Nutrición Hospitalaria

Original

Determination of temperature variation during the individual steps of the production of hospital diets of modified consistency

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Abstract

Background & aim: Many disease outbreaks of food origin are caused by foods prepared in Food Service and Nutrition Units of hospitals, affecting hospitalized patients who, in most cases, are immunocompromised and therefore at a higher risk of severe worsening of their clinical status. The aim of this study was to determine the variations in temperature and the time-temperature factor of hospital diets.

Methods: The time and temperature for the preparation of 4 diets of modified consistency were determined on 5 nonconsecutive days in a hospital Diet and Nutrition Unit at the end of preparation and during the maintenance period, portioning and distribution at 3 sites, i.e., the first, the middle and the last to receive the diets.

Results and discussion: All foods reached an adequate temperature at the end of cooking, but temperature varied significantly from the maintenance period to the final distribution, characterizing critical periods for microorganism proliferation. During holding, temperatures that presented a risk were reached by 16.7% of the meats and 59% of the salads of the general diet, by 16.7% of the garnishes in the bland diet and by 20% of the meats and garnishes in the viscous diet. The same occurred at the end of distribution for 100% of the hot samples and of the salads and for 61% of the desserts. None of the preparations remained at risk temperature for a time exceeding that established by law.

Conclusion: The exposure to inadequate temperature did not last long enough to pose risks to the patient.

(*Nutr Hosp.* 2011;26:488-494)

DOI:10.3305/nh.2011.26.3.4679

Key words: *Time-temperature factor. Critical control points. Hospital diets.*

DETERMINACIÓN DE LAS VARIACIONES DE TEMPERATURA DURANTE LOS DISTINTOS PASOS DE LA PRODUCCIÓN DE LAS DIETAS DEL HOSPITAL CON MODIFICACIÓN EN LA CONSISTENCIA

Resumen

Antecedentes y objetivos: muchas epidemias de origen alimentario están causadas por alimentos preparados en las unidades de alimentación y nutrición de los hospitales y afectan a pacientes hospitalizados que, en su mayoría, están inmunodeprimidos y presentan, por lo tanto, un mayor riesgo de empeoramiento grave de su estado clínico. El objetivo de este estudio fue determinar las variaciones en la temperatura y el factor tiempo-temperatura en las dietas de los hospitales.

Métodos: se determinó el tiempo y la temperatura de preparación de 4 dietas de consistencia modificada durante 5 días consecutivos en una Unidad de alimentación y nutrición, al final de la preparación y durante el periodo de mantenimiento, racionamiento y distribución en 3 sitios, es decir, el primer sitio en recibir la dieta, el intermedio y el último.

Resultados y discusión: todos los alimentos alcanzaron una temperatura adecuada al final de su preparación, pero la temperatura varió significativamente desde su periodo de mantenimiento hasta su distribución final, caracterizando periodos críticos para la proliferación de microorganismos. Durante su almacenamiento, las temperaturas que representaron un riesgo se dieron en el 16,7% de las carnes y el 59% de las ensaladas de la dieta general, en el 16,7% de las guarniciones de la dieta blanda y en el 20% de las carnes y las guarniciones de la dieta viscosa. Lo mismo ocurrió al final de la distribución en el 100% de las muestras calientes y de las ensaladas y en el 61% de los postres. Ninguna de las preparaciones permaneció a una temperatura de riesgo durante un tiempo que excediese el tiempo establecido por ley.

Conclusión: La exposición a una temperatura inadecuada no fue lo suficientemente prolongada para presentar un riesgo para el paciente.

(*Nutr Hosp.* 2011;26:488-494)

DOI:10.3305/nh.2011.26.3.4679

Palabras clave: *Factor tiempo-temperatura. Puntos de control críticos. Dietas hospitalarias.*

Abbreviations

FNU: Food Service and Nutrition Units.
CVS-6: Center of Sanitary Vigilance of the State Health Secretariat.

Introduction

Many disease outbreaks of food origin are caused by foods prepared in Food Service and Nutrition Units (FNU) of hospitals.[1] These diseases are particularly important because they affect hospitalized patients who, in most cases, are immunocompromised and therefore at a higher risk of severe worsening of their clinical status due to the ingestion of contaminated foods compared to healthy individuals.[2] About 50% of the infections occurring in hospitalized patients are caused by pathogens that colonize the gastrointestinal tract. Nevertheless, little importance is attributed to food as the source of microorganisms that can cause hospital infections.[3]

In order to be a safe source of maintenance and recovery of health, food must be processed within a system of stage control, using materials of good quality, satisfactory hygienic-sanitary conditions and proper storage and transportation. When these conditions are not met, food may possibly become a source of disease.[4]

An indispensable procedure for the control of food quality is the adoption of the Hazard Analysis Critical Control Point (HACCP), whose objective is to identify and prevent sites, situations and actions involving hazards of food contamination by pathogens with consequent proliferation.[5] According to Oliveira et al.,[6] the implantation of the HACCP system during the stages of food processing for hospital diets results in a significant improvement of their microbiological quality.

