

**FOOD SAFETY RISK FACTORS IN A HOSPITAL FOOD SERVICE UNIT
SERVING LOW MICROBIAL DIETS TO IMMUNE-COMPROMISED
PATIENTS**

Hanekom SM^{1*}, Vermeulen EE², W Oldewage-Theron³



Grieta Hanekom

*Corresponding author email: grieta.hanekom@nwu.ac.za

¹Doctor, TReNDS, a North-West University Centre of Excellence in Nutrition, North-West University, Private Bag x6001, Potchefstroom, South Africa, 2520

²Student, TReNDS, a North-West University Centre of Excellence in Nutrition, North-West University, Private Bag x6001, Potchefstroom, South Africa, 2520

³Professor, Institute of Sustainable Livelihoods, Vaal University of Technology, Vanderbijlpark, South Africa, 1900

ABSTRACT

The objective was to investigate the food safety and hygienic status in a hospital food service unit (FSU) serving low microbial diets (LMDs) to immune-compromised patients, by means of an audit (questionnaire) and bacterial samples to validate the audit findings. The primary research was done in a FSU of a 350-bed hospital in Gauteng, South Africa. One audit was done in ten areas (for receiving, storage, preparation, serving/distribution, customer, premises and equipment hygiene, staff dress code, staff premises and rest areas, and quality assurance/records procedures) of the FSU using a pre-tested form based on Hazard Analysis Critical Control Points (HACCP) principles/standards. The audit form consisted of a set number of questions for each one of the ten areas, with a possible maximum score of two (2) for each question. A set of five (5) questions for the staff premises was set, with a possible maximum score of 10. If a score of only two (2) were then reached, a % was calculated to score the area, in this case 20%. In addition to the audit, four surface swabs (patient food serving tray, chef's gloved hands, chopping board for salads and sandwiches, microwave oven door handle) and four food samples (green beans and potatoes, chicken gravy, cold meat cuts, quiche) were randomly taken during the survey. The samples were tested to assess the microbiological safety of the foods prepared for *Total aerobic plate count* (TAPC), *Escherichia coli*, total *Coliforms*, *Staphylococcus aureus* and *Salmonella spp.* The results of the audit, surface and food samples were used to evaluate possible food and safety risks in the FSU according to internationally approved HACCP standards. All ten areas audited were below the set standard (> 80% value) with an average score of 41.1%. The service and distribution area had the highest score (69.4%), while the quality procedures and records division had the lowest score (5.6%). The microbiological tests showed relatively high microbial counts for a number of samples. The results of this study suggests, that even though so called safety procedures were in place, they were not followed, which could have severe health implications for the critically ill. The results of the study support the important role of food and safety protocols in FSUs to lower food safety risks when providing food that is safe for immune-compromised patient use.

Key words: HACCP, food safety, immune-compromised, critically ill

INTRODUCTION

Food safety is defined as an assurance that food will not cause harm to consumers when it is prepared and/or eaten according to its intended use [1]. Food-borne illness caused by micro-organisms is common in food service institutions [2]. Although this matter is of some concern for the general public, it is a matter of high concern for immune-suppressed patients (organ transplant, cancer and HIV/AIDS), for whom food-borne infections can be life threatening [2, 3]. Other individuals at increased risk of developing more severe outcomes from micro-organisms are the young, elderly and pregnant women [4].

The use of low microbial diets (LMDs) for immune-suppressed patients is controversial [2, 3, 5]. Low microbial diets is intended to reduce the ingestion of bacterial and fungal contaminants by exclusion of uncooked fruits, vegetables, cold cuts, undercooked eggs and meat, un-sterilized water, un-pasteurized milk produce and soft cheeses [1, 6]. Some argue that insufficient research and high cost of LMDs is enough reason not to implement it, while others argue that despite lack of clinical evidence, it is prudent to be cautious and continue to provide immune-suppressed patients with LMDs [3, 5]. Wilson [6] suggested that to protect the immunosuppressed patient from pathogens, a regime to eliminate any possible high-risk sources of pathogens should be followed by providing LMDs. Nutritional support is considered by healthcare providers as an integral part of supportive care of immune-suppressed patients. Not only should nutritional support provide the necessary nutrients for body function of the immune-suppressed patient, but it should also entail the prevention of infection [7].

