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Comparison of the microbiological quality of diets offered in syringes and bottles and their cost in a lactário of a national health institute

Comparação da qualidade de dietas distribuídas em seringas e frascos e seu custo em um lactário de um instituto nacional de saúde

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ABSTRACT

Introduction: Healthcare-associated infections are considered a serious public health issue. When caring for newborns admitted to the Neonatal Intensive Care Unit, the administration of a diet contaminated with pathogenic microorganisms can help spread infections. **Objective:** To compare the cost and microbiological quality of the diet offered in syringes and bottles by the lactator for enteral administration to patients admitted to the Neonatal Intensive Care Unit (NICU). **Methods:** An exploratory experimental study "in loco" carried out between January and May 2019, consisting of the microbiological analysis of 72 samples of enteral diets and pasteurized donor human milk (PDHM) distributed in syringes and bottles. The microbiological parameters used were those of the Board of Health Collegiate Resolution No. 63/2000 and No. 171/2006. The microbiological quality of the water used in the reconstitution of the enteral diet; the swab of the manipulators' hands and oropharynx; surfaces such as benches and equipment, utensils, and the air quality of the areas for diet preparation were also assessed. The critical control points of the diet manipulation flowcharts reviewed were defined. **Results:** In the enteral diet samples, coliforms at 35°C and mesophilic aerobic microorganisms above the established standards levels were found in both modalities of the diet administration (bottle and syringe) during two days of collection (lots). In the LHOP samples, no microorganisms from the coliform group were found. When filling plastic bottles, mesophilic bacteria exceeding the established standards were detected. It was observed that the cost of distributing the diet in bottles was higher than that of using a syringe. **Conclusion:** It was found that the microbiological quality of the diets supplied in syringes was safer than that of the diets distributed in bottles. In addition, the diet infusion time was shorter and cost was lower with the use of the syringe.

KEYWORDS: Microbiological Quality; Breast Milk Dispensary; Enteral Diet; Pasteurized Human Milk; Syringes

RESUMO

Introdução: As infecções relacionadas à assistência à saúde são consideradas um grave problema de saúde pública. No cuidado com o recém-nascido internado em Unidade de Terapia Intensiva Neonatal (UTIN), a dieta, quando contaminada por microrganismos patógenos, pode ser um dos veículos de transmissão de infecções. **Objetivo:** Comparar a qualidade microbiológica e o custo da dieta ofertada em seringas e em frascos pelo lactário para administração via enteral aos pacientes internados em UTIN. **Métodos:** Realizou-se um estudo experimental exploratório *in loco*, entre janeiro e maio de 2019, com análise microbiológica de 72 amostras de dietas enterais e de leite humano ordenhado pasteurizado (LHOP) distribuídas em seringas e frascos. Os parâmetros microbiológicos utilizados foram baseados nas Resoluções da Diretoria Colegiada nº 63/2000 e nº171/2006.

A análise também abrangeu a qualidade microbiológica da água utilizada na reconstituição da dieta enteral, o *swab* de mãos e orofaringe dos manipuladores, de superfície como bancadas e equipamentos, de utensílios, e a qualidade do ar das áreas de preparo das dietas. Foram definidos os pontos críticos de controle dos fluxogramas de manipulação das dietas estudadas. **Resultados:** Verificou-se nas amostras de dietas enterais coliformes a 35ºC e microrganismos aeróbios mesófilos além dos padrões estabelecido, em ambas as modalidades de administração da dieta (frasco e seringa), em dois dias (lotes) de coleta. Observou-se ausência de microrganismos do grupo coliforme nas amostras de LHOP. O custo com a distribuição da dieta em frasco foi maior em relação ao uso da seringa. **Conclusões:** Verificou-se que a qualidade microbiológica das dietas envasadas e distribuídas em seringas foi mais segura em relação as que foram distribuídas por frascos. Além disso, o uso da seringa teve menor custo etempo de infusão da dieta.

PALAVRAS-CHAVE: Qualidade Microbiológica; Lactário; Dieta Enteral; Leite Humano Ordenhado e Pasteurizado; Seringas

INTRODUCTION

Hospital-acquired infections, currently known as healthcare-related infections (HAIs)[1], are acquired after a patient is admitted to a hospital and can manifest themselves during hospitalization or after discharge[2,3]. They are considered a serious public health problem both in Brazil and globally[4], and it is important to note that around 20% to 30% of these infections are preventable if intensive control and hygiene programs are applied. According to the European Centre for Disease Prevention and Control[5], HAIs can be reduced by up to 70% with knowledge and adherence to prevention programs by all professionals involved in health care[6].

In the hospital environment, infections have numerous means of transmission, among which are food-borne diseases (FBD)[1] which occur due to the ingestion of contaminated food at any stage of the food chain or during preparation. Several factors are considered vehicles for the transmission of pathogens in the diet, such as: contaminated water and/or supplies, handling in poor hygienic and sanitary conditions, use of poorly sanitized utensils, inadequate temperature during preparation, storage, transport and distribution of ready meals[7,8,9,10]. Therefore, any failure in hygienic-sanitary control at the stages of the preparation process, including the distribution of diets in the lactarium, can jeopardize the microbiological quality of the diet and lead to infections in newborn babies (NB), who are more susceptible to FBD in hospital environments[11,12,13].

