The Impact of Genomics Course on Nursing Students' Knowledge and Attitude Towards Embedding Genomics in the Nursing Program

Naglaa Youssef, Ph.D.

Assistant professor of Medical-Surgical Nursing Department, Faculty of Nursing, Cairo University, Cairo, Egypt.& Medical-Surgical Nursing Department, College of Nursing, Princess Nourah bint Abdulrahman University, Riyadh, Saudi Arabia.

Abstract

Background: Genetics/genomics has been acknowledging to be integrated into the nursing curriculum worldwide. **Aim:** This study evaluates the impact of the genomics course on nursing students' knowledge and attitude towards embedding genomics in the nursing program. **Design**: A observational pre and post design was adopted among a convenience sample of 116 nursing students at a nursing college in Riyadh city. **Tools:** An electronic-based questionnaire was administered twice (per- and post the genetics course) from September to December 2018. **Results:** The genomics knowledge mean was significantly improved after the course (p=0.0001). Only the subscale of the genomic base was significantly improved after the courses (p=0.0001). The total attitude scores before and after the genetics course showed an insignificant difference (p= 0.930). **Conclusion:** Although the students had genomics knowledge score below the average before and after the course, they have a positive attitude towards studying and integrating genomics in the nursing program even before studying the course. **Recommendations:** Genetics topics must be incorporated and expanded into the nursing curriculum, and innovative teaching methods must be applied.

Keywords: Attitude, Embedding Genomics, Genetic; Knowledge, Students.

Introduction

The implications of genomics/genetics in nursing are becoming more evident in nursing care and drugs administrations (Howington et al., 2011). Genetic causes of many diseases have been discovered (Howington et al., 2011). Therefore, studying genomics/genetics science has been necessary to reshape nurses understanding of human health and illness concerning genetics (De Sevo, 2013; Godino & Skirton, 2012). Genomics/genetics has been acknowledged as a basic science for nurses' professional (Calzone et al., 2013). Genetics has been defined as the *''study of individual genes and their impact on relatively rare single-gene disorders"*. In contrast, genomics has been defined as the *"study of genes in the human genome, including their interactions with each other, the environment, and the influence of other psychosocial and cultural factors"* (Greco et al., 2012). Therefore, there is no contrast between genetics and genomics, except that genomics is more comprehensive than genetics (Munroe, 2014). Thus, genomics has been used in the current study to refer to both terms.

Previous studies acknowledged that nurses must be taught genetics key terminologies, processes, and assessment steps to be familiar with its knowledge to provide appropriate care for patients who are at risk of inherited diseases (Hickey et al., 2018; Greco et al., 2012; Montgomery et al., 2017). Embedding genomics topics in the nursing curriculum has been emphasis worldwide on improving nurses' genetic literacy (Dewell et al., 2019; Murakami et al., 2020; Sharoff et al., 2017). High-quality nursing education aims at equipping the students with clinical competencies to meet the patient's expectations and the family's needs (World Health Organization, 2016).

Essential nursing competencies framework for genomics has been established and used to embed genomics science in the nursing curriculum by many western countries, like the UK and the USA (Jenkins & Calzone, 2007; Kirk et al., 2014). This framework has been acknowledged to be implemented by other countries to integrate genomics topics in nursing practice. A well-designed genomics education programmes are allocated mainly for nurses; these programs

elaborate the essential genomics competencies that nurses must incorporate into clinical practice (HEE.NHS.UK 2021). These competencies have been divided into four categories: nursing assessment, identification of genetic risk, referrals, education, care, and support (Calzone et al., 2011).

Significance of the Study

Integrating genetic content into nursing education still poses significant challenges (Read & Ward, 2016), especially in the Middle East nursing colleges, and it has been considered a sophisticated subject. Therefore, genomics education in nursing schools at Middle East Regions (MERs) is still in infancy. Nevertheless, preparing the undergraduate nursing students for the community health needs is the core of nursing colleges' mission. Equipping the students with the basic genomics knowledge through innovative teaching methods and well-developed genomics education courses is the first step that the nursing colleges must take in the MERs where genetic diseases are prevalent and steadily increasing (Younes, & Zayed, 2019). Moreover, the response to the disease process and medical regimens has a genetic relationship (Abd El-Fattah, 2021).