Enteric bacteria most commonly associated with food borne infections are *Salmonella*, *Camphylobacter*, *Shigella* and *Escherichia coli* [4], and associated mortality rate is three times higher than in healthy persons [8]. *Salmonellosis* is estimated to be nearly 20 times more common in AIDS patients than in healthy persons [9]. Approximately 75% of reported food borne illness in the United States of America is due to mishandling of food in FSUs [10]. A study by Helms *et al.* [8] showed that 55.2% out of 99.4% of patients treated in hospitals for gastro-intestinal infections, had *Salmonella* infection. The massive *Escherichia coli* outbreaks in healthy schoolchildren in Japan in 1996 was found to be due to consumption of contaminated radish sprouts served at centralized lunch programs [11]. An important aspect in prevention of similar food borne illnesses in immune-compromised patients is the food safety system the FSU uses.

A formal programme for promoting and maintaining food safety is essential in any setting where immune-compromised patients are cared for. Therefore, the Hazard analysis and critical control points (HACCP) program is an ideal, proactive approach to ensure food safety [12]. HACCP is defined as a management system ensuring products which are microbiologically, chemically and physically safe [13, 14]. This system identifies potential hazards before problems occur. It is applied to the food chain from purchase to consumption. It ensures the safety of food and nutrition

products while creating a process for corrective action and continuous improvement rather than relying on spot checks of manufacturing processes and random sampling of finished products to ensure safety [12, 14, 15]. This program, first developed for the National Aeronautic and Space Administration (NASA) food space program consists of seven main principles namely: 1) Identify hazards and assess their severity and risks; 2) Identify the Critical Control Points (CCP) in food preparation; 3) Establish critical limits for preventive measures associated with each identified CCP; 4) Establish procedures to monitor CCPs; 5) Establish the corrective action to be taken when monitoring shows that a critical control limit has been exceeded; 6) Establish effective record keeping system that document the HACCP system; and 7) Establish procedures to verify that the system is working [16]. HACCP principles have since become a widely used reference standard for safe food practices. Even though clear controversy exists on whether to use LMDs or not, safe food handling and general HACCP guidelines can ensure that all sick patients in hospitals get the advantage of receiving safe food. Unless it can be established that LMDs provide no protective effect of reducing risks of infection in immune-compromised patients, two assumptions can be made. Firstly, that LMDs provide some degree of protection against infections attributed to food sources and unsafe food practices, and secondly, that it may be advantageous to continue the use of food service safety protocols that avoid foods potentially containing harmful bacteria to decrease risk of infection for all hospitalized and immune-suppressed patients [3].

Because of poor record keeping by the hospital nursing and food service staff, no previous incidences of food borne illnesses in immune-compromised patients linked to food safety and hygiene practices has been documented. Although the first signs of food borne illnesses (diarrhea) was documented in some cases, it was not investigated any further to link it directly to food and hygiene practices, but mostly regarded as the side effects of medicine like antibiotics. The objective for this study was therefore, to investigate the food safety and hygiene status in a hospital FSU serving LMDs to immune-compromised patients, by means of an audit (questionnaire) based on the HACCP principles and bacterial samples.

SUBJECTS AND METHODS

An investigative study was conducted in the FSU of a 350-bed private hospital in Gauteng, South Africa. The FSU served approximately 1200 meals per day of which an average of 21 meals was served to immune-suppressed patients. The composition and cooking procedures were similar to normal and other diets, but served without fresh garnishes or salads. Each plate was sealed with cling film, delivered to the ward and kept on the serving counter until patients were ready to eat. The food was then heated in a microwave oven and served still sealed. Cutlery was disinfected in boiling water before service.