Among the tools used by the HACCP for the identification and prevention of contamination is the control of food temperature, which is considered to be a critical control point. Several pathogenic microorganisms may multiply in food that is not kept at an appropriate temperature. Thus, depending on the microbiological load present in food and on the nutritional status of an individual, the contaminated food may provoke clinical manifestations ranging from mild symptoms that resolve spontaneously within a few hours such as nausea, vomiting and diarrhea to more severe and potentially fatal disorders such as botulism, salmonellosis and hepatitis A.[7]

According to the Judicial Directive CVS-6/99 of the Center of Sanitary Vigilance of the State Health Secretariat,[8] which is currently in effect in the state of São Paulo, hot foods are safe when they are kept at 65ºC or more for a maximum of 12 hours, at 60ºC for 6 hours, or below 60ºC for 3 hours, and cold foods are adequate when kept at a maximum of 10ºC for up to 4 hours or between 10 to 21ºC for up to 2 hours. By controlling the temperature and time of food processing, maintenance and distribution, improved food quality can be obtained and the risks of outbreaks of foodborne disease can be minimized.[9]

On this basis, the objective of the present study was to determine the variation in temperature at the end of preparation and during the maintenance, portioning and distribution of hospital diets of modified consistency, and the adequacy of the time-temperature factor throughout the process, with the identification of critical control points for the management of quality related to the monitoring of temperature.

Materials and methods

The study was conducted at a Food and Nutrition Unit (FNU) of the University Hospital of Ribeirão Preto, State of São Paulo, Brazil. The measurements of meal handling time and temperature were made in the area of general production responsible for the general diet, and in the dietary area responsible for the bland, viscous and liquid diets. The preparations were assessed individually for each diet and are presented in table I, which lists the menu to be distributed for lunch.

Temperature was measured with an Incoterm insertion thermometer, model 9790. The technique for the measurement of food temperature was based on the recommendations of the International Association of Milk, Food and Environmental Sanitarians,[10] which determine the geometrical center as the point where the highest temperature of a food is recorded during cooling and the lowest temperature is recorded during heat-

Table I			
Standard menu of the diets			
Diet	*General*	*Bland*	*Viscous*	*Liquid*
-------	---------	-------	---------	--------
Preparations	Rice	Rice	Rice	Soup
	Beans	Beans	Beans	Dessert
	Meat	Meat	Meat	
	Garnish	Garnish	Garnish	
	Salad	Dessert	Dessert	
	Dessert			

ing. The rod of the sensor was disinfected with 70% alcohol between the measurements of the different preparations. Temperature and time of measurement were recorded simultaneously.

Temperature and time were recorded at three stages of the production process. First, immediately at the end of preparation (corresponding to T_0 temperature), then during the maintenance period (T_1), corresponding to the mean time elapsed between the end of preparation and the beginning of distribution, and at the beginning of distribution, when the foods were duly portioned in an appropriate place in the FNU according to previous clinical prescription. Three different sites of destination of the portioned meals were considered (A, B and C): A, first site where distribution was started; B, site that received the meals at half the total time of distribution, and C, last site of meal destination. During the portioning stage, data were collected at the time when portioning was performed in the FNU for site A (T_{A1}), site B (T_{B1}), and site C (T_{C1}), and then at the end of distribution when the meal reached the patient, with two additional times being considered, i.e., the time when the first patient received the meal (T_{A2}, T_{B2} and T_{C2}) and the time when the last patient received it (T_{A3}, T_{B3} and T_{C3}). The measurements were made in triplicate for each time point and type of modified diet during 5 non-consecutive days. Figure 1 illustrates the design of the study.

The evaluation of the variation in temperature between stages was stratified in order to identify the periods during which the temperature decreased or increased for hot and cold foods, respectively. The following stages were analyzed: T_0 to T_1, T_0 to $T_{A1-B1-C1}$, T_0 to $T_{A2-B2-C2}$, $T_{A1-B1-C1}$ to $T_{A2-B2-C2}$, $T_{A1-B1-C1}$ to $T_{A3-B3-C3}$, $T_{A2-B2-C2}$ to $T_{A3-B3-C3}$, and T_0 to $T_{A3-B3-C3}$.