Notably, several studies assessed registered medical-surgical nurses' and midwifes' knowledge and attitude towards genomics, especially in western countries (Calzone et al., 2013; Dewell, 2019; Montgomery et al., 2017). Nevertheless, when it comes to nursing students and the effect of a genetic education program on their knowledge and attitude, the evidence is to some extent limited (Munroe, 2014; Munroe & Loerzel, 2016). In the MERs, there is a lack of evidence that explores the current existence of genomics education programs in the nursing curriculum, their components, and their impact on improving the students' basic knowledge and attitude towards studying genomics.

Aim of the Study

This study aims to evaluate the impact of the genomics course on nursing students' knowledge and attitude towards embedding genomics in the nursing program using the genomics Nursing Concept Inventory in Saudi Arabia.

Research Questions

Specifically, the study aimed to answer two research questions:

(1) Does the genomics course significantly improve the students' genomics knowledge compared to the pre-course?

(2) Does the course make a significant difference in the students' attitude towards including a genomics course in the nursing program?

Subjects and Methods

Study Design

A quasi-experimental design (pretest-posttest) was used. A descriptive design was adopted at time-0 to investigate the students' knowledge and attitude towards genomics. A comparative design was adopted to evaluate the differences between two times (pre and post attending the genomics course).

Setting

The study was conducted from September to December 2018 in a nursing college at one of the largest public universities in Riyadh city, Saudi Arabia.

Subjects

A convenience sample was recruited over two time points [pre the course] and [post the course]. One hundred sixty-seven undergraduate nursing students who attended the course were invited to participate. G*power 3.1.9.4 was used to calculate the required sample (Faul et al., 2009). Based on the significance level (α) at 0.05, the test power (1-B err prob) at 0.95, effect size at 0.5, a total of 45 students was required sample for assessing the impact of the genomics course on knowledge and attitude (Figure 1).

Tools of Data Collection

An anonymous electronic questionnaire consisted of two scales alongside the sociodemographic data sheet was demonstrated in this study.

Sociodemographic Datasheet

It contained 11 items relating to age, marital status, academic level, and attendance at previous genetic education.

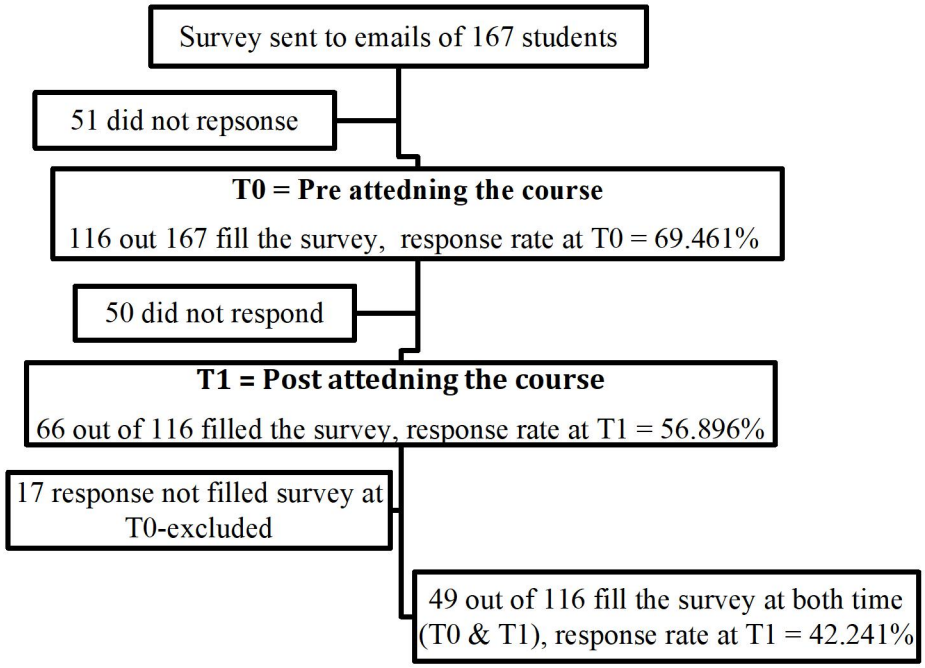

Figure (1): Sample Flowchart.

