Ergonomic Work Analysis in a Long Term Residency Institution for the Elderly in the South of Brazil

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Abstract

The increase in life expectancy and the sharp drop in the fertility rate of the population over the last years have resulted in the rapid growth of the number of elderly people worldwide, and this reality is also perceived in countries such as Brazil. In order to maintain the minimum housing standards of Long-Term Care Institutions for the Elderly (LTRIEs), there was a great impact perceived in work routines of the employees of these institutions, encouraging researches focused on the re-evaluation of the existent situations. The purpose of this article is to present the results of a research carried out in 2019, which, under the guidance of ergonomic science, applied the Ergonomic Work Analysis (EWA) at Lar Velhinhos de Zulma, located in the city of São José, Santa Catarina . Catarina, Brazil, with the objective of structuring the recommendations to improve the quality of life of workers in the laundry sector, supported by the application of research tools, such as REBA and Corlett Diagram.. The results of this investigation may contribute to the theoretical basis of other studies focused on the theme of the article and/or the application of the research tools in other contexts involving LTRIEs, or not. They might also help designers and specialists involved with the reality of LTRIEs to rethink the work environments that respect the psycho-physiological conditions of their employees.

Keywords

Ergonomic Work Analysis (EWA). Long Term Residency Institution for the Elderly (LTRIE). REBA Tool. Corlett Diagram.

1. Introduction

The increase in life expectancy and the sharp drop in the fertility rate of the population over the last years have resulted in the rapid growth of the number of elderly people worldwide, and this reality is also perceived in countries such as Brazil. This fact tends to encourage research and, from its results, stimulate the interventions needed to meet the new demands generated, as is the case of this study. Data from the Pan-American Health Organization (OPAS, 2017) demonstrate that in the year of 2050 the number of people of ages 60 or over will reach 2 billion, opposed to the 900 million recorded in 2015.¹ In 2016, Brazil was in the fifth position in the ranking of the largest elderly population in the world, with about 28 million people, aged 60 or over. Within this population, the one with the highest growth was that of the long-lived elderly, that is, those aged 80 years or older (MS, 2016).

Given this, it is important to reevaluate the role of the Long-term Care Institutions of the Elderly (LTRIE), as they are collective residences intended for the housing of people aged 60 years or over, who have family support or not, according to Brazilian laws. The new demands for LTRIEs also impacted the work of these institutions' employees, increasing the number of researches aimed at reevaluating existing situations, as a way of proposing more balanced environments that respect their psychophysiological characteristics in the performance of activities. Often, staffs continue to work without recognizing the impact of new demands on LTRIEs, which tends to increase the number and diversity of injuries to workers, including the lack of staff to attend the growing number and diversity of older people in these institutions.

Therefore, this article aims to present the results of the research carried out in 2019, which, under the guidance of ergonomic science, conducted the Ergonomic Work Analysis (EWA) at Lar dos Velhinhos de Zulma, located in the city of São José, Santa Catarina, in south if Brazil. After conducting the global assessment of working conditions, it was decided to apply the EWA in the institution's laundry, in order to structure the recommendations to improve the quality of life of workers in this sector. To support the EWA, site visits, semi-structured interviews with the work staff and the residents were conducted, and the application of the REBA and Corlett Diagram tools, as well as noise and force measurements, aiming to verify the adequacy of the situations found, including, in relevant legislation and standards.

The results demonstrated that the activities present risks that predispose work injuries, even in long term. Ergonomic recommendations were made in the short, medium and long terms, as a way to minimize and even eliminate the problems diagnosed in the sector, mainly due to repetitive activities and the weight of loads while using carts. The EWA was applied according to five steps that assisted the process of assessment of working conditions: demand analysis, task analysis, activity analysis, diagnosis and recommendations, as guided by Guérin (*et al*, 2001). The analysis of activities in the laundry sector at Lar de Velhinhos de Zulma identified some risks due to cargo loading and repetitive activities. Evaluation by the REBA and Corlett Diagram tools indicated the need for changes in the work process, seeking improvements to reduce the overload, especially of upper limbs in these activities. By assessing the noise level, measures were proposed to minimize and eliminate some situations for residents and workers.

