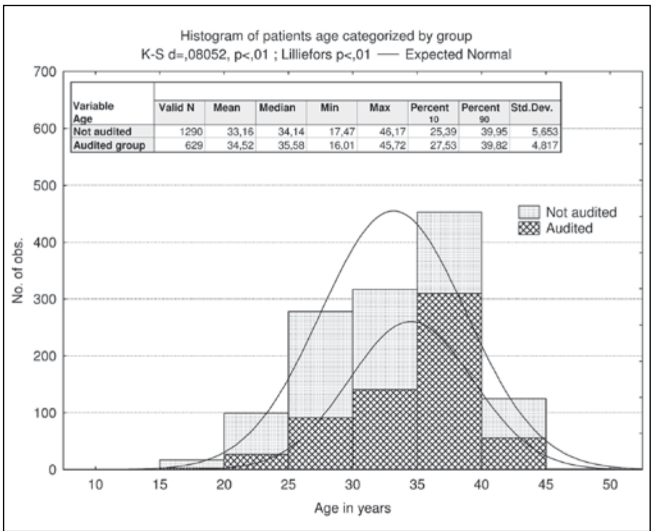

Figure 1. Histogram of age distribution in the study group.

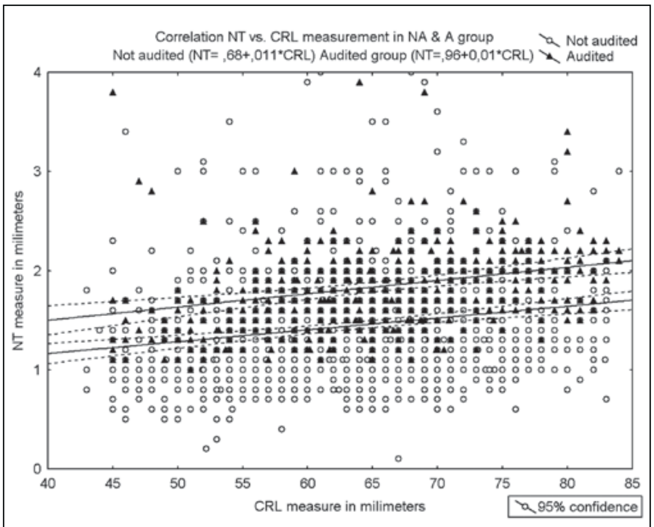

Figure 2. Correlation of NT and CRL measure in millimeters in the studied groups. On ordinate located NT measurement in millimeters and on abscissa CRL in millimeters (circles shows measurements – Non-Audited; triangles shows measurements – Audited).

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Table I. Comparison of NT measurements in millimeters in the studied groups additionally divided into age groups that were 5 years apart.

Variable NT in millimeters grouped by	Wald-Wolfowitz Runs Test in Non-Audited (NA) vs. Audited (A) groups. Marked tests are significant at p<0.05					
	Number of cases		Mean in millimeters		p-level	Z-adjusted
Age range	Non-Audited	Audited	Non-Audited	Audited		
All groups	1290	629	1.44	1.83	<0.001	16.8
00-24 years	116	30	1.62	1.95	NS	0.58
25-29 years	278	91	1.46	1.77	<0.001	5.42
30-34 years	317	141	1.48	1.89	<0.001	9.41
35-39 years	453	310	1.38	1.77	<0.001	11.7
40-49 years	126	57	1.38	1.07	<0.001	5.71

Table II. Comparison of NT measurements in millimeters in the studied groups additionally divided into groups ranged by CRL every 10 millimeters. Wald-Wolfowitz Runs Test in Non-Audited (NA) vs. Audited (A) research workers groups. Marked tests are significant at p<0.05.

Variable NT in millimeters grouped by	Wald-Wolfowitz Runs Test in Non-Audited (NA) vs. Audited (A) groups. Marked tests are significant at p<0.05					
	Number of cases		Mean in millimeters		p-level	Z-adjusted
CRL range	Non-Audited	Audited	Non-Audited	Audited		
All groups	1290	629	1.44	1.83	<0.001	16.8
40-49 mm	94	28	1.17	1.74	<0.001	3.00
50-59 mm	348	146	1.37	1.71	<0.001	8.03
60-69 mm	498	258	1.46	1.79	<0.001	11.4
70-79 mm	310	155	1.57	1.95	<0.001	7.85
80-89 mm	40	42	1.57	2.16	<0.001	3.00

Table III. Detailed statistical results of Logistic regression. Odds ratio and p-level shown in the Table. Statistically significant OR accepted at p<0.05. Study population grouped by Not-Audited and Audited research workers. Categorized by age range.