The Genomic Nursing Concept Inventory (GNCI)

The GNCI is a widely used scale to assess fundamental genetic knowledge (Ward et al., 2014; Ward, 2011). It covers 18 concepts in four topical categories, including (1) Human Genome Basics (12 items), (2) Mutations (3 items), (3) Inheritance Patterns (8 items), and (4) Genomic Healthcare Applications (8 items). Each item of the GNCI questions was scored as correct = 1 or incorrect = 0, giving a total score range of 0–31. The GNCI has acceptable internal consistency reliability (Cronbach's α 0.77), and its content validity was established (Ward et al., 2014; Ward, 2011).

Attitude Toward Nursing Genetic Questionnaire (ATNGQ)

The eight-item ATNGQ was used to assess the students' attitude toward studying genomics (Munroe, 2014). The students gave their responses on a Likert scale, where 0 = disagree, 1 = unsure, and 2 = agree. The total scale score was calculated to give the overall attitude score. A higher rating indicates a more positive attitude toward the importance of studying and applying genomics knowledge into the nursing curriculum. Cronbach's alpha of 0.675 for the pretest and 0.844 for the posttest demonstrates the reliability of the questionnaire (Munroe, 2014). The questionnaires were administered in the original language (English) since the students are studying in English, and the genomics course is taught in English.

Background About the Genomics Course

The medical-surgical nursing department at the nursing college introduces a standalone genomics three-credit-hour theoretical course titled ''*Introduction to Genomics.''* The course was designed to give the students a theoretical introduction to genomics science, and it is taught over 15 weeks (three-credit-hour/week = 30 face-to-face contact hours in the class). The genomics course covers theoretical topics to provides the students with basic knowledge about: (1) the genetics basic principles, (2) the tools used for studying the various genetic processes, (3) the role of genomes in controlling the complexity of biological control, and (4) the genetic basis for transcription, translation, and replication. The course is one of the mandatory courses for a Bachelor of Nursing Science (BSN) program that the undergraduate students should complete at level five to achieve the program requirements. The designer and tauter of the course is a specialist in microbiology, immunity, and pharmaceutical background.

Ethical Considerations

The Institutional Review Board (IRB) approved the study (Ref No. 18-0151). The electronic questionnaire had a cover page that introduces the study's purpose. The students were confirmed that participation is voluntary, and course assessment method and grades are not going to be affected by their participation, and they can

withdraw at any time. The data was coded without any personally identified information to assure anonymity and confidentiality. The students were aware that they gave their informed consent by completing the questionnaire.

Data Analysis

The Statistical Package for Social Sciences (SPSS) 26.0 was used to enter, manage, and analyze the data. Mean, standard deviation (SD), median, and range were used to summarise the data. Non-parametric statistical tests were used because the sample was not normally distributed. The Wilcoxon signed-rank test was used to compare the mean GNCI scores between pretest and posttest. The correlation between the studied variables was examined using the Spearman correlation test. According to the demographic and academic variables, the Mann-Whitney U test was applied to test the differences in knowledge and attitude. The confidence interval was considered at 95%, and the significance level was at $p \leq .05$ two-tailed.

Results

Characteristics of the Participants

Table (1): All the participants were female (100%), and their mean age score was 20.78. ± (SD) 1.806. The majority were single (93.9%), having middle-income level (85.7%), and were at level five of their study (98%). All the students successfully passed the introductory sciences courses such as biology, anatomy, physiology, and health assessment courses before enrolling in the genetic course according to the plan of the nursing program. 30.6% reported having a family member or friend with a genetic condition. Diabetes, sickle cell anaemia, and Down syndrome were the topmost genetic diseases reported**.**

Genomics Knowledge Before and After the Course

Table (2): The genomics knowledge score at pretest was ≤16, and at posttest was ≤ 31 (out of a total score of 31), among the 49 students who participated at both times. The GNCI mean score was significantly improved after the course (T0 = 5.41 & T1= 7.63, $p = .0001$). Nevertheless, only the human genome basics domain score was significantly improved after the course ($Z = -4.83$, $p = .0001$) **.**Using the Mann-Whitney U test, the study findings revealed insignificant differences in the students' knowledge and attitude (before and after attending the course) towards genomics study according to their demographic and academic variables, p>0.05.