The articles evaluating diets filled into bottles by the lactarium and then re-filled at the bedside by nursing staff are scarce. In view of this, this study aimed to compare the microbiological quality and cost of the diet offered in syringes and bottles by the lactarium for enteral administration to NBs admitted to neonatal intensive care units (NICUs).

METHODS

The National Institute of Women, Children and Adolescents Health Fernandes Figueira of the Oswaldo Cruz Foundation (IFF/Fiocruz) is a maternal and child reference hospital that treats highly complex patients under the Unified Health System (SUS). This study was carried out in the IFF lactarium, which serves the pediatric and neonatology wards on a 24-hour basis.

Ethical issues

The study was approved by the Clinical Research Management and Research Ethics Committee of IFF/Fiocruz (CAEE: 07564818.3.0000.5269), observing compliance with the guidelines and regulatory standards of Resolution No. 466, of December 12, 2012, of the National Health Council[14].

Lactarium description

The lactarium is a hospital unit that prepares, sanitizes, and distributes infant formulas (IF) and their substitutes for consumption by NBs and other patients in the pediatric unit. The service is outsourced, and at the time of the study it had 21 staff on duty, two production nutritionists, and a daytime nutritionist who was the technical manager. The daytime cooks were divided according to their duties: two distributed the diets on the wards, two handled the enteral diet, one prepared the oral FIpor, and one portioned the pasteurized expressed human milk (PEHM).

Diet preparation and distribution

The PEHM was transported from the Human Milk Bank (HMB) to the lactarium frozen in an isothermal box and ice packs, with temperature monitoring throughout the journey. It was thawed in a water bath and kept under refrigeration until it reached 4 ºC for portioning in a laminar flow cabinet using sterile gloves and syringes, after which it was labeled, checked and kept under refrigeration until 40 minutes before the prescribed administration time.

The IFs were prepared once the patient identification labels had been printed. The amount of powder and water needed for each diet was calculated using the Microsoft® Office® Excel program. The powder was weighed on a Bel® precision scale and the water used for reconstitution was filtered through micron filters (25, 10, 5, 0.5 mm) and then boiled. The cook checked and recorded the temperature of the water (≥ 75 ºC) in the pot using a skewer thermometer and measured the amount established on the spreadsheet in a sterile beaker. The diets were homogenized in mechanical stirrers (Quimis®) and filled according to the prescription/identification on the patient's label into disposable enteral diet bottles.

After preparation, the diets were checked by the lactarium's production nutritionist, then stored in specific refrigerators until 40 minutes before administration, when they were heated in a water bath until they reached an average temperature of 36 to 40 °C to meet body temperature during administration. Sequentially, the diets were distributed to the NICUs by the lactarium cook and administered by the nursing team according to the doctor's prescription.

Sample collection procedures

Between January and May 2019, six random sampling sessions were held on non-consecutive days to collect samples of enteral diets and PEHM for microbiological analysis. A total of 72 samples were collected, 36 from enteral diets and 36 from PEHM, of which 18 were filled into sterile syringes and 18 into non-sterile plastic bottles. The six random moments took place due to the need to monitor the work routine of the different teams on duty, both in the lactarium and the NICU.

During the collection procedure, the lactarium simulated the process of filling the diets into syringes and kept the filling in plastic bottles. In the NICU, the nursing department received diets in bottles, as usual, for refilling into syringes at the bedside, as well as diets already filled into syringes to be attached to the infusion pump or by gavage system.

The syringes used in this study were sterile, single-use hypodermic syringe pumps with a capacity of 60 ml and a luer lock nozzle (SR®) and certified by the National Institute of Metrology Standardization and Industrial Quality (Inmetro), Ordinance No. 503 of December 29, 2011[15].

For microbiological analyses, samples of enteral diets and PEHM were collected at three different stages of the preparation and distribution process, identified in this study as AE1, AE2, and AE3. Stages AE1 and AE2 took place in the lactarium and AE3 in the NICU.

At the filling stage, the enteral diet was filled into three bottles and three syringes containing 120 mL. The PEHM was filled into three bottles and three syringes containing 60 mL. The analyses were carried out on spare diets, which were identified as the study sample.

In AE1, which took place after filling and checking by the nutritionist, one sample of the enteral diet and PEHM was taken from a bottle and one from a syringe for microbiological analysis. The samples were kept refrigerated at between 2 and 7.4 °C for an average of 2 hours, until they were heated in a water bath at 65 °C for a minimum of 5 and a maximum of 7 minutes.

At AE2, after the diets had been heated in the lactarium, one sample in a bottle and one in a syringe were taken from each type of diet and sent for microbiological analysis.

At AE3, the samples distributed by the lactarium were exposed for an average of 30 minutes at room temperature until the nursing team simulated an infusion using an infusion pump in the NICU. The diets distributed in bottles were opened at the bedside and refilled, as was the service's practice. The diets distributed in syringes were simply attached to the infuser and simulated administration. On the fifth and sixth day of the study, a simulation of the administration of the diet by gavage was carried out by the nursing team, outside (fifth day) and inside the incubator (sixth day), which were then analyzed.