Variable NT in millimeters grouped by	Logistic regression (logit) Odds ratio (unit ch) OR of measure differences in Non-Audited and Audited groups divided in Age groups. Number of cases: 1919					
	Number of cases		Odds ratio		p-level	OR
Age range	Non-Audited	Audited	-95%CI	+95%CI		
All groups	1290	629	2.23	3.27	0.00	2.70
00-24 years	116	30	0.92	1.81	0.14	1.29
25-29 years	278	91	1.23	2.34	0.00	1.70
30-34 years	317	141	1.35	3.39	0.00	2.36
35-39 years	453	310	5.00	11.01	0.00	7.42
40-49 years	126	57	3.65	19.43	0.00	8.42

Maternal weight and height did not differ between the subgroups. Also, comparison of CRL between the subgroups showed no statistically significant differences between both, A and NA populations as a whole and divided according to maternal age. On the contrary, comparison of the NT value between A and NA examiners revealed statistically significant differences in all age groups, except for the youngest (<24 years) patients (Table I).

Moreover, plotting of NT against CRL values showed that NT measurements obtained by non-audited sonographers were markedly underestimated comparing to audited examiners (Figure 2).

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Also, distribution of NT values differed between audited and non-audited sonographers, showing a clear shift to the left, towards the lower values, for the non-audited subgroup (Figure 3).

Interestingly, 26.9% of all NT measurements done by the non-audited subgroup were of 1.0 mm or less – values practically not reported at all in the audited subgroup. All these differences translated also into different percentiles: the 5^{th} percentile was 0.7 mm for non-audited examiners versus 1.2 mm for the audited subgroup. The 95^{th} percentile was similar in both groups**.** This shift to the left was also clearly seen for all studied age groups (Figure 4).

In the next step, we compared NT taken by audited versus non-audited sonographers across CRL categories and found highly significant differences for all CRL categories (Table II).

Having detected such marked differences between AS versus NAS, we also investigated the risk of a measurement done by a non-audited sonographer being different from that taken by an audited sonographer. We found significantly elevated risk for differences in measurements in all maternal age categories, except for the youngest patients. Importantly, the highest risk was found for the oldest women (Table III and Figure 5).

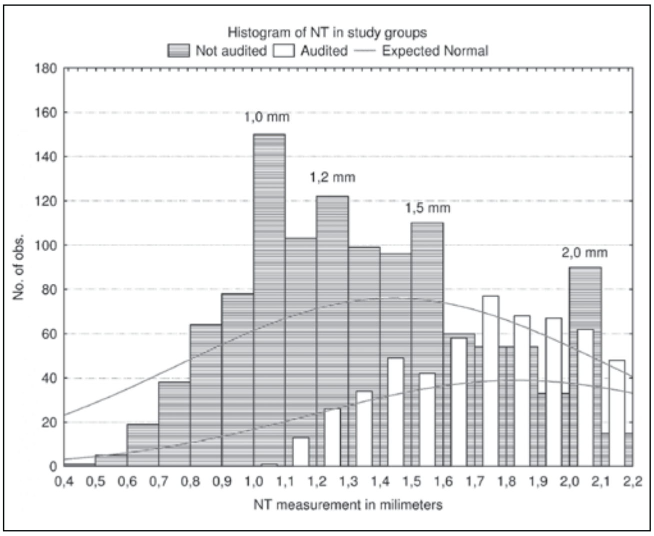

Figure 3. Distribution of NT measurements in the compared groups of Non-Audited and Audited research workers. Non-Audited (NA) Number of valid cases=1290 (patterned plot) and Audited (A) Number of valid cases =629 cases (white plot). On ordinate located number of cases and on abscissa groups divided in NT measurement.

Discussion

In our study, we report a statistically significant difference between audited and non-audited sonographers. Importantly, the measurements were done under similar conditions: patient populations did not differ between the subgroups and gestational age at examination was also similar. All sonographers had similar medical background and specialty. They also received similar information on the examination technique and requirements, participating in standardized trainings offered by referral units, and were familiarized with the national guidelines issued for all obstetricians. The main characteristic that might have differed between the subgroups was the quality of ultrasonic equipment. It can be reasonably expected that small, local outpatient units, dealing mainly with low-risk pregnant women, were equipped with medium quality machines. On the other hand, all clinics dealing with antenatal scanning are obliged to provide images of acceptable quality and their equipment should meet at least some of the boundary conditions. Unfortunately, no data on the quality of the equipment were available.

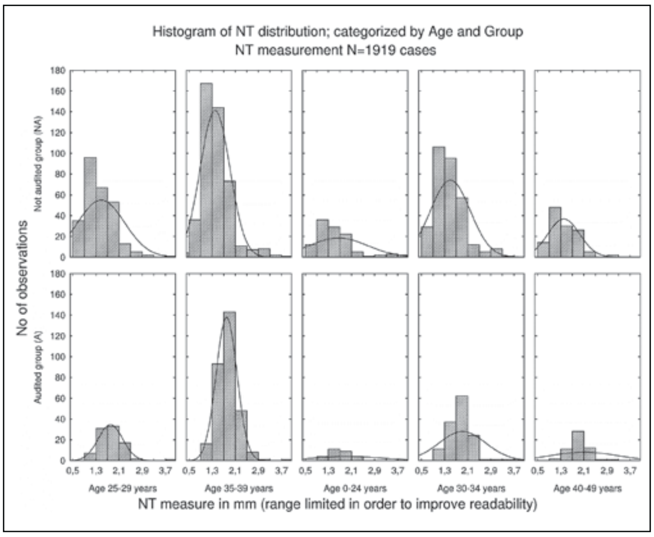

Figure 4. Histogram of NT distribution in the compared groups of Non-Audited and Audited research workers. Non-Audited (NA) Number of valid cases = 1290 (upper plot) and Audited (A) Number of valid cases = 629 cases (lower plot). On ordinate located number of cases and on abscissa groups divided in NT measurement range as subordinate. Age groups 5 years apart also apply lower and upper plots. Range of NT measurement is limited to 4 mm to improve readability.