The results of this investigation may contribute to the basis of studies of other researchers interested in the theme of the article and / or apply the research tools in other contexts involving LTRIEs, or not. They will also help designers and specialists involved with the reality of LTRIEs to rethink work environments that respect the psychophysiological conditions of their workers.

1.1 "Lar de Velhinhos de Zulma": a Long-term Care Institution of the Elderly

Situated in the city of São José, Santa Catarina, Brazil, Lar de Velhinhos de Zulma is a philanthropic institution founded in 1959. In this Long-term Care Institution of the Elderly (LTRIE) thirty-six residents ages 70 and over are attended, all coming from situations of social vulnerability. Despite being a private institution, this LTRIE receives financial aid from the City of São José, in order to pay more than fifty percent of its monthly expenses. The staff is

¹ Available in <u>https://www.paho.org/bra/index.php?option=com_content&view=article&id=5515:no-dia-internacional-da-pessoa-idosa-opas-chama-atencao-para-envelhecimento-saudavel&Itemid=820>. Accessed Nov. 11 of 2019.</u>

composed of 32 employees, divided within the following activities: management, general care and health care of the residents, cooking, and cleaning and laundry services. Figure 01 presents the distribution of the environments: the sectors of the LTRIE studied through colors that demonstrate their location in the building, with the main entrance indicated by an arrow:



Figure 1. Sectors and environments of the institution. Source: Elaborated by the authors (2020).

The main entrance is located entering the TV room, an environment that integrates with the other sectors such as the dining hall, the kitchen, the management office and the residents' rooms. The rooms are in halls 01 and 04, being double or triple, distributed by gender, with a nursing post, a pharmacy and doctor's office disposed in the center between these aisles. There is also a large external area with a garden, and, annexed to the Main Building, there is also three other edifications: the laundry room, a party room and a Spirist Center. This last one is frequented both by residents and employees of the LTRIE as well as by the community in which it is inserted.

After the evaluation of other LTRIEs in the state of Santa Catarina, Lar Velhinhos de Zulma was chosen to undergo the EWA, due to the ergonomic demands presented, which are verified in more detail in the items of the results. Besides this, since the building has suffered a recent intervention in its structure, the effectiveness of the solutions implanted were evaluated, generating data such a post-occupation analysis (POA) after the renovation, using ergonomic analysis tools such as the REBA and the Corlett Diagram, specified in item 1.3.

1.2 The Ergonomic Work Analysis (EWA)

Ergonomics is an applied Science that aims to transform work activities and their dimensions, which may be projected observing the human limitations and activities, covering three domains: the physical, cognitive and organizational ones (ABRAHÃO, 2009; KASPER, 2013; GRUBER *et al*, 2017). By turn, the Ergonomic Work Analysis (EWA) is the main tool of ergonomics, structured in steps that aim at the comprehension of the transformation of the work activities, over which the hypothesis of improvement is constructed, validated and/or refuted during its application process (ABRAHÃO, 2009; IIDA; GUIMARÃES, 2016).

This transformation is the first objective of the ergonomic action, which is outlined in a manner to contribute to the modification of unfavorable situations for the worker into other ones which value his/her health and well-being during the performance of his/her work activities. The first step is the demand analysis; the problem to be solved has

to be defined, assuming a certain number of objectives to be attained. Once the demand is defined, it is necessary to analyze the task of the work post, which is generally established by the management with specific conditions and foreseen results. This way, the task differs from the activity (third item of analysis), because it consists in the actual work that is performed by the worker, with real conditions and effective results, and possibly, different from the work prescribed (task). With the three items of the EWA analyzed it is possible to generate a diagnosis of the conditions of the work post and, at last, list recommendations to diminish or eliminate the situations that are harmful for the workers, improving their quality of life in the work environment (GUÉRIN et al, 2001; IIDA; GUIMARÃES, 2016), a fact that will reflect in its general condition, and also beyond it.

1.3 EWA Support Tools

In order to conduct a EWA important research tools may be used, that have the role of verifying hypotheses raised during a scientific study, potentializing the capacity of discovery of the work risk dimensions (ABRAHÃO, 2009; IIDA; GUIMARÃES, 2016). In this research, based on the technical and observation visits of the work post of the LTRIE laundry room, analysis tools were applied that allowed the verification of the postures and movements performed during the execution of the activities, in order to obtain the necessary data with due precision. Two tools were considered for these analyses, which were able to meet the objectives and answer to the problematics of the research, which are described below.