Microbiological analysis

The microbiological analyses of the enteral diet and the PEHM were carried out by a specialized laboratory contracted by the outsourced company responsible for managing the IFF's lactarium.

The method used was based on Normative Instruction (IN) No. 30, of June 26, 2018[16], and the Compendium of Methods for the Microbiological Examination of Foods, according to the American Public Health Association[17]. The results obtained were compared with the reference parameters of the following legislation: Collegiate Board Resolution (RDC) No. 63, of July 6, 2000[18], for enteral diets, and RDC No. 171, of September 4, 2006[19], for PEHM.

To analyze the filtered and boiled water used to reconstitute the enteral diets, a volume of 200 mL was collected in a plastic bottle. The method used was that recommended by the American Public Health of Water and Wastewater; Standard Methods for the Examination of Water and Wastewater[20]. For this analysis, the absence of *Escherichia coli*/100 mL and a pH between 6.0-9.5 were used as reference standards[21].

Hand swabs were collected by swabbing the back and palmar side of one of the hands and between the fingers. The oropharyngeal swab was collected from the oropharyngeal cavity of the lactarium workers. The compliance standards for the hand swab were absence of coliforms at 45 °C, *Escherichia coli*, aerobic mesophilic microorganisms, and *Staphylococcus aureus* (CFU/hand) - 1.0×10^2 [22,23,24], and for the oropharyngeal swab the reference standard was absence of *Streptococcus* spp. and *Staphylococcus aureus* (CFU/hand) - 1.0×10^2 [22,23,24]. and *Staphylococcus aureus*, according to the Brazilian National Health Surveillance Agency (Anvisa) for the Detection and Identification of Bacteria of Medical Importance[25].

The absence of coliforms and *Staphylococcus* coagulae was considered to be in agreement for the analysis of the surface samples of benches and utensils and equipment. There is no microbiological reference standard for assessing the ambient air in the lactarium. Therefore, the laboratory considered the absence of mesophilic aerobic microorganisms up to 20 colony-forming units (CFU)/20 min and molds and yeasts up to 10 CFU/20 min of exposure to be satisfactory environmental hygiene.

Cost evaluation

To compare the costs of diets in bottles or syringes, the costs of the IFF and the company that was tendered to provide the lactarium service were taken into account. The IFF's costs for the lactarium refer to the purchase of cans of powdered formula, pump syringes and plastic bottles of enteral diets. The

amount spent by the IFF on the HMB, on the other hand, was not reported, so it was not accounted for. The tendered company's costs relate to employee payroll, the purchase of disposable items, replacement equipment and utensils, space rent, water, electricity, and telephone, as well as paying for pest control, the microbiological analysis laboratory, and preventive and corrective maintenance of equipment, including the air-conditioning unit. In estimating the monthly cost of using syringes and enteral diet bottles in 2019, the following were considered: the average monthly consumption of syringes for pump use (1,800 units), the average monthly consumption of plastic enteral bottles and the cost of an 800 g can of starter formula. The estimated monthly cost for the production of enteral IF distributed in bottles and syringes was based on the average value of 108 liters of diet produced and distributed in May of that year.

All the procedures described, especially those that took place in the lactarium and NICU, were carefully defined to ensure the validity and reliability of the study's results and to guarantee the routine of these services, without interfering with quality and safety.

RESULTS

The microbiological results of the enteral diets and PEHM handled and distributed by the lactarium to the NICU are shown in Tables 1 and 2.

On the first day of collection at stage AE3 of the enteral diets handled in the lactarium and distributed to the NICU, filled into syringes and bottles, the presence of coliforms at 35 ºC was identified. On the second day, the presence of mesophilic aerobic microorganisms was identified in the AE1 stage in the enteral diet samples filled into syringes and bottles. On the same day, in the syringe-filled samples, the presence of coliforms at 35 ºC was identified in stage AE2. In stages AE2 and AE3, mesophilic aerobic microorganisms were identified in both filling methods (syringes and bottles). On the fifth day, in stage AE3, the presence of coliforms at 35 ºC in the bottle was identified (Table 1).

The PEHM samples filled into bottles and syringes in the three stages of the study were within the parameters established by current legislation (Table 2).

Table 3 shows the results of the microbiological analyses of the hand and oropharyngeal swabs of the handlers, surface (worktops and equipment) and utensils swabs, the water used to reconstitute the enteral diet, and the quality of the air conditioning in the preparation rooms.

The results of the microbiological analyses of the hand and oropharyngeal swabs of the handlers, surface (countertops and equipment) and utensils swabs, the water used to reconstitute the enteral diet, and the quality of the air conditioning in the preparation rooms were all within the parameters established by current legislation (Table 3).

Table 4 shows the estimated cost of enteral diets distributed by the lactarium in enteral diet bottles and syringes.

Table 1. Results of the microbiological analysis of the samples of enteral diets in bottles and syringes in the three stages of the study and the microbiological standards of RDC No. 63/2000[18].