Attitude Towards Studying Nursing Genomics

Figures(2 & 3): The total score of students' attitude towards studying nursing genomics before and after the course showed no significant difference (mean of 9.69 ± 3.03 & 9.53 ± 4.45, respectively, $Z = -0.09$, $p = .930$). More than 50% of the students, at the two-time points, believed it is essential to incorporate a genetic health risk assessment into clinical practice, and nurses are responsible for discussing and teaching patients and their families about genomics. Most of the students were unsure about the other items (items: 2, 4-8) of the attitude questionnaire **(Figures 2 & 3)**. Most of them are unsure about using of genomics knowledge base in clinical practice (pre = 55.1% & post = 42.9%), drawing a pedigree (pre = 53.1% & post = 49.0%), and identifying patients in need of genomics referral (pre = 57.1% & post = 49.0%)**.**

Relationship between Genomics Knowledge and Attitude

Spearmen correlation test shows an insignificant relationship between the students' attitude towards genomics and the total score of genomics knowledge at pre-and post- attending the genomics course (rho = -.095 to -.088 respectively, $p > 0.5$).

Table (1): Participants' Characteristics (N = 49).

Variable		**Number**	**%**
Age [Mean (X)±SD]	20.78. (1.806)		
Median	(20 years)		
Range	19-29 years)		
• Gender			
• Female		49	100
Marital status			
• Single		46	93.9
• Married		3	6.1
Academic level			
• 5th level		48	98
• 6th level		1	2
Current work status (part-time work)			
• Unemployed		45	91.8
• Working		4	8.4
Perceived current income level			
• Low		7	14.3
• Middle		42	85.7
Enrolled in previous clinical training courses			
• No		47	95.9
• Yes (summer training)		2	4.1
I took a course wholly dedicated to genomics before attending the current course.			
• No		49	100
Have a family member or friend with a known genetic disease or condition			
• No		34	69.4
• Yes		15	30.6
If the answer is yes, what condition(s)			
• Cancer		2	11.1
• Down syndrome		4	22.1
• Diabetes		3	16.7
• Epilepsy/heart disease		1	5.6
• Asthma		1	5.6
• Heart diseases		2	11.1
• Sickle cell anaemia		3	16.7
• Others (eyes and skin disorders)		2	11.1
Have you encountered a clinical patient with a known genetic disease or condition during training in the hospital?			
• No		49	100

Table (2): Genomics Knowledge Before and After Attending the Genomics Course (N = 49).

Variable	**Before**	**After**	**Comparison* T0 & T1**	**Effect size (r)**
	Participants who participated at both times (N = 49)		**Z (p-value)**	
The Genomic Nursing Concept Inventory (GNCI) (Total score 31)			**-3.36(.0001)**	**0.34 (medium effect)**
• Range	2-13	3-30		
• Mean (χ^2) ±SD	5.41±2.22	7.63±4.29		
Percentiles				
• 25th	4.00	5.00		
• 50th (Median)	5.00	7.00		
• 75th	6.50	9.75		
GNCI subscales	χ^2±SD		**Z (p-value)**	**Effect size (r)**
Inheritance	1.734±1.01	2.27±1.64	-1.77(0.76)	0.18
Genomic Healthcare	1.85±1.25	1.80_1.29	-0.54(0.59)	0.05
Genomic Base	1.33±1.07	3.02±1.89	**-4.83(0.0001)**	**0.49 (large effect)**
Mutation	0.49±0.54	0.55±0.71	-0.58(0.56)	0.05