A Rapid Entire Body Assessment (REBA) consists in the postural analysis of the subject during his/her work, investigating static or dynamics postures with musculoskeletal injuries (HIGNETT; McATAMNEY, 2000). The Assessment presents six steps to be followed: the observation of the activities, the selection of postures to be evaluated, the scores of the postures, the application in the Score system, the application in the scale of risk levels and the verification of the priority of actions to be taken (HIGNETT; McATAMNEY, 2000; AL MADANI; DABABNEH, 2016). This orientation was followed in this study.

Also, the Corlett Diagram identifies the painful areas of the body, evaluating the intensity of the discomfort. This tool divides the body in parts (torso, left side and right side) and illustrates it in a map of body areas. There is a progressive scale of discomfort for this map, where level 01 represents "no discomfort at all" and level 05 represents "unbearable discomfort" (CORLETT; MANENICA, 1980). For this analysis the worker must indicate the areas where he feels or not the discomfort, checking in the scale described the level of intensity of discomfort, right after the occurrence of pain in these areas (CORLETT; MANENICA, 1980; LEMEA; MAIA, 2015). Besides these instruments, others were also used to assess strength and noise.

2. Methodological Fundaments

The method used in this research is the descriptive one, presupposing the analysis and register of the important events of the EWA (GIL, 2008; KASPER, 2013) and the attainment of the objectives of the research. The nature of the research is qualitative, where a comprehension of the specificities surrounding a LTRIE was sought, especially the ones related to the work posts and their activities, as well as the relation of interdependence between them and the needs of the residents, relating them to the situations pointed out by the ergonomic demands in the workplace, according to the orientations of Denzin and Lincoln (2017). Based on the considerations above, there was an attempt to understand profoundly the context of functioning of a LTRIE, including the foresight of its low range, a fact that characterizes a case study (YIN, 2017).

Based on this methodological depiction, research techniques were applied, such as documental and bibliographic researches in secondary sources, semi-structured interviews (KASPER, 2013; LAKATOS; MARCONI, 2017) with the nursing staff and residents, emphasizing on the workers of the laundry sector of the LTRIE. Interview scripts were elaborated and, for the collaborator, eighteen guiding questions were used, with the objective of trying to get to know the work routine (tasks, use of equipment, physical environment in general and its organization, social interaction). For the elderly residents, there was the objective of seeking the understanding of how the daily conditions of well-being could be improved during their life period at the LTRIE. The questions were recorded and later transcribed. All of the interviews occurred at the institution studied, from August 09-12 of 2019.

Another research technique used was the onsite observation (where the levels of strength employed in some activities and the noise generated by the sector were verified), as indicated by Pacheco Júnior, Pereira and Pereira Filho, (2007) such as: systematic observation as a previous planning of what is to be observed in the future; non-participant observation in which the fact was witnessed without participation; and individual observation. During the observations a MARK-10 Series 5, [AK2] dynamometer was used to assess the strength exerted during the activities that were performed by the laundry workers, in order to verify if there was an excessive loading of weight, above the recommended level by ISO 11228-2 (2007). This equipment was adjusted to eight readings of strength per second, with measurements in Newtons (N).

The second instrument employed in the observations was the Minipa MSL-1355[AK3] Digital Sound Level Meter, to investigate if the levels of noise generated during the activities analyzed were compatible with the acoustic comfort of the environments of the institution, according to the recommendations of ABNT NBR 10152 (1987). The measurements made by the instrument were in decibels (dB). Through the general observations and in the defined work posts, there was an understanding of the activities exerted in by the workers in general and in the laundry, making it easy to discover and approach the reality of each function.

The methodological fundaments exposed are in line with the EWA proposal and its structuring steps: the analysis of demand, the analysis of tasks and activities, the diagnosis and the recommendations. Figure 02 demonstrates the sequence in which the steps of the EWA and the procedures adopted in each one of these steps were performed, with the support of the Corlett Diagram and the REBA.



Figure 2. Sequence of steps of the EWA and the research techniques employed. Source: Elaborated by the authors (2020).