Analysis days	Enteral samples	Stage 1 (AE1)				Stage 2 (AE2)				Stage 3 (AE3)			
		coliforms at 35°C - max 3.0 (NMP/g)	*Staphylococcus aureus* - less than 3.0 (CFU/g)	aerobic mesophilic microorganisms - less than 103 (CFU/g)	*Salmonella* spp - Absent (in 25 g)	coliforms at 35°C - max 3.0 (NMP/g)	*Staphylococcus aureus* - less than 3.0 (CFU/g)	aerobic mesophilic microorganisms - less than 103 (CFU/g)	*Salmonella* spp - Absent (in 25 g)	coliforms at 35°C - max 3.0 (NMP/g)	*Staphylococcus aureus* - less than 3.0 (CFU/g)	aerobic mesophilic microorganisms - less than 103 (CFU/g)	*Salmonella* spp - Absent (in 25 g)
1	Bottle	1.0	<1.0x10	1.0	Absence	1.0	<1.0x10	1.0	Absence	4.0	<1.0x10	3.0	Absence
	Syringe	< 1.0	<1.0x10	8.0	Absence	1.0	<1.0x10	3.0	Absence	6.0	<1.0x10	4.1x10	Absence
2	Bottle	< 1.0	<1.0x10	>6.5x10^3	Absence	< 1.0	<1.0x10	>6.5x10^3	Absence	< 1.0	<1.0x10	>6.5x10^3	Absence
	Syringe	< 1.0	<1.0x10	>6.5x10^3	Absence	>6.5 x10^3	<1.0x10	>6.5x10^3	Absence	< 1.0	<1.0x10	>6.5x10^3	Absence
3	Bottle	< 1.0	<1.0	<1.0x10^2	Absence	< 1.0	<1.0	<1.0x10^2	Absence	< 1.0	<1.0	<1.0x10^2	Absence
	Syringe	< 1.0	<1.0	<1.0x10^2	Absence	< 1.0	<1.0x10	<1.0	Absence	< 1.0	<1.0x10	1.4x10	Absence
4	Bottle	< 1.0	<1.0x10	<1.0	Absence	< 1.0	<1.0x10	<1.0	Absence	< 1.0	<1.0x10	<1.0	Absence
	Syringe	< 1.0	<1.0x10	<1.0	Absence	< 1.0	<1.0x10	<1.0	Absence	< 1.0	<1.0x10	<1.0	Absence
5	Bottle	< 1.0	<1.0x10	<1.0	Absence	< 1.0	<1.0x10	<1.0	Absence	3.5x10^2	<1.0x10	<1.0	Absence
	Syringe	1.0	<1.0x10	1.0x10	Absence	1.0	<1.0x10	<1.0	Absence	1.0	<1.0x10	<1.0	Absence
6	Bottle	< 1.0	Absence	NA	Absence	2.0	Absence	NA	Absence	< 1.0	Absence	NA	Absence
	Syringe	< 1.0	Absence	NA	Absence	< 1.0	Absence	NA	Absence	< 1.0	Absence	NA	Absence

Source: Prepared by the authors, 2024.
MPN/g: most probable number per gram; CFU/g: colony-forming unit per gram; NA: not analyzed due to low count result.

Table 2. Results of the microbiological analysis of PEHM samples in bottles and syringes in the three stages of the study and the microbiological standards of RDC No. 171/2006[19].

Analysis days	PEHM samples	Stage 1 (AE1)	Stage 2 (AE2)	Stage 3 (AE3)
		Coliform microorganisms - Absent	Coliform microorganisms - Absent	Coliform microorganisms - Absent
1	Bottle	Absence	Absence	Absence
	Syringe	Absence	Absence	Absence
2	Bottle	Absence	Absence	Absence
	Syringe	Absence	Absence	Absence
3	Bottle	Absence	Absence	Absence
	Syringe	Absence	Absence	Absence
4	Bottle	Absence	Absence	Absence
	Syringe	Absence	Absence	Absence
5	Bottle	Absence	Absence	Absence
	Syringe	Absence	Absence	Absence
6	Bottle	Absence	Absence	Absence
	Syringe	Absence	Absence	Absence

Source: Prepared by the authors, 2024.
PEHM: pasteurized expressed human milk.

Table 3. Results of microbiological analysis of hand and oropharyngeal swabs from handlers, swabs from surfaces (worktops and equipment) and utensils, the water used to reconstitute the enteral diet, and the quality of the air conditioning in the preparation rooms.

Analyses carried out	2019						
	jan	Feb	sea	Apr	mai	jun	jul
Water	C	C	C	C	C	C	C
Hands	NA	NA	NA	C	C	C	C
Oropharynx	NA	NA	NA	C	C	C	C
Surfaces	NA	NA	NA	C	C	C	C
Utensils	NA	NA	NA	C	C	C	C
Air conditioning	NA	NA	NA	C	NA	NA	NA

Source: Prepared by the authors, 2024.
C: Compliant; NA: Not analyzed; NC: Non-compliant.

Table 4 Estimated cost of enteral diets distributed by the lactarium in enteral diet bottles and syringes, 2019.