Methods and HACCP Audit

Microbial data generated through sampling were used to investigate the hygienic performance of the FSU, comparing it to a HACCP audit. Four randomly selected

food samples (each weighing 25g), including green beans and potatoes (stewed green beans), chicken gravy, cold meat cuts, and quiche were placed in sterile plastic containers obtained from a registered pathologists on the day of sampling for measuring of TAPC in colony forming units; *Coliform*, *Escherichia coli*, *Staphylococcus aureus* and *Salmonella spp.* These four food samples from plates destined for immune-suppressed patients were collected 30 minutes after preparation, at the end of the dishing up period. Four surface samples (25cm²) for a patient food tray, chef's hands (gloves), chopping boards used in the salad, cold dessert and sandwich area, and the microwave oven door handle, were swabbed and sealed in a sterile container for measuring of TAPC in colony forming units; *Coliform*, and *Escherichia coli*.

All eight samples (food and surface) were stored immediately after collection in a temperature controlled fridge (2°C – 5°C) to minimize bacterial growth [17]. These food samples and swabs were delivered to the laboratory within 12 hours of the audit while temperature control was maintained.

An unannounced, independent audit to evaluate current HACCP practices in the FSU, was conducted by the authors. A pre-designed HACCP audit form developed and tested by *Societe Generale de Surveillance* Group (SGS), South Africa Proprietary (PTY) Ltd, accredited with the South African national accreditation system (SANAS), was utilized. The seven HACCP principles were incorporated in the form for the ten areas (categories) identified for evaluation (Table 1) of adherence to the set hygiene and food safety principles. Each area, consisting of its own set of questions, was scored as follows: 2 = *Excellent, HACCP standards achieved*; 1 = *Need action plan to improve*; 0 = *Not up to HACCP standards*. Actual scores for each area (and its own set of questions) were calculated as percentage of maximum possible score. A score <80% for any area indicates the need to implement CCP to upgrade current food and hygiene standards and a score >80% means the facility complies to current HACCP standards, as indicated on the audit form. The audit data was analyzed with formulas using Microsoft Excel spreadsheets.

Bacteriological cultures

Ten grams (10g) of each food sample were weighed and diluted in 90 milliliters (m) of peptone water, and then placed in a Stomacher for 2 minutes. Subsequent 10-fold dilutions were made to 10⁻⁶. **Total Aerobic Plate Count:** TAPC is intended to indicate the level of micro-organisms in a product [18, 19]. Duplicate dilutions were plated by pour-plate method using South African Bureau of Standards (SABS) International Organization for Standardization (ISO) method 4833:2003. Average counts obtained were expressed as colony-forming units per gram of food (cfu/g) [20, 21]. **Coliform count and Escherichia coli:** *Coliforms* are defined as gram-negative rods that produce acid and gas from lactose during metabolic fermentation [20, 21]. Duplicate dilutions were plated by pour-plate method using violet red agar (VRA) according to SABS ISO method 4832:1991. *E.coli* was differentiated from other *Coliforms* using standard microbiological tests. A positive indole test and presence of short Gram-negative rods were taken as positive for presence of *E.coli* [20, 21]. Most *E.coli*

strains are harmless and live in the intestines of healthy humans and animals, but the 0157:47 strain can produce powerful toxins and cause severe illness [20, 21]. *E.coli* count should not be more than 100cfu/25cm². *Staphylococcus aureus*: Dilutions were plated onto Baird-Parker agar base containing appropriate supplements, using the spread-plate method, according to ISO method 6888:1993E. Five typical colonies were picked off and the coagulase test was conducted using *Staphylase* Kit Dir 595. Coagulase-positive colonies were recorded as *S.aureus* [20, 21]. *Salmonella*: Ten grams (10g) of each food sample taken were placed into 225 ml of buffered peptone water and incubated at 37°C for 24 hours according to SABS ISO method 6579:2002. Presence of *Salmonella* was determined by means of laboratory tests designed to identify this form of bacteria [20, 21].

Permission to conduct the audit was obtained from the Food Service manager of the FSU and the Safety, Health, Environment and Quality (SHEQ) coordinator of this medical hospital.