Examinations performed as population screening constitute the main problem. Indications for prenatal examination include age, malformations in previous pregnancies, or abnormalities diagnosed in ultrasound examination at a screening level. Most of the screening scans show underestimated NT measurements, and this can be the reason why a part of the patients might not be referred to appropriate, invasive diagnostic procedures.

Unacceptably wide variation in NT measurements has been observed worldwide when practitioners have not received adequate training and supervision. In order to avoid such situations, in 2001 the Fetal Medicine Foundation (FMF) established a multi-step program of education, practical training, accreditation, and ongoing quality assurance. Temporal distributions of NT measurements obtained in the US by FMF-accredited sonographers over a 4-year period were evaluated and compared to the worldwide FMF distribution of over 1,000,000 patients to assess risk adjustment, and for epidemiological monitoring [8]. The distribution was initially skewed towards under measurement, and this difference has diminished with increasing experience. Over the 4 years, the overlap between the US and FMF worldwide distributions has increased, although changes in the trend in the US distributions were not statistically significant. Training and credentialing have obviated inaccuracies seen in many programs with resultant poor screening performance when rigor in training and certification are not practiced [8].

It is important to know the impact of the program of Quality Maintenance on epidemiological analysis of participants of nuchal translucency (NT) measurements. Our observations are similar to the study by Karin Fuchs. Out of 3557 monitored

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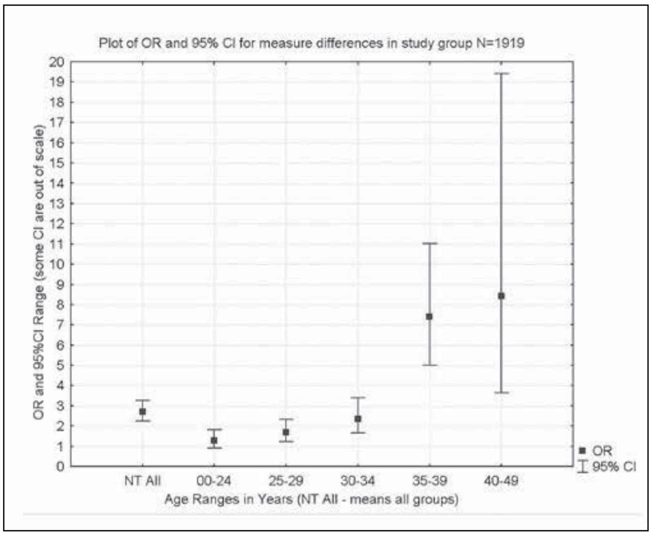

Figure 5. Plot of odds ratio (points) and confidence level (whiskers) of logistic regression performed in the study, grouped by Non-Audited and Audited research workers. Categorized by age range.

NTQR participants, 279 (7.8%) were assigned to RQM in 2010. Out of the 64 (22.9%) participants completing RQM before 28 February, 2011, 30 (47%) were within the range and 34 (53.1%) had decreased their SD by at least 0.02 on their July 2011 report. Of the 26 re-mediated participants who had submitted 30 NT measurements after completing RQM, 88.5% (n=23) had increased their median NT MOM by -0.05 above their pre-RQM MOM and 61.5% (n=16) had a post-RQM NT median MOM of 0.89-1.1. They concluded that after completing the required quality maintenance program, participants with a low median NT MoM and/or a high SD demonstrate improved performance [9]. Ongoing quality review after remediation is an essential part of a quality monitoring program.

Based on our findings, it seems safe to conclude that training of sonographic skills in fetal medicine needs to be complemented by a regular audit to ensure adequate quality of the measurements.

Conclusions

Also, in light of constant developments in the field of prenatal care and introduction of new diagnostic parameters, e.g. Doppler sonography of the hepatic vein, it is very important to keep protocols and sonographers' skills the same across all sites [10].

An accumulating amount of data report an association between abnormal NT value and proportion of chromosomal abnormalities [11]. Therefore, an inappropriate measurement of this parameter may result in a miscalculation of fetal risk for chromosomal aberrations and, consequently, an increase in the number of false-negative results. That in turn translates into a reduced clinical use and reliability of the whole procedure of antenatal testing.

Oświadczenie autorów

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4. Karolina Szczeszek – autor analizy i interpretacji wyników, przygotowanie, korekta i akceptacja ostatecznego kształtu manuskryptu.
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