Items	Average monthly value for dispensing diets per sterile syringe for pump in real (R$)*	Average monthly value for distributing diets per bottle plastic non-sterile enteral diet in real (R$)*
Sterile syringe (60 mL) (SR) - unit value R$ 6.30	11,340.00	11,340.00
Universal cap - unit value R$ 0.15	270.00	-
Plastic bottle of non-sterile enteral diet (100 mL) - unit value R$ 0,55	-	990.00
Infant Formula (800g can) - unit value R$ 30.00	540.00	540.00
PEHM (1)	Unregistered	Unregistered
Outsourced service (2)	178,598.71	178,598.71
Stock clerks	5,312.40	5,312.40
Total diet cost per container (3)	196,061.11	196,781.11

Source: Prepared by the authors, 2024.
*The tabulated data was estimated on an average consumption of 1,800 disposable plastic containers per month.
(1) The cost of the PEHM could not be verified, as this process is carried out by the HMB; (2) The cost of outsourced labor (including tickets, meals, and food vouchers), rent, payroll, taxes, and services; (3) Microbiological analyses, fumigation, and preventive and corrective maintenance of equipment were not included in the calculation of the total cost, as this amount is included in the amount passed on to the outsourced company that provides services in the lactarium.

The total estimated amount spent per month on diets distributed in syringes for administration in an infusion pump for NICU patients was R$ 196,061.11 and on diets distributed in bottles was R$ 196,781.11 per month. There is a difference of R$720.00 between the two procedures for distributing and filling diets in the NICU per month, which generates around R$ 8,640.00 per year for the IFF (Table 4).

DISCUSSION

Regarding the microbiological data of the enteral diets handled in the lactarium and distributed to the NICU, filled into syringes and bottles, the presence of coliforms at 35 ºC was identified on the first day of collection in stage AE3.

On the second day of collection in the enteral diet samples filled into syringes and bottles, the presence of mesophilic aerobic microorganisms was identified in stage AE1. On the same day of collection, in the samples filled into syringes, the presence of coliforms at 35 ˚C was identified in stage AE2. In stages AE2 and AE3, mesophilic aerobic microorganisms were identified in both filling methods (syringes and bottles).

It should be noted that the hands of handlers involved in patient care in hospitals are considered an important route of contamination by microorganisms[11,35]. Santos et al.[34] analyzed hand cultures of enteral diet handlers administered in a private hospital in the city of João Pessoa, Paraíba (PB), and found coliforms at 35 ºC. The highest prevalence of HAI is in the NICU[36], with *Staphylococcus*, *Pseudomonas aeruginosas*, *Enterococcus* spp., Candida sp., and *Enterobacter* sp.[37,38] being the predominant pathogenic bacteria. Therefore, hand washing is an effective measure for preventing cross-contamination of microorganisms, although there is still a strong resistance to this procedure by the professionals involved in patient care[39].

On the fifth day of collection, coliforms at 35 ºC were identified in the AE3 stage in the bottle-filled sample.

On this day, in stage AE 3 in the NICU, the administration of the diet was simulated by gavage, keeping the diet exposed during the simulated administration at a temperature of 20 ºC, unlike on the other days of the study, where the diet was administered by infusion pump.

This result, although unique, may confirm the need to improve handling techniques, care with hand hygiene, and evaluation of the way the diet is administered due to the higher risk of HAIs in NICU patients.

Araújo et al.[30] report that administering the diet by gavage to premature infants admitted to the NICU is important to encourage the mother's participation in feeding her child and is in line with the strategies of the Baby-Friendly Hospital Initiative (BFHI), the Global Strategy for Infant and Young Child Feeding (WHO), and the United Nations Children's Fund (UNICEF). However, this study did not assess the microbiological risk of the diet.

Another important finding in this study was the exposure time of the ready-made diets distributed by the lactarium (in bottles and syringes) to the NICU for subsequent administration. There was a variation of 1h40min and 3h at 21.1-29.0 ºC, considered the optimum temperature for bacterial proliferation by coliforms[27]. This prolonged exposure of the diet to room temperature may justify the presence of coliforms at 35 ºC in the enteral diet sample from the first day of collection. On the third and fourth days analyzed in AE 3, the samples were exposed in the NICU for two hours and reached the highest temperature in the study (29 ºC), but no microorganisms were found in quantities above the reference standard[18,19] used in the study, indicating the possible effectiveness of the GPs adopted in the lactarium.

Similarly to this study, Rossi et al.[28] microbiologically evaluated powdered and reconstituted diets using the same reference standard and observed that the powdered samples were adequate, but the reconstituted ones showed high mesophile counts after 2 hours of distribution (5.7 x 10^7 CFU/mL). Trindade[29] found diets contaminated by mesophiles and noted that this was due to non-conformities found in the hygiene and health conditions, mainly attributed to inadequate time and temperature in the process stages. This shows that effective GP management is extremely important[31,32,33].

In the PEHM analyses, all the samples were appropriate according to RDC no. 171/2006[19].

The results found in this study of the analysis of the water used to handle enteral diets, hand, oropharynx, surfaces, equipment swabs, and the air-conditioned air in the diet preparation areas showed no non-conformities, thus proving the effectiveness of GP management and the monitoring of the standards established in the management of the lactarium.

Proper sanitization of equipment and utensils is also fundamental for food safety, as they are one of the vehicles for direct or indirect transmission of pathogens during the manufacturing and/or distribution process[19,26,39,40,41]. This contamination can be cross-contaminated, resulting from transmission from a surface, from other food, from contaminated hands or saliva to the food[39,42,43].