RESULTS

Results gathered from the audit are represented in Table 1. The following 10 areas with actual and maximum possible point scores and % given in brackets, were evaluated: 1) receiving [10/22: 45.5%]; 2) dry and refrigerated storage [16/50: 32%]; 3) sub-zero storage [3/18: 16.3%]; 4) preparation and production [30/62: 48.4%]; 5) service and distribution [25/36: 69.4%]; 6) customer area [15/22: 68%]; 7) premises and equipment hygiene [19/42: 45.2%]; 8) staff standards [11/18: 61%]; 9) sanitary facilities [2/10:20%]; and 10) quality procedures and records [1/18:5.6%]. None of the ten areas audited met acceptable food safety standards (average for all 10 areas = 41.1%). Category 5 had the highest (69.4%) and category 10 the lowest (5.6%) scores. The score for category 7 was low at 45.2%. Staff premises (sanitary facilities) category 9, scored even lower at 20%.

Microbial loads on the patient food tray and chopping board both had higher than permitted counts of 870 cfu/25cm² and 350 cfu/25cm², respectively for *E.coli* (normal < 100 cfu/25cm²), and >1000 cfu/25cm² for TAPC and *Total Coliforms (TCs)*, respectively (normal < 100 cfu/25cm²) (Table 2).

Surprisingly, the chef's hand and the microwave oven door handle in the ward kitchen showed no microbiological activity at all. TAPC (Table 3) for green beans and potato, cold meat cuts and quiche were within normal range. Chicken gravy had a high TAPC of 12700 cfu/g, *E.coli* of 280 cfu/g and *TCs* of 2760 cfu/g. The cold meat cuts had an *E.coli* count of 30 cfu/g where none should be present while the *TCs* were barely below normal range. No *Staphylococcus aureus* or *Salmonella spp* were found on any food item.

DISCUSSION

Contamination of food due to poor hygiene practices, temperature control, receiving of contaminated food from suppliers, incorrect storing regimens and cross contamination may be a serious problem when the HACCP audit report and laboratory analysis for this study is investigated. Contaminated equipment was found, which supported cause for concern that surface hygiene practices in the FSU was not properly executed. The low dishwasher temperature (<38°C) is cause for concern, because only with very hot water (>82°C) can thermal disinfection be obtained [14]. No disinfection liquids or bleach to disinfect crockery and cutlery without hot water was available, according to the audit report. High microbial loads were found in some of the surface swabs (Table 2). Both the patient food tray and chopping board contained high counts of *Coliforms*, *E.coli* and TAPC.

Raspor and Jevšnik [1] stated that “safe food is a consumer’s basic right”. The nature of food and extent to which it is handled make the opportunity for contamination commonplace. A major goal, according to Dezenhall *et al.* [19] of any hospital FSU should be to provide food that is microbiologically safe because hospitalized patients with impaired immunity are more susceptible to infection and consequent morbidity and mortality [18, 19].

According to the Food and Drug Administration (FDA) [22] and Barrie [14] several important factors could cause food borne illness in a FSU. These factors are 1) food received from unsafe and contaminated sources, 2) inadequate cooking and re-heating temperatures, 3) improper holding temperatures, 4) contaminated equipment, 5) preparing food too long in advance, 6) cross contamination between raw and cooked food, and 7) poor personal hygiene [14, 22, 23]. On visual inspection it was found that the FSU received food from suppliers that were not HACCP approved which meant that food could have been bacterially compromised before reaching the FSU. It is the responsibility of all parties included in the food chain to ensure food traceability and food safety by internal control in all production phases according to HACCP principles [1]. The fact that no food cooking or holding temperatures were recorded in this FSU may have led to temperature abuse and eventual spoilage, specifically with regard to chicken gravy as confirmed by the microbial results [17]. The importance of hand washing and good personal hygiene practices are highly emphasized and may prevent contamination and food borne illnesses, especially in immune-compromised patients.

Food handlers must be educated by an infection control team in the significance of safe handling of food by addressing good manufacturing practices (GMP) and hygienic food preparation topics such as hand washing procedures, sterilization of equipment and work surfaces, and elimination of cross-contamination, to ensure consumer protection from food borne illness [1, 14, 24]. However, FSU management should also ensure that the necessary cleaning materials are available for use by food handlers. The audited FSU also complied poorly to the South African Occupational Health and Safety Act [25]. Although a copy of the Act was filed, no monthly audits

or formal induction training on health and safety issues had been done, a first-aid box was not available, and safety user instructions were not displayed at equipment. Assured safe catering is a practical method based on risk assessment (CCP) and involves investigating each operation (task) step by step.