The analysis of the results attempted to confront the results obtained through this research with those that characterize the state of the art (secondary sources), supported by the research techniques and instruments used for the raising of data and treatment, through content analysis. In this last one, according to the guidance of Bardin (2010), allowing the identification of important guiding elements of ergonomic solutions, in face of the problems identified. To apply the technique, the phases of the pre-exploration, of selection of the units of analysis were developed, following the categorization and referential interpretation of these units (of analysis) (BARDIN, 2010). The Content Analysis offered intake to confront the data obtained in the EWA, and at the same time, complementing the other information necessary for the option of the most viable solutions, in face of the problems that were found.

3. Analysis of the Results

Following the five steps adopted for the conduction of the EWA (analysis of demand, task and activity, diagnosis and recommendations), the development of this study is highlighted within the physical domain of ergonomics, observing the influences of the other dimensions (the cognitive and organizational ones) within in this domain.

Given this, there was an option to evaluate the activities performed the workers due to the postures adopted and their movements (including flows) in the work posts of the Laundry sector of the LTRIE, having in mind the several demands identified in the work place described.

In general, the physical and organizational structure of the LTRIE is according to the determinations of the legislation and applicable laws in Brazil, such as the Senior Citizen Statute (2003), NBR ISO 11228-2 (2017) and NBR 1015 (1987), and ANVISA RDC n°283 (2005), which demands minimal conditions to be raised for a LTRIE. The environments, in general, presented a distribution of the furniture according to the flow of people, wheelchairs and service carts circulating, making the daily work routines easier, both for the residents as well as the health staff, according to some authors, (VERGARA; RIBET, 2012; MODESTI; KASPER, 2019), respecting, in the spatial distribution, the sizing required for the furniture, including the openings of doors and drawers and distances for circulation, meeting the anthropometric measurements needed for the users.

The tasks performed in the laundry room were divided in two stages: the first was conducted in the dirty area and the second in the clean area of the sector. The activities of the dirty area were: collect, separate and place the dirty clothes in the washing machine and its maintenance during the washing process. The activities of the clean area included centrifugation and drying of the already washed clothes, besides ironing, folding, verifying and separating by resident and putting them in their closets. These stages are divided in two workers, the first perform the activities in the dirty and clean areas, and the second concentrates only on the clean area (Figure 3).



Figure 3. Sequence of activities performed in the Laundry Room of the LTRIE Source: Elaborated by the authors (2020).

As verified in Figure 3, the tasks among the workers are sequential; therefore, they were organized in the flowchart using letters of the alphabet. The demand for services of the first worker is greater on Mondays, due to the greater accumulation of clothes during the weekend. For the second worker, the demand for services is greater on Tuesday, when she irons the washed clothes in greater quantity of the day before, and on Fridays, when it is necessary to organize the clothes for the weekend. The workload of the employees corresponds to 08 hours per day, from Monday to Friday, with pauses for breakfast and an afternoon snack (15 minutes) and lunch (60 minutes).

In general, the laundry room has good illumination natural ventilation. However, on high temperature days, summed to the heat emitted by the equipment, the area becomes very uncomfortable. The dirty area is equipped with a tank, a conventional washing machine, a double-door industrial washing machine with the exit towards the clean area, and baskets to separate the clothes. The clean area has a centrifuge, an industrial dryer, an iron, an ironing board, a table to organize the clothes, closets and shelves for storage. The objects available to aid in the tasks are: carts, buckets, irons, clothes line clamps, equipment for personal protection (EPP) such as goggles and earplugs. The analysis of the activities and risks involved, besides the ergonomic recommendations, may be verified in Chart 01, where the dirty and clean areas are identified.

		Sequence of activities	performed in the	Eddiary Room, Hoko mv	ented and ergener	
ΑСΤΙVΙΤΥ			DESCRIPTION OF THE ACTIVITY	RISKS INVOLVED	RESEARCH TECHNIQUES AND SUPPORTING TOOLS FOR EAWA	ERGONOMIC RECOMMENDATIONS
DIRTY AREA OF THE LAUNDRY ROOM	(a)		To pick up the dirty clothes in the rooms and bathrooms.	Musculoskeletal injuries: arm extended backwards and tension of the shoulder. Use of strength to pull the cart. Loss of hearing: noise of the cart.	REBA CORLETT Sound level meter	Substitution of the cart for a model that will allow its handling with both hands, with less depth to make the withdrawal of dirty close from the bottom easier (Figure 4), with silicone wheels to make less noise and use less strength (easy to slide).
	(b)		Separation of the dirty clothes by colors in baskets; placing of clothes in the washing machine.	Musculoskeletal problems : flexion of the torso and arms full extended.	REBA CORLETT	
	(c)		To start the process of Washing.	Musculoskeletal problems: flexed torso.	REBA CORLETT	Substitution of the baskets for models with springs, for the worker to not flex his/her body so much forward in order to reach the clothes.
	(d)		Maintenance of the washing process.	Musculoskeletal problems: squatting.	REBA CORLETT	Training of the worker to use the leverage with the (existing) foot, as it should be done, instead of handling it with the hand.