No studies were found that evaluated the cost of the diet distributed by the lactarium in bottles or syringes, so the supply of food to patients in the NICU has a direct and indirect impact on hospital costs[44]. However, other authors have studied hospital costs related to the care of NBs admitted to the NICU. Melo et al.[45] estimated the direct costs of hospital care for 147 extreme, moderate or late preterm NBs treated in a public hospital in 2018, and investigated whether factors associated with birth and maternal conditions were associated with costs and length of hospital stay. It was found that extreme prematurity resulted in a 15.5 times higher cost compared to late prematurity. It was also found that factors associated with cost included gestational age (GA), NICU admission and the number of prenatal visits.

Desgualdo et al.[46] analyzed the hospital cost of treating premature newborns between 22 and 36 weeks of gestational age, born in a reference hospital in São Paulo, and found that the average daily cost for premature babies under 1,000 g was US$ 115.

However, this study did not compile figures for indirect costs (electricity, water, and sewage), which account for 16% of the total amount spent on caring for this group. The cost of salaries and indirect services rendered accounted for 76%, which means that most of the cost of caring for NBs is spent on hospital services.

In view of this demand, a survey was carried out of the hospital costs of the care unit. The current contract with the lactarium's outsourced company establishes that the disposable items used, and the utensils involved in the entire enteral diet and PEHM process flow, as well as the cost of labor, preventive and corrective maintenance of equipment and the central air system, fumigation and space rental are the cost of the contracted company. However, in addition to passing on the amount to the company providing the lactarium service, the care unit also has the cost of purchasing raw materials, bottles, syringes, equipment, perfuser, and renting an infusion pump.

There was a monetary loss when comparing the average monthly cost of supplying diets in bottles to be filled later in syringes, as well as the greater disposal of plastic waste that cannot go through the recycling process, causing environmental damage. It was not possible to compare the cost of the enteral diet procedure and the PEHM procedure, as the amounts spent on human milk at the HMB were not provided by the institution.

Public health is one of the main pillars of public investment. Expenditure on hospitalization time, human resources, medicines, the purchase of supplies, and food for patients and companions is important for public coffers. Reducing these costs directly or indirectly is important for the country's economy[47].

Therefore, the findings of this study show that it is a good idea for the service to improve the use of syringes for enteral administration to NBs admitted to the NICU. As well as reducing hospital costs, this improvement will make it easier to control contamination and microbiological proliferation, since the diet is administered immediately after distribution, minimizing process errors and the time the diet is exposed at the bedside.

It is therefore very important for the service to establish new routines, using standard operating procedures (SOPs) and registration forms to monitor the stage of distributing diets from the lactarium to the NICU, ensuring that administration by syringes in infusion pumps is carried out safely.

CONCLUSIONS

Based on the results of this study, it was observed that the distribution of diets in syringes by the lactarium would be extremely important to extinguish bedside refilling, which would minimize the risk of HAIs to NBs admitted to the NICU, reduce the time it takes to administer diets to NBs, increase the practicality of administering diets and reduce public costs, thus improving the service provided by the lactarium and the institution to the patients it assists.

REFERENCES

1. World Health Organization – WHO. Guideline: protecting, promoting and supporting breastfeeding in facilities providing maternity and newborn services. Geneva: World Health Organization; 2017.
2. Centers for Disease Control and Prevention – CDC. 2016 National and State Healthcare-Associated infections progress report. Atlanta: Centers for Disease Control and Preservation; 2016.
3. Siqueira DR. Gestão da qualidade no preparo de dietas enterais e fórmulas infantis no lactário de um hospital universitário [dissertação]. Rio de Janeiro: Universidade Federal do Rio de Janeiro; 2016.
4. Agência Nacional de Vigilância Sanitária - Anvisa. Boletim segurança do paciente e qualidade em serviços de saúde Nº 16: avaliação dos indicadores nacionais das infecções relacionadas à assistência à saúde (IRAS) e resistência microbiana do ano de 2016. Brasília: Agência Nacional de Vigilância Sanitária; 2017.
5. European Centre for Disease Prevention and Control – ECDC. Health care associated infections acquired in intensive care units: annual epidemiological report for 2016. Stockholm: European Centre for Disease Prevention and Control; 2018.
6. Ferreira LL, Azevedo LMN, Salvador PTCO, Morais SHM, Paiva RM, Santos VEP. Nursing care in healthcare-associated infections: a scoping review. Rev Bras Enferm. 2019;72(2):498-505. https://doi.org/10.1590/0034-7167-2018-0418
7. Agência Nacional de Vigilância Sanitária – Anvisa. Pediatria: prevenção e controle de infecção hospitalar. Brasília: Agência Nacional de Vigilância Sanitária; 2006.
8. Linhares IW. Avaliação das condições higiênico - sanitárias no preparo de fórmulas infantis em e Lactário hospitalar [dissertação]. Belo Horizonte: Universidade Federal de Minas Gerais; 2012.
9. Silva AV, Silva KRA, Bezerra MLS. Conhecimento do controle higiênico-sanitário na manipulação de dietas em domicílios: revisão bibliográfica. Nutrir Gerais. 2012;6(10):918-32.
10. Momesso NN, Lanziotti RS, Caproni PRR, Souza LH, Andrade MC. Estudo da contaminação microbiana no preparo de fórmulas lácteas infantis em lactário de um hospital universitário do Sul de Minas Gerais. Rev Cienc Saúde. 2016;6(3):94-110. https://doi.org/10.21876/rcsfmit.v6i3.581