The non-identification of weak points in the general management of food production and correction thereof in this FSU, are cause for concern [1, 26]. A systemic approach, such as the HACCP system, to identify, evaluate and control food safety hazards must be carried out to achieve food safety and to prevent food borne illnesses [26, 26, 27]. Although oral reports of specific training relevant to work was given, no record to this account could be found. If training and re-training takes place on a regular basis, no contaminated food items should be found on the premises, provided all necessary precautions are taken and cleaning and sanitizing materials are available in the FSU. Legnani *et al.* [28] performed 236 inspections for ± 10 years on 27 catering establishments in the province of Ferrara, Italy, after the HACCP system was introduced and educational programs for food staff was undertaken [28]. Their results revealed an improvement in the microbiological quality of food and equipment. The positive impact of training on safe food handling practices can improve from 11.7% to 75% as soon as two months after training [10].

A study by Shojaei *et al.* [29] showed that poor personal hygiene by food handlers frequently contributed to outbreaks of food borne illnesses caused by enteric bacteria [29]. In the audited FSU the same cutting boards were used for raw and cooked food, without sufficient sterilizing in between the tasks. The presence of *E.coli* on surfaces may be ascribed to poor hygiene practices as a result of the absence of cleaning materials in both the staff sanitary facilities and the FSU, as identified by the audit (20% score achieved). Only a small amount of these enteric bacteria are required to cause illness, especially in immuno-compromised patients [17]. The fact that no microbial activity was found on the chef's gloves may be ascribed to the changing of gloves just before the swab was taken. Enteric diseases are among the most devastating problems in persons with AIDS, where 50-90% suffers from chronic diarrhea illnesses which can be fatal. The rate of diarrhea in HIV-infected patients in developing countries are higher than in developed countries, reflecting more frequent exposure to enteric pathogens. The fact is that outbreaks of food borne infection in hospitals are, however, preventable [30].

Even though patients did receive LMDs in this survey, some of the food items still had high microbial counts which increased the risk of food borne illnesses. From the audit it became clear that large numbers of food items were stored directly on floors in opened tins and containers without covering while no "use by" dates were evident and most of storage shelves were rusted. These practices could have contaminated food and contributed to high microbial counts found on some of the food items. The cold meat cuts had high counts of several of the tested microbes, which could be explained by poor personal and equipment hygiene practices, and removed from the fridge long before use, leaving it at room temperature. Poultry products support the growth of disease-causing and spoilage micro organisms. The intestinal track and

skin of poultry may contain a variety of food borne disease bacteria, including *Salmonelle spp.*, *E.Coli* and *Campylobacter jejuni* [17]. Chicken breasts were left at room temperature ($\pm 25^{\circ}\text{C}$) rather than the cold storage facility, for defrosting. Rapid bacterial growth takes place at temperatures $>21^{\circ}\text{C}$, while most disease-causing bacteria can grow within a range of 5°C to 57°C [17]. The major causes for concern in these instances are the poor hygiene and food safety protocols present in the FSU. It is the authors' opinion that it may well be wise to eliminate products, such as chicken, which may be hazardous to patients when not handled according to strict hygiene and safety measures and HACCP principles, from the menu.

CONCLUSION

The results of the study confirmed that, besides mainly focusing on the selection of food items allowed and cooking methods used in LMD, the type of food service and food and safety protocols followed, could play an important role in providing food that is safe for immune-compromised patient use. The implementation of HACCP system, while not without its own challenges, is essential to produce hygienically prepared meals safe for human consumption, especially when the patient is immune-compromised. It is important to take into account any co-existing diseases such as HIV/AIDS when food hygiene becomes a problem, because of increased morbidity rate [8].