The total duration of the process, in minutes, was calculated on the basis of the variation in mean time between T_0 and T_3 for each of sites A, B and C. The adequacy of the time-temperature factor was calculated as established by the Judicial Directive CVS-6/99.[8] Thus, the minimum temperature considered to be adequate for T_0 was 74ºC, 70ºC for 2 minutes or 65ºC for 15 minutes in the geometric center of a hot food. The temperature

considered to be adequate for the holding, portioning and distribution steps was a minimum of 65ºC for a maximum of 12 hours (720 minutes), a minimum of 60ºC for 6 hours (360 minutes) or a value below 60ºC for 3 hours (180 minutes) in the geometrical center of hot foods. For cold foods, the adequate temperature was considered to be a maximum of 10ºC for a maximum time of 4 hours (240 minutes) or a value between 10 and 21ºC for 2 hours (120 minutes) in the geometrical center.

Methodology similar to that for foods was used for the measurement of the temperature of the water in the thermal containers used to hold the foods before they are distributed. Water temperature was measured on five non-consecutive days at the time when the first foods were stored in the container for later distribution. It should be pointed out that not all foods were packed in these containers due to insufficient size of the latter.

Data were analyzed statistically by the mixed effect linear regression model (random and fixed effects), with the level of significance set at $p < 0.05$ regarding temperature variation between processes. The analysis was carried out using the PROC MIXED feature of the SAS® 9 software.[11]

Results

The number of temperature measurements performed in all foods of all diets by the end of the 5 days of collection was 180 for the production stage, 270 for the portioning stage, and 1.620 for the distribution stage, for a total of 2.070 determinations.

During the first stage (T_0 to T_1), except for meat which suffered variation in all diets, only rice and the garnish of the bland and viscous diets and the beans of the bland diet suffered a reduction of temperature. During the last stage (T_2 to T_3), between the beginning and the end of distribution, there was little or no variation in temperature, with a significant change only occurring in rice and beans in some diets. The liquid diet did not vary in temperature during any of the stages cited above.

During all the other stages, many foods underwent a significant variation in temperature. During the stages

Table II

Foods with variation in temperature (p < 0.05) according to stage for each diet of modified consistency

Stage of temperature determination	Process	Foods with variation in temperature (p < 0.05)			
		General	*Bland*	*Viscous*	*Liquid*
From the end of preparation to the beginning of holding	T_0[a] to T_1[b]	M[c]	R[d], B[e], M, G[f]	R, M, G	–
From end of preparation to the beginning of portioning	T_0 to T_{A1}[g]	R, B, M, G, Sa[h], De[j]	R, B, M, G, De	R, B, M, G, De	De
	T_0 to T_{B1}[k]	R, B, M, G, Sa, De	R, B, M, G, De	R, B, M, G, De	De
	T_0 to T_{C1}[l]	R, B, M, G, De	R, B, M, G, De	R, B, M, G, De	De
From end of preparation to the beginning of distribution	T_0 to T_{A2}[m]	R, B, M, G, De	R, B, M, G, De	R, B, M, G, De	Sp, De
	T_0 to T_{B2}[n]	R, B, M, G, De	R, B, M, G, De	R, B, M, G, De	Sp, De
	T_0 to T_{C2}[o]	R, B, M, G, De	R, B, M, G, De	R, B, M, G, De	Sp, De
From the beginning of portioning to the beginning of distribution	T_{A1} to T_{A2}	R, B, M, G, Sa	R, B, M, G	R, B, M, G, De	Sp, De
	T_{B1} to T_{B2}	R, B, G	R, B, M	R, B, M, G, De	Sp
	T_{C1} to T_{C2}	R, B, G	R, B, M	R, B, M, G	–
From the beginning of portioning to the end of distribution	T_{A1} to T_{A3}[p]	R, B, M, G, Sa	R, B, M	R, B, M, G, De	Sp, De
	T_{B1} to T_{B3}[q]	R, B, M, G	R, B, M	R, B, M, G, De	Sp
	T_{C1} to T_{C3}[r]	R, B, M, G, Sa	R, B, M	R, B, M, G	Sp
From the beginning to the end of distribution	T_{A2} to T_{A3}	R	B	R, B	–
	T_{B2} to T_{B3}	R	–	R	–
	T_{C2} to T_{C3}	-	–	R	–
Total process From the end of preparation to the end of distribution	T_0 to T_{A3}	R, B, M, G, De	R, B, M, G, De	R, B, M, G, De	Sp, De
	T_0 to T_{B3}	R, B, M, G, De	R, B, M, G, De	R, B, M, G, De	Sp, De
	T_0 to T_{C3}	R, B, M, G, De	R, B, M, G, De	R, B, M, G, De	Sp, De