11. Ferreira MS, Carvalho LMF, Bezerra KCB. Boas práticas na elaboração de dietas enterais em ambiente hospitalar: uma revisão. Res Soc Dev. 2020;9(11):1-15. https://doi.org/10.33448/rsd-v9i11.10293
12. Oliveira VA, organizador. Guia prático de terapia nutricional enteral no âmbito hospitalar e domiciliar. Parnaíba: Acadêmica; 2020.
13. Oliveira CR Lima MV, Siqueira DR, Oliveira AGM, Garcia SRMC. Elaboração e validação de lista de verificação dos processos produtivos de dietas pediátricas em lactários hospitalares. Cienc Saúde Colet. 2022;27(9):3763-76. https://doi.org/10.1590/1413-81232022279.00642022
14. Ministério da Saúde (BR). Resolução Nº 466, de 12 de dezembro de 2012. Aprova as diretrizes e normas regulamentadoras de pesquisas envolvendo seres humanos e revoga as resoluções CNS Nos 196/96, 303/2000 e 404/2008. Diário Oficial União. 13 jun 2013.
15. Ministério do Desenvolvimento, Indústria e Comércio Exterior (BR). Portaria Inmetro N° 503, de 29 de dezembro de 2011. Estabelece os critérios para o programa de avaliação da conformidade para seringas hipodérmicas estéreis de uso único, sob regime de Vigilância Sanitária, com foco na saúde, por meio do mecanismo de certificação compulsória. Diário Oficial União. 30 dez 2011.
16. Ministério da Agricultura, Pecuária e Abastecimento (BR). Instrução normativa Nº 30, de 26 de junho de 2018. Estabelece como oficiais os métodos constantes no manual de métodos oficiais para a análise de alimentos de origem animal, oriundas dos programas e controles oficiais do MAPA. Diário Oficial União. 27 jun 2018.
17. Salfinger Y, Tortorello ML. Compendium of methods for the microbiological examination of foods. Washington: American Public Health Association; 2015.
18. Agência Nacional de Vigilância Sanitária - Anvisa. Resolução RDC Nº 63, de 6 de julho de 2000. Aprova regulamento técnico para fixar os requisitos mínimos exigidos para a terapia de nutrição enteral. Diário Oficial União. 7 jul 2000.
19. Agência Nacional de Vigilância Sanitária - Anvisa. Resolução RDC Nº 171, de 4 de setembro de 2006. Dispõe sobre o regulamento técnico para o funcionamento de bancos de leite humano. Diário Oficial União. 5 set 2006.
20. American Public Health Association - APHA. Standard methods for the examination of water and wastewater. 21a ed. Washington: American Public Health Association; 2005.
21. Ministério da Saúde (BR). Portaria de consolidação Nº 5, de 28 de setembro de 2017. Do controle e da vigilância da qualidade da água para consumo humano e seu padrão de potabilidade. Diário Oficial União, 3 out 2017.
22. International Organization for Standardization - ISO. ISO 4833-1:2013 Microbiology of the food chain: horizontal method for the enumeration of microorganisms part 1: colony count at 30 degrees C by the pour plate technique. Geneva:International Organization for Standardization; 2013[acesso 9 set 2019]. Disponível em: https://www.iso.org/obp/ui/#iso:std:iso:4833:-1:ed-1:v1:en
23. Moberg L, Kornacki JL. Microbiological monitoring of the food processing environment. In: Salfinger Y, Tortorello ML. Compendium of methods for the microbiological examination of foods. Washington: American Public Health Association; 2015.
24. Associação Brasileira de Normas Técnicas - ABNT. NBR ISO 6888-1, Microbiologia de alimentos para consumo humano e animal: método horizontal para enumeração de estafilococos coagulase positiva parte 1: técnica usando ágar Baird-Parker. Rio de Janeiro:Associação Brasileira de Normas Técnicas; 2019.
25. Agência Nacional de Vigilância Sanitária - Anvisa. Microbiologia clínica para o controle de infecção relacionada à assistência a saúde: módulo 6: detecção e identificação de bactérias de importância médica. Rio de Janeiro: Agência Nacional de Vigilância Sanitária; 2013.
26. Soares DSB, Henriques P, Ferreira DM, Dias PC, Pereira S, Barbosa RMS. Boas práticas em unidades de alimentação e nutrição escolares de um município do estado do rio de janeiro - brasil. Cienc Saúde Colet. 2018;23(12):4077-83. https://doi.org/10.1590/1413-812320182312.23992016
27. Conte VD, Colombo M, Zanrosso AV, Salvador M. Qualidade microbiológica de águas tratadas e não tratadas na região do nordeste do Rio Grande do Sul. Infarma. 2004;16(11/12):83-4.
28. Rossi P, Kabuki DY, Kuayre AY. Avaliação microbiológica do preparo de fórmula láctea infantil em lactário hospitalar. Rev Inst Adolfo Lutz. 2010;69(4):503-9.
29. Trindade AA. Subsídios para implementação do sistema de análise de perigos e pontos críticos de controle-APPCC em lactário [dissertação]. São Paulo: Universidade de São Paulo; 2006.
30. Araújo VC, Maciel ACM, Paiva MAR, Bezerra ACB. Volume derramado, saturação de oxigênio e frequência cardíaca durante a alimentação de recém-nascidos prematuros: comparação entre dois métodos alternativos de oferta. CoDAS. 2016;28(3):212-20. https://doi.org/10.1590/2317-1782/20162015152
31. Amaral MN, Morales TSP, Vieira VBR, Taglietti RL. Conhecimento dos manipuladores de dietas do interior paulista acerca das boas práticas de manipulação. In: Anais do 6° Congresso Internacional em Saúde: vigilância em saúde: ações de promoção, prevenção, diagnostico e tratamento; 2019, Ijuí. Ijuí:Universidade Regional do Noroeste do Estado do Rio Grande do Sul; 2019.
32. Maia ICP, Monteiro MAM, Fonseca JL, Coelho MRL, Lopes SLC. Análise da contaminação de utensílios em unidades de alimentação e nutrição hospitalar no município de Belo Horizonte-MG. Alim Nutr. 2011;22(2):265-71.
33. Ávila MO, Santos PHS, Gois FN, Furtado MC, Reis IAO. A importância do controle das condições microbiológicas e higiênico sanitárias na prevenção de doenças transmitidas por dietas: uma revisão de literatura. Sergipe: Instituto Federal de Sergipe; 2016.