Results of this study should also serve as a warning for all other hospital FSUs to ensure safe food for all patients. Although this was an investigative study and an intervention process was not part of this study, the data can still be of substantial value for future use in planning and implementation of food safety measures in a hospital FSU. A follow up study is recommended where a detailed HACCP action plan, after a first phase of inspection has taken place, is planned and implemented. Intensive personnel training and motivation will form an essential part of the HACCP implementation. After HACCP implementation three follow-up audits should be done after a selected time lapse by independent auditors to prevent bias. The results of these audits could be compared to investigate improvement in the quality of food as well as safety standards. Standard audit forms and patient questionnaires can then be used when food borne illnesses are documented during the hospitalization period of immune-compromised patients. Oral food intake, patient satisfaction and nutritional status of patients could also form part of a follow-up study. Bacterial analysis of food and surface areas can be used to correlate improvements and identify possible topics for retraining.

The results of the audits could be compared to investigate the quality of food as well as safety standards. Standard audit forms and patient questionnaires can then be utilised when food borne illnesses are documented during the hospitalization period of immune-compromised patients. Oral food intake, patient satisfaction and nutritional status of patients could also form part of a follow-up study. Bacterial analysis of food and surface areas can be used to correlate improvements and identify topics training of staff in the FSU.

Table 1: HACCP audit report (hygiene and safety)

Area in FSU	^a Percentage scored (%)	Actual points scored	^b Maximum possible points score	Specific observations made during the Audit	Cause for concern
1. Receiving area	45.5%	10	22	No cleaning schedule for floors, cleaned only once daily. Floors cleaned on Tuesdays with industrial machine. No expiry date or temperature recordings for perishable food items on receiving and while stored.	Contamination. Incorrect food storage. Inadequate temperature control.
2. Storage areas: Dry Storage Refrigerated Storage	32%	16	50	Products not labeled; bins without lids, torn boxes and packaging not removed from storage. Open goods not stored in applicable, closed containers; "use by" dates absent. Store room shelves rusted; in poor repair. Food items stored directly on floors.	Poor stock control and rotation. Poor stock rotation. Potential unfit/unsound food. Incorrect food storage.
3. Sub-zero Storage	16.7%	3	18	Freezers floors slippery; ice build-up evident. Cooked produce re-frozen for later use.	Inadequate temperature control. Incorrect food storage.
4. Preparation/ Production	48.4%	30	62	Chicken breasts defrosted at room temperature (>25°C). Separate food preparation areas not formally identified. Perishable items removed from cold storage long before needed. No temperature control points. No thermometer available. Anti bacterial soap and paper towels only available at one hand wash basin in the FSU. No sanitizer available to clean work surfaces before, during and after preparation. Water in preparation and pot wash sinks very dirty, not sufficient chemicals available to clean pots with.	Food defrosted by improper method and temperature. Cross contamination. Inadequate temperature control. Cleaning schedule/standards.

Area in FSU	^a Percentage scored (%)	Actual points scored	^b Maximum possible points score	Specific observations made during the Audit	Cause for concern
				Some food for lunch (13:00) fully prepared by 10:30.	
5. Service/ Distribution	69.4%	25	36	No hand sanitizer and gloves available.	Cross contamination. Food borne illnesses.
6. Customer Area	68%	15	22	Tables not cleaned according to schedule, no antibacterial agent used in cleaning. Tray slide rails had evident grease and grime build-up. No sneeze guard over Bain-Maries to protect food from contamination.	Cleaning schedule/standards.
7. FSU Premises and Equipment Hygiene	45.2%	19	42	General lack of hygiene, very little-no cleaning agents evident. Dishwasher temperature <38°C (recommended >65°C), no disinfectant available	Cleaning schedule/standards.
8. Staff Standards	61%	11	18	Staff uniforms, apron dirty, open toe sandals and jewelry worn	Cleaning schedule/standards.
9. Staff Premises (Sanitary facilities)	20%	2	10	Only one working toilet for all staff members, showers and hand dryer not working, lockers old and rusted, hole in ceiling, mirror broken. No anti bacterial soap or paper towels.	Cleaning schedule/standards. Cross contamination.
10. Quality Procedures/ Records	5.6%	1	18	No quality control records available. No temperature recordings for: any food area at any time; cold and sub-zero storing; hot or cold food holding. Frying oil not replaced weekly, no daily hygiene or any other inspections (e.g. stock control) for any area available.	Safety and cleaning standards/schedule.
Average for FSU	41.1%				

^aScores <80% for any area = implement CCPs to upgrade current food and hygiene standards.