Chart 01. Sequence of activities performed in the Laundry Room, risks involved and ergonomic recommendations

CLEAN AREA OF THE LAUNDRY ROOM	(e)		To put the wet clothes in the centrifuge.	 Musculoskelet al problems: slight flexion and rotation of the body. Loss of hearing: noise from the machine. 	REBA CORLETT Sound Level Meter	To position the machine in a higher altitude and cart as demonstrated in figure 4 (p.09). Exchange the equipment for another that emits less noise. Use of the IPE to minimize or eliminate possible damages due to the noise.
	(f)		To hang the clothes to dry on the external clothesline or to put them in the dryer.	✓ Musculoskelet al problems: extension of the body, inclination of the head, arms raised above the shoulder, legs and feet in unstable position, rotation of the torso.	REBA CORLETT	To take breaks in order to rest; To have a structure for the external clothesline to be in reach of the worker.
	(g)		To put the clothes in the dryer when necessary (on rainy days).	 Musculoskelet al problems: flexion and rotation of the torso; High temperature. 	REBA CORLETT	To position the machine higher and the use of air conditioning in order to minimize the high temperatures.
	(h)	No register of activity being performed	To place the sheets to be ironed.	 Musculoskelet al problems: flexion and rotation of the torso; High temperature. 	REBA CORLETT	Use of air conditioning to minimize the high temperatures.
	(i)		To iron, fold and separate each piece of clothing by name, and also verify the state of the pieces.	 Musculoskelet al problems: repetitive movements when ironing and folding, unstable position (lack of support for feet). High temperature. 	REBA CORLETT	To plan pauses for resting; To plan a support platform for the feet, according to figure 5 (p. 10), to improve the stability during the activity. Use of air conditioning to minimize the high temperatures.
	(j)		To put away and distribute the clean clothes in the closets.	 Musculoskelet al problems: flexion forward of the body, harmful position for the hands (when pulling by the side with no handles for the hands) Excess of strength to push the cart. Loss of hearing: noise of the cart. 	REBA CORLETT	To plan a cart that allows a flexibility of height, with correctly positioned wheels fixed and mobile), making it possible to manage it without using too much strength in a controlled manner.

Source: Elaborated by the authors (2020).

As verified on Chart 01, noise was also a general complaint of the LTRIE, generated by the dirty and clean clothes carts of the laundry sector that circulated in the main hallway of the institution, compromising, many times, the concentration and the communication of the health staff while taking care of the elderly, sometimes scaring them. This problem also interfered in the sleep and in the daily activities of the residents during their baths, and at the end of the day, when a laundry cart passed by the rooms taking clean, ironed and folded clothes. Having in mind the necessity to eliminate or minimize the noise that interferes in the comfort of the residents and employees of the LTRIE as a whole, summed to the several postural problems by the activities performed in the Laundry Room, the analysis of the tasks performed by the workers in the sector was conducted.

In relation to the strength applied to handle the carts with clean and dirty clothes, an assessment with a dynamometer was conducted in the following way: during the visit with the assessment the employee was using the cart to remove the clothes from the washing machine and place them in the centrifuge (activity (e)). Through the understanding and knowledge of the factors involving musculoskeletal issues related to the movements, and the orientation of ISO 11228-2 (2007)², the equipment was placed on the handle of the cart, which the employee pulls and pushes within a distance of 3.3 meters and with a work frequency of 1/5 min. The measurements collected for the application of the method were: maximum initial strength of 57 N; average sustained strength of 45.5N; maximum halting strength of 0N; absolute height of hand support of 08cm. The results demonstrated that the strengths do not exceed the limits imposed by the norm for this activity. Despite being in agreement with ISO 11228-2 (2007), the option chosen was the one to improve the work conditions, considering the strength demanded by all of the carts used in the activities of the laundry room.