*Wilcoxon Signed Ranks Test

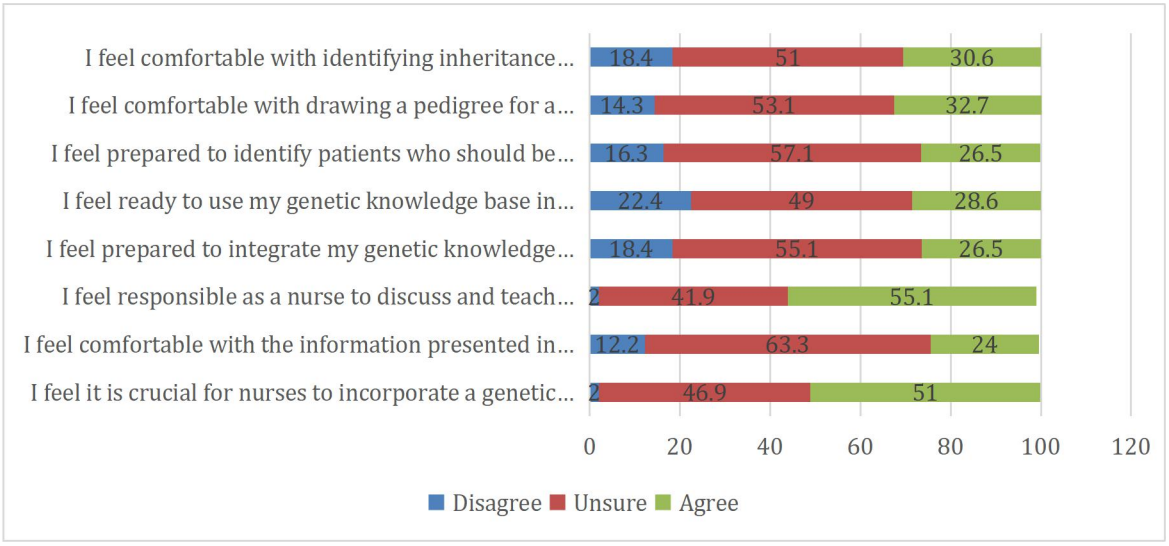

Figure (2): Attitude towards Genomic Study Before the Course, (N = 49).

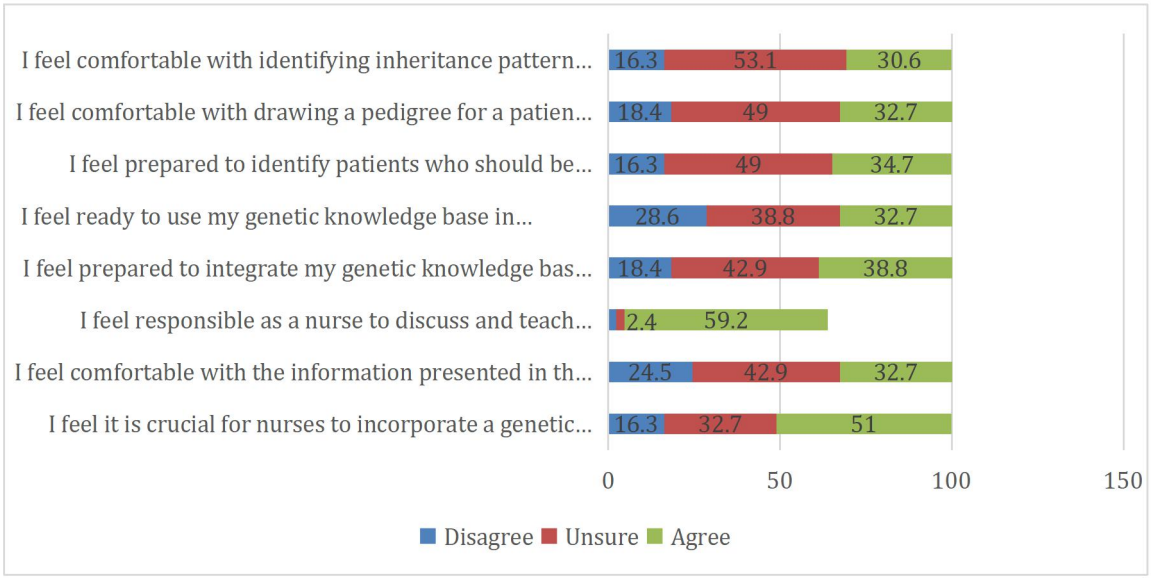

Figure (3): Attitude towards Genomic Study After the Course, (N = 49).

Discussion

The past three decades demonstrated advances in genomics that have shaped genomics science. Subsequently, extensive evidence has accumulated supporting the hidden relationship between genes, the presence of diseases, and treatment effectiveness. As a result, many nursing educators and researchers call for integrating genomics in nursing education to meet the patients and family's needs (Hickey et al., 2018; Seibert, 2020; Tonkin et al., 2020). Interestingly, one of the nursing colleges where the current study was conducted has infused a standalone genomics course in the bachelor science program, as explained before. A specialist professor from the pharmacy college designed the course contents and its specification. Hence, it was essential to highlight the impact of the course on knowledge and attitude towards genomics among the students by conducting the current study.