Score >80% = facility applies to HACCP standards.

^bMaximum possible points scored: 2=Excellent, HACCP standards achieved

1=Need action plan to improve

0=Not up to HACCP standards

Table 2: Microbiological report of surface samples (n=4)

Analysis	^a Normal counts for swabs taken	Patient food tray	Chef hand (latex gloves)	Chopping board – salad, cold desserts, sandwich area	Microwave oven door handle – ward kitchen
<i>TAPC</i> (cfu/25cm ²)	0-100	>1000	ND	>1000	ND
<i>Total Coliforms</i> (TC) (cfu/25cm ²)	0-100	>1000	ND	>1000	ND
<i>E. coli</i> (cfu/25cm ²)	0-100	870	ND	350	ND

^aRegulations Governing Microbiological Standards for Foodstuff and Related Matters (R.692 of May 1997)

ND = None detected

Table 3: Microbiological analysis of food samples (n=4)

Food Sample	TAPC	Normal	EC	Normal	TC	Normal	SA	Normal	S	Normal
	(cfu/g)	value ^a	(cfu/g)	value ^a	(cfu/g)	value ^a	(cfu/g)	value ^a	(cfu/g)	Value ^a
Green beans & potatoes	490	<100000	ND	A	ND	<10	ND	A	A	A
Chicken gravy	12700	<10000	280	A	2760	<100	ND	A	A	A
Cold meat cuts	1220	<200000	30	A	190	<200	ND	A	A	A
Quiche	18700	<20000	ND	A	30	<50	ND	A	A	A

TAPC = Total aerobic plate count; EC = *Escherichia coli*; TC = Total Coliforms; SA = *Staphylococcus aureus*; S = *Salmonella* spp /g; ND = None detected; A = Absent

^aRegulations governing Microbiological Standards for Foodstuff and Related Matters (R.692 of May 1997)

REFERENCES

- 1 **Raspor P and M Jevšnik** Good nutritional practice from producer to consumer. *Crit. Rev. Food. Sci. Nutr.* 2008; **48**: 276-292.
- 2 **Todd J, Schmidt M, Christain J and R Williams** The low bacteria diet for immunocompromised patients. *Cancer Practice* 1999; **7**:205-207.
- 3 **French MR, Levy-Milne R and D Zibrik** A survey of the use of low microbial diets in pediatric bone marrow transplant programs. *J. Am. Diet. Assoc.* 2001; **101**: 1194-1198.
- 4 **Gerba CP, Rose JB and CN Haas** Sensitive populations: who is at greatest risk? *Int. J. Food. Microbiol.* 1996; **30**:113-123.
- 5 **Muscaritoli M, Grieco G, Capria S, Iora P and R Fanelli** Nutritional and metabolic support in patients undergoing bone marrow transplantation. *Am. J. Clin. Nutr.* 2002; **75**:183-190.
- 6 **Wilson B** Dietary recommendations for neutropenic patients. *Sem. in Oncol. Nurs.* 2002; **18**: 44-49.
- 7 **Moody K, Charlson ME and J Finlay** The Neutropenic Diet: What's the Evidence? *J. Ped. Hemat/Oncol.* 2002; **24**:717-721.
- 8 **Helms M, Vastrup P, Gerner-Smidt P and K Mølbak** Short and long term mortality associated with foodborne bacterial gastrointestinal infections: registered based study. *BMJ* 2003; **326**:357.
- 9 **Hayes C, Elliot E, Krales E and G Downer** Food and water safety for persons infected with Human Immunodeficiency Virus. *CID* 2003; **36**:S106-109.
- 10 **Martin KE, Knabel S and V Mendenhall** A model train-the-trainer program for HACCP-based food safety training in the retail/foodservice industry: an evaluation. *J. Ext.* 1999; **37**. Available from <http://www.joe.org/joe/1999june/a1.html> assessed 10 July 2008.
- 11 **Mermin JH and PM Griffin** Invited commentary: Public health in crisis: Outbreaks of *Escherichia coli* 0157:H7 infection in Japan. *Am. J. Epidemiol.* 1999; **150**:797-803.
- 12 **Stamey J** Protecting residents from foodborne illnesses. *Nursing Home Magazine* 2006; June: 48-56.
- 13 **Strohbehn C, Sneed J and SA Gilmore** Food Safety Practices and Readiness to Implement HACCP Programs in Assisted-Living Facilities in Iowa. *J. Am. Diet. Assoc.* 2004; **104**:1678-1683.