At the end of the diagnosis, the improvement proposal aimed to make the activities more comfortable and safe for the employees of the Laundry Room and for the institution in general, including the residents and employees of other sectors. For each problem identified potential actions were chosen, with their levels of complexity of being carried out and their time periods for the implementation of the solutions/recommendations, are described in Chart 01. For some postural demands there was the recommendation of the use of new artifacts to solve them, supporting the activities of the workers studied in the research. In the case of the postural demand of the first worker, identified in activity (b), the substitution of the cart for the model of Figure 04 was suggested. The model was proposed by Nickel and Ferreira (2010) for the laundry room of the University Hospital of Federal University of Santa Catarina (UFSC) in the city of Florianópolis (Brazil).



Figure 4: Load Cart proposed for activities (a), (b), (e) and (j). Source: Nickel and Ferreira (2010), adapted by the authors (2020).

The model consists in an adaptable load cart, because as the weight of the load increases, the springs are compressed and the platform is lowered. If the weight decreases the platform is raised, allowing the employee to adopt safer and

² Proposes two methods for the identification of the risks: The Generalized Risk Estimate and Evaluation of Risk, when it is considered an acceptable risk (green), and the Estimate of Specialized Risk and Risck Evaluation Approach, when the risk is relevant, in which the first method mentioned presents a yellow and or red alert diagnosis. In this case it was necessary to apply the first method.

more comfortable postures, as verified in Figure 04. Another proposed artifact for the postural demand of the second employee in the ironing clothes activity (k) was the installation of a support platform for the feet (figure





Figure 5: Support platform for the feet. Source: Elaborated by the authors based on the International Work Organization (2018, p. 323).

This recommendation was forecast according to the orientations of the book of Ergonomic Verification Points (OIT, 2018), which proposed actions to obtain positive effects without the need of sophisticated or high cost solutions. In this case, the platform is used to alter the position of the feet during the activity, avoiding that the employee stays in a static position during the whole period of work, a fact that may cause musculoskeletal problems and fatigue.

The analysis of the activities in the Laundry sector of Lar Velhinhos de Zulma identified some risks that may affect the health of the employee in the long term, due to harmful situations in the carrying of loads and because of repetitive activities. The evaluation generated by REBA and by the Corlett diagram indicated the need for alterations in the work processes focused in this article, seeking for improvements that aim both the quality of life of the employees as well as the residents of the institution, in the issue related to noise. On the other hand, the analysis revealed that, even though a recent renovation had been done in the LTRIE, it was perceived that the objective was mainly the improvement focused on the resident and sanitary issues involved, once these constitute the main focus for this kind of institution to receive their business license.

4. Conclusion

In face of the results found in this article, it is believed that the objective of the research was attained, once they were presented in the process of investigation conducted in 2019, where, under the guidance of ergonomic science an Ergonomic Work Analysis (EWA) was performed in Lar Velhinhos de Zulma, in the city of São José. The entire process of raising data and analysis of harmful situations culminated in the most important recommendations in order to diminish or eliminate them, and by this, improving the quality of life of the employees of the laundry sector and of the LTRIE in general. The application of the research tools REBA and Corlett Diagram demonstrated to be compatible with the situations encountered, as well as the use of the dynamometer and sound level meter to verify the complaints related to the use of strength in the handling of the carts and the noise generated by these and by the other equipment of the laundry room, that caused harm to the employees of other sectors and affected the comfort of the elderly residents.

The theoretical basis and methodological design demonstrated to be compatible and relevant to offer methodological-theoretical support, once this combination offers a contribution for the construction of knowledge within the area approached in the research, allowing other studies focused on the theme of the article and/or the application of the research tools in other contexts involving LTRIEs, or not. Also, they may help designers and specialists involved in the reality of LTRIEs, to plan and rethink the work environments with possibility of respecting the psychophysiological conditions of their employees. As a proposal for future studies, we suggest that the analysis conducted in this study be applied in other LTRIEs, aiming at not only the improvement in the laundry sector and its work activities, but also, on the improvement of the LTRIE as a whole, offering benefits for the employees and also for the residents.

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