[a]End of preparation; [b]beginning of the maintenance period; [c]meat; [d]rice; [e]beans; [f]garnish; [h]beginning of portioning for the first site; [j]salad; [j]dessert; [k]beginning of portioning for the site at half the time of distribution; [l]beginning of portioning for the last site; [m]first dish to be distributed at the first site; [n]first dish to be distributed at half the time of distribution; [o]first dish to be distributed at the last site; [p]last dish to be distributed at the first site; [q] last dish to be distributed at half the time of distribution; [r]last dish to be distributed at the last site.

from T_0 to T_2 and from T_0 to T_3, except for salad in the general diet, all the foods of all diets underwent a significant change of temperature. From stage T_1 to T_2 and T_1 to T_3, the foods that predominantly showed a significant variation in temperature were rice, beans and garnish in the general diet, rice, beans, meat and garnish in the bland and viscous diets, and soup in the liquid diet. Table II lists the foods with a significant variation in temperature during the preparation, maintenance, portioning and distribution stages ($p < 0.05$).

Mean variation in temperature and mean duration of the process evaluated from the end of preparation to the end of distribution for each food in each diet are listed in table III. The foods that suffered the greatest reduction of temperature were those with the longest holding times, such as rice and garnish of the bland diet, meat of the general diet, and rice, chopped meat and garnish of the viscous diet.

At the end of the preparation, all foods of all diets were at a temperature of more than 74ºC, except for soup in the liquid diet. However, the temperature of the soup was above 65ºC, with the period of more than 15 minutes at this temperature being respected. Starting during the distribution stages, all hot foods were below 60ºC, but none of them exceeded the maximum tolerated time of 360 minutes at this temperature. The minimum and maximum waiting times were 124 and 231 minutes.

Among the cold foods, only salad exceeded 21ºC during a holding time ranging from 140 to 145 minutes. In contrast, dessert remained at temperatures ranging from 10ºC to 21ºC in all diets. However, dessert did exceed the maximum tolerable time of 120 minutes within this temperature range, with maximum holding times of 172 and 286 minutes.

During holding, temperatures that presented a risk were reached by 16.7% of the meats and 59% of the salads of the general diet, by 16.7% of the garnishes in the bland diet and by 20% of the meats and garnishes in the viscous diet. The same occurred at the end of distribution for 100% of the hot samples and of the salads and for 61% of the desserts. For all foods of all diets tested, the greatest variation in temperature during the period from holding to final distribution caused these stages of the production process to be of great importance as critical control points. The mean temperature of the water in the thermal containers used to hold the foods waiting for distribution was 66.9ºC.

Discussion

In the present study, all foods suffered significant variations in temperature considering the whole process, except for the salad of the general diet. At the

Table III
Variation in time and temperature from the end of preparation to the end of distribution at three sites according to food and to a diet of modified consitency