- 14 **Barrie D** The provision of food and catering services in hospitals. *J. Hosp. Infec.* 1996; **33**:13-33.
- 15 **Riswadkar AV** The Hazard Analysis and Critical Control Point System for Food Processors. *Am. Soc. Safety. Eng.* 2000; JUNE: 33-36.
- 16 **Payne-Palacio J and M Theis** Introduction to Foodservice. Pearson Prentice Hall. 2009.
- 17 **McSwane D, Rue N and R Linton** Essentials of food safety and sanitation. Pearson Prentice Hall; 2005.
- 18 **Askarian M, Kabir G, Aminbaig M and ZA Memish** Knowledge, attitudes and practices of foodservice staff regarding food hygiene in Shiraz, Iran. *Infect. Control. Hosp. Epidemiol.* 2004; **25**: 16-20.
- 19 **Dezenhall A, Curry-Bartley K, Blackburn SA, De Lamerens S and AR Khan** Food and nutrition services in bone marrow transplant centers. *J. Am. Diet. Assoc.* 1987; **879**: 1351-1353.
- 20 **Martins JH** Socio-economic and hygiene features of street food vending in Gauteng. *SA. J. Clin. Nutr.* 2006; **19**: 18-25.
- 21 **Maturin LJ** Aerobic plate count. In: Bacteriological Analytical Manual. Rockville, MD:US Food and Drug Administration Center for Food Safety and applied Nutrition, 2002. Available from <http://vm.cfsan.fda.gov/~ebam/bam-3.html> accessed July 2008.
- 22 United States Department of Health and Human Services. Division of Cooperative Programs (HFS-625). *United States Food and Drug Baseline Report*. College Park. Available from <http://www.cfsan.fda.gov/~dms/retrsk.html> accessed July 2008.
- 23 **Réglier-Poupet H, Parain C, Beauvais R, Gillet H and JY Le Peron** Evaluation of the quality of hospital food from the kitchen to the patient. *J. Hosp. Infec.* 2005; **59**: 131-137.
- 24 **Stern JM, Bruemmer B, Moinpour C, Sullivan KM and SN Aker** Impact of a randomized, controlled trail of liberal versus conservative hospital discharge criteria on energy, protein, and fluid intake in patients who received marrow transplants. *J. Am. Diet. Assoc.* 2000; **100**: 1015-1022.
- 25 **South Africa** Occupational Health and safety Act (Act. No 85 of 1993). Available from <http://thor.sabinet.co.za> accessed 1 August 2002

- 26 **Doménech E, Escriche I and S Martorell** Assessing the effectiveness of critical control points to guarantee food safety. *Food. Control.* 2008; **19**: 557-565.
- 27 **Young S and J Sneed** Implementation of HACCP and prerequisite programs in school foodservice. *J. Am. Diet. Assoc.* 2003; January: 55-56.
- 28 **Legnani P, Leoni E, Berveglieri M, Mirolo G and N Alvaro** Hygienic control of mass catering establishments, microbiological monitoring of food and equipment. *Food. Control.* 2004; **15**: 205-211.
- 29 **Shojaei H, Shooshtaripoor J and M Amiri.** Efficacy of simple hand-washing in reduction of microbial hand contamination of Iranian food handlers. *Food. Res. Intern.* 2005; 1-5.
- 30 **Maguire H, Pharoah P, Walsh B, Davidson C, Barrie D, Threlfall EJ and S Chambers** Hospital outbreak of *Salmonella virchow* possibly associated with food handler. *J. Hosp. Infec.* 2000; **44**:261-266.