Genomics Knowledge Before and After the Course

According to the current study findings, the genomics course could significantly increase the students' basic knowledge level, specifically a total scale score and the genome basics subscale score. A previous study among undergraduate nursing students found that two subscales, inheritance and genomic base, alongside the total scale score, were significantly improved by the end of a semester with genomics content obtained from pathophysiology and nursing courses (Munroe & Loerzel, 2016).

Furthermore, congruent with a previous similar study (Munroe 2014), the students' knowledge was still below the average of 13.83. Indeed, this finding was predictable because the GNCI has challenging questions for undergraduate students (Munroe 2014), nursing educators (Read & Ward, 2016), and practitioner nurses (Wright et al., 2019) that the course contents did not cover, like the subscales of genomic healthcare and mutation.

Read & Ward (2016) acknowledged that GNCI purposefully measures understanding complex genomics concepts, so obtaining a high score is not easily attained. Hence, it was logical that only the human genome basics domain score was significantly improved after attending the genomic course. These findings support the need for modifying and extending the genomic course contents that can improve all aspects of genomic science, specifically mutations, inheritance and genomic healthcare applications, combined with genome basics. The scale items can be used to modify the course contents, especially the application part that encourages critical thinking and understanding of the genomics application in nursing.

Most of our study respondents felt uncomfortable with GNCI questions, and they are not ready to use the acquired genomics knowledge in the clinical setting. A previous study confirmed that undergraduate nursing students reported increased knowledge in genomics as they come close to graduation, but they felt discomfort integrating that knowledge into clinical practice (Dodson & Lewallen, 2011). In reality, one genomics course is not enough to improve the students' understanding of the sophisticated concepts of genomics and its clinical implications, especially if it was taught using traditional teaching methods (i.e., lectures). The genomics topics might become more understandable if they were taught using nontraditional teaching methods like case scenarios, problem-based cases, and storytelling. Also, the course contents must include drawing a pedigree and application of genomics knowledge in health care.

Attitude Towards Studying Nursing Genomics

Students' attitude towards studying nursing genomics before and after the course showed insignificant change, indicating that they had a consistently positive attitude towards studying genomics topics even before attending the course, supporting the previous studies results (Besse, 2014; St-Martin et al., 2017).

Like previous research (Munroe & Loerzel, 2016), most of our study' participants believed it is essential to incorporate a genetic health risk assessment into clinical practice and acknowledged that nurses are responsible for discussing and teaching patients and their families about genomics. However, they had not yet attended the clinical setting at that level of the study. This finding is reasonable since most of them were unsure about using the genomics knowledge base in clinical practice, drawing a pedigree, and identifying patients needing genomics referral. These findings mirror the students' awareness of their genomics knowledge deficit (Munroe & Loerzel 2016). Increasing the students' knowledge of genomics may enhance their confidence and attitude towards its applications during caring for patients and families. Therefore, repeating this study after the students attending the clinical settings can gain various findings regarding

applying acquired genomics knowledge in clinal practice.

Conclusion

Briefly, genomics knowledge was low among nursing students; however, the introductory genomics course could significantly improve their basic knowledge of the topic. They also had a positive attitude towards integrating genomics into the nursing curriculum. Thus, our study is a pre-post design that could provide indications for integrating and teaching genomics contents in nursing and its influence on students' knowledge and attitude.

Recommendations

Based on the current study's findings, the following recommendations were concluded:

- A standalone genetics/genomics course is recommended to be designed by nursing colleges to enhance the students' knowledge and skills of genetics applications in nursing practice.
- Genetics practice hours must be added to the genetics course to provide the students the opportunity to practice therapeutic communication skills when talking about genetic diagnoses, performing health risk assessments, drawing pedigrees, and identifying when a patient should be referred to a genetics counsellor.
- In addition to lectures, different teaching methods, such as simulations, case studies, and discussions, could be used to make students understand the genetics concepts and their application in clinical settings.
- Nursing educators in general and medical-surgical nursing educators in specific must be adequately prepared and knowledgeable to incorporate genetic and genomic principles during clinical training.
- Further studies are needed to determine the nursing educators' knowledge and attitudes towards impeding genomics in nursing education.
- Future studies are required to identify the barriers to genomics knowledge utilization in clinical practice as the student and faculty staff perceive.

Declaration of conflict of interest

None declared

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