Food	Process	General Diet		Bland Diet		Viscous Diet		Liquid Diet	
		T_0^a-T_3^b (ºC)	Duration (minutes)	T_0-T_3 (ºC)	Duration (minutes)	T_0-T_3 (ºC)	Duration (minutes)	T_0-T_3 (ºC)	Duration (minutes)
Rice	T_0 to T_{A3}^c	82.4 (7.4)-37.8 (1.8)	138.8 (16.8)	90.6 (7.5)-33.6 (1.3)	209.8 (6.7)	87.4 (4.7)-36.2 (1.3)	214.2 (7.9)	–	–
	T_0 to T_{B3}^d	82.4 (7.4)-39.5 (3.5)	140.6 (18.1)	90.6 (7.5)-37.7 (2.9)	203.0 (8.7)	87.4 (4.7)-39.7 (2.0)	200.0 (11.1)	–	–
	T_0 to T_{C3}^e	82.4 (7.4)-38.0 (2.7)	155.8 (22.7)	90.6 (7.5)-38.2 (1.5)	221.0 (5.1)	87.4 (4.7)-40.0 (2.9)	222.5 (4.1)	–	–
Beans	T_0 to T_{A3}	85.0 (8.0)-35.0 (2.1)	129.0 (33.1)	83.2 (8.1)-31.8 (1.5)	172.8 (31.6)	83.2 (8.1)-33.4 (1.1)	179.2 (31.9)	–	–
	T_0 to T_{B3}	85.0 (8.0)-37.3 (3.1)	130.8 (29.2)	83.2 (8.1)-34.5 (1.5)	166.0 (23.0)	83.2 (8.1)-36.5 (0.7)	165.0 (25.8)	–	–
	T_0 to T_{C3}	85.0 (8.0)-34.7 (2.2)	138.5 (33.4)	83.2 (8.1)-33.7 (0.5)	183.5 (36.8)	83.2 (8.1)-35.2 (2.2)	187.5 (36.4)	–	–
Meat	T_0 to T_{A3}	78.6 (11.1)-36.4 (2.6)	186.8 (38.5)	82.0 (9.7)-32.8 (3.1)	130.8 (25.2)	87.0 (8.0)-34.4 (1.3)	172.2 (26.9)	–	–
	T_0 to T_{B3}	78.6 (11.1)-39.5 (5.9)	188.6 (36.4)	82.0 (9.7)-34.3 (1.0)	124.0 (29.5)	87.0 (8.0)-37.2 (1.3)	158.0 (28.6)	–	–
	T_0 to T_{C3}	78.6 (11.1)-33.7 (2.5)	213.3 (32.9)	82.0 (9.7)-37.5 (2.6)	148.5 (32.3)	87.0 (8.0)-36.0 (1.4)	181.3 (33.0)	–	–
Garnish	T_0 to T_{A3}	78.2 (7.0)-35.6 (1.1)	147.4 (30.3)	79.6 (11.7)-32.0 (1.6)	217.4 (9.6)	74.2 (11.3)-34.2 (1.3)	218.8 (15.1)	–	–
	T_0 to T_{B3}	78.2 (7.0)-37.1 (4.0)	149.2 (26.8)	79.6 (11.7)-35.4 (1.1)	210.6 (19.9)	74.2 (11.3)-36.7 (3.2)	204.6 (22.3)	–	–
	T_0 to T_{C3}	78.2 (7.0)-36.0 (1.8)	162.8 (33.3)	79.6 (11.7)-35.5 (1.3)	231.0 (17.2)	74.2 (11.3)-36.7 (4.0)	230.0 (19.9)	–	–
Salad	T_0 to T_{A3}	23.8 (1.9)-22.4 (2.4)	139.8 (49.9)	–	–	–	–	–	–
	T_0 to T_{B3}	23.8 (1.9)-24.5 (0.9)	141.6 (47.1)	–	–	–	–	–	–
	T_0 to T_{C3}	23.8 (1.9)-22.5 (1.9)	145.3 (52.9)	–	–	–	–	–	–
Dessert	T_0 to T_{A3}	16.8 (3.2)-21.4 (3.6)	171.6 (53.4)	16.8 (3.2)-22.0 (3.2)	197.5 (2.1)	16.2 (5.0)-22.6 (2.5)	199.0 (20.7)	10.0 (1.0)-25.8 (8.1)	280.0 (12,7)
	T_0 to T_{B3}	16.8 (3.2)-21.9 (3.6)	173.4 (46.1)	16.8 (3.2)-22.2 (2.2)	186.5 (4.9)	16.2 (5.0)-23.5 (2.0)	191.0 (6.1)	10.0 (1.0)-20.9 (2.6)	264,5 (6,4)
	T_0 to T_{C3}	16.8 (3.2)-20.5 (3.7)	182.0 (57.9)	16.8 (3.2)-21.7 (2.2)	213.0 (1.0)	16.2 (5.0)-22.0 (2.2)	225.5 (12.0)	10.0 (1.0)-20.2 (4.5)	286,5 (2,1)
Soup	T_0 to T_{A3}	–	–	–	–	–	–	69.6 (8.8)-32.8 (7.4)	173,0 (41,1)
	T_0 to T_{B3}	–	–	–	–	–	–	69.6 (8.8)-39.5 (4.1)	166,0 (20,4)
	T_0 to T_{C3}	–	–	–	–	–	–	69.6 (8.8)-46.5 (12.1)	197,3 (23,4)

[a] End of preparation; [b] end of distribution; [c] last dish to be distributed at the first site; [d] last dish to be distributed at the half time of distribution; [e] last dish to be distributed at the final site. Data are reported as mean (standard deviation).

end of preparation, all foods reached the recommended temperatures, except the salad of the general diet which in general was 3.8ºC above the temperature recommended. All foods of the general, viscous and liquid diets suffered variations in temperature from the end of preparation to the beginning of portioning, whereas this occurred only for the dessert of the liquid diet.