34. Santos BHC, Souza EL, Sousa CP, Serrão LHC, Amaral WC. Manipuladores como causas potenciais de contaminação microbiana de dieta enteral. Infarma. 2004;15(11/12):71-3.

35. Anderton A, Aidoo KE. The effect of handling procedures on microbial contamination of enteral feeds: a comparison of the use of sterile vs non-sterile gloves. J Hosp Inf. 1991;17(4):297-301. https://doi.org/10.1016/0195-6701(91)90274-c

36. Carvalho ES, Marques AR. Infecção hospitalar em pediatria. J Pediatr. 1999;75(Supl.1):31-45. https://doi.org/10.2223/JPED.369

37. Silva N, Junqueira VCA, Silveira NFA, Taniwaki MH, Gomes RAR, Okazaki MM. Manual de métodos de análise microbiológica de alimentos e água. São Paulo: Varela; 2017.

38. Bastos ECB, Lima PS, Laurindo MV, Ribeiro LML, Vasconcelos, FF, Rocha RR et al. Perfil epidemiológico das infecções em uma unidade de terapia intensiva de emergência. Braz J Health Rev. 2019;2(3):1654-60.

39. Cunha Neto A, Rosa OO. Determinação de microrganismos indicadores de condições higiênicas sanitárias nas mãos de manipuladores de alimentos. Rev Bras Tecn Agroind. 2014;8(1):1251-61. https://doi.org/10.3895/S1981-36862014000100010

40. Kochansk S, Pierozan MK, Mossi AJ, Treichel H, Cansian RL, Ghisleni CP et al. Avaliação das condições microbiológicas de uma unidade de alimentação e nutrição. Alim Nutr. 2009;20(4):663-8.

41. Custódio J, Alves JF, Silva FM, Dolinger EJOV, Brito DVD. Avaliação microbiológica das mãos de profissionais da saúde de um hospital particular de Itumbiara, Goiás. Rev Cienc Med. 2009;18(1):7-11.

42. Souza PA, Santos DA. Microbiological risk factor associated with food handlers in elementary schools from Brazil. J Food Safety. 2009;29(3):424-9. https://doi.org/10.1111/j.1745-4565.2009.00166.x

43. Githiri M, Okemo P, Kimiywe J. Hygienic practices and occurrence of coliforms and Staphylococcus on food at a public hospital in Kenya. J Appl Biosci. 2009;27:1727-31.

44. Araújo VC, Maciel ACM, Paiva MAR, Bezerra ACB. Volume derramado, saturação de oxigênio e frequência cardíaca durante a alimentação de recém-nascidos prematuros: comparação entre dois métodos alternativos de oferta. CoDAS. 2016;28(3):212-20. https://doi.org/10.1590/2317-1782/20162015152

45. Melo TFM, Carregaro RL, Araújo WN, Silva EM, Toledo AM. Custos diretos da prematuridade e fatores associados ao nascimento e condições maternas. Rev Saúde Publica. 2022;56:1-14. https://doi.org/10.11606/s1518-8787.2022056003657

46. Desgualdo CM, Riera R, Zucchi P. Cost estimate of hospital stays for premature newborns in a public tertiary hospital in Brazil. Clinics. 2011;66(10):1773-7. https://doi.org/10.1590/S1807-59322011001000016

47. Barbosa TA. Epidemiologia da colonização e infecção microbiana em unidade de terapia intensiva neonatal: abordagem clínica e molecular [dissertação]. São Paulo: Universidade Estadual Paulista; 2016.

Authors' Contributions

Garcia SRMC, Guimarães ACLD, Roppa A - Conception, planning (study design), acquisition, analysis, data interpretation, and writing of the paper. Marano D - Acquisition, analysis, and data interpretation. All the authors approved the final version of the paper.

Conflict of Interest

The authors inform that there is no potential conflict of interest with peers and institutions, political or financial, in this study.