The foods continued to vary considerably in temperature during the stage from the end of preparation to the beginning of distribution, including the soup of the liquid diet, which had not shown an important fall in temperature up to this stage, and with the exception of the salad of the general diet, which remained at an inadequate temperature. All foods of all diets suffered variations in temperature during the stage from the beginning of portioning to the beginning of distribution, whereas this occurred only for rice and beans between the beginning and the end of distribution. At the end of the process, all hot foods had suffered a reduction of temperature (reaching less than 40ºC), whereas the cold foods had become warmer (reaching more than 20ºC).

Ehiri et al.[12] and Rosa et al.,[13] like in the present study, also observed the temperatures at the end of cooking were adequate (reached from 70 to 89ºC), whereas during holding until the end of distribution all hot foods lost heat (reached from 39 to 54ºC) and cold foods reached a higher temperature, in analysis of 120 meals prepared at home[12] and in meat preparations in schools.[13] During the time of distribution of hot preparations in self-service restaurants, temperature was inadequate for 33.3% of the meals,[14] and around 25.0% were below 60ºC,[15] and some products such as fried fish and chicken were exposed to ambient temperature for prolonged periods of time (about 2 hours), and meats and garnishes were also at temperatures of less than 60ºC on both heated counters[16]. Including, Silva et al[17] noted that the school diets not submitted to reheating at the time of distribution presented temperatures of less than 50ºC.

Inadequate food temperatures can favor the development and proliferation of bacteria such as *S. aureus, Listeria, Yersinia,* and *Salmonella* and of anaerobic microorganisms,[7,18-21] possibly causing foodborne disease outbreaks.[7,18-21] Even if these foods reach the correct temperature during preparation, according to Rosa et al[13], heat destroys in part or in full the bacterial flora but does not have a residual effect, i.e., once its action ends, recontamination and/or microorganism multiplication may occur. For this reason, products submitted to heat treatment should be consumed immediately.

The possible reasons for the undesired variation in temperature throughout the process of production of

most foods, both cold and hot, were: an insufficient number of thermal containers holding the preparations during the stages of maintenance, portioning and distribution, their inadequate temperature and/or delay in the delivery of the meal.[7] In the present study, the mean water temperature of the thermal distribution containers was found to be 66.9°C, a value below the 80°C recommended by the CVS-6 Judicial Directive[8]. Although in the present study the calculated time-temperature factor was not considered inadequate to the point of causing the proliferation of microorganisms according to the recommended by the sanitary health agencies,[8] it is possible to state that time may have contributed to this variation in temperature.

Regarding the limitations of the present study, some variables could not be controlled. At the end of preparation, the diets were divided into small portions and packaged in different places from the holding period to the time of distribution, a fact that caused different variations in temperature at each site. For example, foods placed in their own pans underwent a greater variation in temperature than those placed in the thermal container. Also, in the containers in which a smaller amount of food was placed the foods underwent a greater variation compared to the containers with larger amounts, and the food lying on the surface presented a much greater variation than the food in the middle and at the bottom of the container. In parallel, the thermometer used for the measurements took 1 to 3 minutes to correctly determine the temperature of the food and since all the preparations of 4 different diets were evaluated at the same time, it was not possible to determine the temperature of all foods simultaneously, with a delay of a few minutes between measurements.

Additionally, hospitalized patients usually have less appetite[22] and a preconceived notion of dissatisfaction with hospital meals,[23] thus, the temperature of the meal is strongly associated with its degree of acceptance.[23-26] Since we did not measure the sensory quality of the foods, we cannot make any comment about this important parameter.

In conclusion, the evaluation of the various stages of production revealed that, for hot foods, the cooking temperature was adequate in all determinations, but was followed by a significant fall during the subsequent stages (holding and distribution). For cold foods, the temperature was inadequate from the very beginning of evaluation. However, the time-temperature factor was adequate for all foods evaluated, i.e., the exposure to inadequate temperature did not last long enough to pose risks to the patient.

The determination and recording of time and temperature in different steps of meal production at a particular service may help in detecting the problems related to the risk of pathological microorganisms proliferation in that specific service, in order to propose more efficient corrective acts to avoid foodborne diseases in patients from the corresponding Hospital Food Service and Nutrition Unit.

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