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CHAPTER 6

GENERAL CONCLUSIONS

6.1 Introduction

Providing consumers with nutritious and safe meals is a principal objective but also a major concern within food production industries, particularly in hospitals. Although food safety is a worldwide problem in both domestic and industrial settings, individuals with compromised immune systems continue to suffer due to food poisoning. Moreover, developing countries such as Lesotho are hard hit by HIV/AIDs and food insecurity and their citizens are therefore vulnerable to a lack of food safety and resultant foodborne infections. It is a common practice in Lesotho for food to be prepared in hospital kitchens from where it is distributed to patients and staff. The diversity of people and their health status thus mandate hospital catering staff to ensure that the food they prepare and serve is healthy and safe. Against this background, the aim and objectives of this study were as follows:

The aim of the study was to investigate microbial contamination of food contact surfaces in hospitals in Maseru, Lesotho. In brief, the research objectives were to:

- Characterize hospital foodborne pathogens associated with food contact surfaces in the hospital under study
- Assess food handlers' food safety knowledge, attitude, and hygiene practices from food preparation to food consumption; and
- Investigate the production of ESBL in gram-negative bacteria detected in the hospitals under study
- Investigate the efficacy of common dis infectants against detected microorganisms in the hospitals under study

To address the aim and achieve the objectives, a semi-structured questionnaire was administered to selected food handlers to determine their knowledge, attitudes and practices (KAPs) regarding food safety in hospital settings. Two selected disinfectants

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available in the market were investigated to determine their efficacy in microbiological pathogen control on food contact surfaces. The food contact surfaces that were investigated included food handlers' hands as well as food contact surfaces (tables, spoons, knives, and chopping boards). The identified microorganisms were profiled for their susceptibility to common antibiotics and the production of extended-spectrum beta-lactamases (ESBLs), while further investigations tested the efficacy of common disinfectants against the detected microorganisms. This study report is presented in six chapters:

Chapter 1: General introduction and discussion on information from the literature regarding the topic under investigation, with emphasis on food contamination and the impact this has on hospital-acquired infections.
Chapter 2: Assessment of food handlers' hygiene, food safety knowledge, attitude, and practices in hospitals in the city of Maseru, Lesotho.
Chapter 3: The prevalence of microbiota on food contact surfaces within hospitals in the city of Maseru, Lesotho.
Chapter 4: Extended-spectrum beta-lactamase production of Gram-negative bacterial strains.
Chapter 5: Efficacy of chlorhexidine isopropanol and sodium hypochlorite against gram-negative and gram-positive bacteria Isolated from food contact surfaces in hospital kitchens in Maseru Lesotho.
Chapter 6: Conclusion and recommendations.

6.2 Concluding remarks on the preceding chapters

In Chapter 2, the selected food handlers' hygiene and food safety knowledge, attitudes, and self-reported practices were discussed. The findings indicated that the food handlers demonstrated good knowledge, positive attitudes, and appropriate food safety practices regarding food safety. However, despite the high scores obtained for these aspects, it was observed that educational levels, work duration, and lack of exposure to appropriate food safety training had no influence on the food handlers' KAPs. It was also found that

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the food handlers had overall sufficient knowledge of hand hygiene practices and cleaning and sanitization procedures.

Although food handlers were knowledgeable of good hand hygiene practices, the discovery of high levels of microbiota reported in Chapter 3 suggests that there was a discrepancy between the food handlers' reported cleaning of food contact surfaces and the washing of hands. The microorganisms that were detected were associated with resistant strains of the families Enterobacteriaceae and Staphylococcaceae. Organisms (such as *S. aureus*) that were found on the contact surfaces where food was prepared are of pathogenic importance in both the food service industry and in clinical environments. The latter microorganism is known to cause food poisoning preceded by gastroenteritis emesis with or without diarrhoea. The presence of clinically important pathogenic microorganisms in the hospital kitchens may be attributed to possible cross-contamination from the hospital wards to the kitchen and is therefore a reason for further investigation.

Chapter 4 reported on the organisms of the family Enterobacteriaceae that were investigated for susceptibility to common antibiotics and for extended-spectrum beta-lactamases (ESBL) production. Beta-lactamases are enzymes that are produced by Gram-negative bacteria that facilitate the resistance of these bacteria to beta-lactam antibiotics. These enzymes are produced by genes embedded in the chromosomes that can be transferred among bacterial populations. In this study, the majority of the isolates (71%) exhibited multi-drug resistance while 43% was positive ESBL producers. The ESBL producers exhibited 100% resistance to penicillin and 66% resistance to amoxicillin. None of these isolates were susceptible to all antibiotics, which highlights the need for new therapeutic interventions as they pose a serious threat to public health if their prevalence is not eradicated, particularly in hospital settings.

Chapter 5 reported on the findings of two commercially available household disinfectants whose efficacy was tested against the detected microorganisms discussed in Chapter 3. It was found that both sodium hypochlorite and chlorhexidine exhibited a bactericidal

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effect against the tested isolates. Sodium hypochlorite exhibited bactericidal effect against all the microorganisms tested, while chlorhexidine achieved bactericidal effect only against the Gram-positive bacteria. Therefore, it is important that further investigations on these disinfectants are conducted to determine which factors influence or diminish their efficacy. These investigations should include testing the efficacy of disinfectants within a certain period of time and on different surfaces where food is prepared.

6.3 Recommendations

Food handlers in hospitals are pivotal in achieving and maintaining food hygiene as they handle food from the acquisition point to the final food distribution point to consumers, who are often immune-compromised patients in hospital settings. Therefore, it is important that food handlers are trained on food safety-related issues to avoid cross-contamination, especially during periods of active infection. Given the results pertaining to the impact of training (or the lack thereof) on food handlers' KAPs, it would be wise to implement continued in-service food safety training of food handlers. Additionally, public health workers and hospital management teams should conduct frequent health education programs that focus on educating food handlers on the risks associated with HIV/AIDS, foodborne diseases, hospital-acquired infections, and susceptible groups.

Customized and recurrent food safety training courses are essential in optimising food safety outcomes. These should acquaint food handlers with the importance of food safety, cross-contamination, and safe food handling practices such as correct food holding temperatures and personal and hand hygiene should be pivotal in these programmes. Hand hygiene is particularly important in food safety measures and infection control. A case in point is that proper hand washing was identified as a key precautionary measure in the control of the spread of COVID-19. Therefore, proper hand hygiene practices by all food handlers in hospitals will curb the spread of both food-related and non-food related pathogenic microorganisms to already immune-suppressed hospitalized patients. The

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HACCP system should be incorporated and consistently monitored as part of the food safety program to identify possible hazards throughout the food production route.

The food and clinical services are in need of effective, accurate, and real-time protocols for the constant evaluation of environmental hygienic conditions. The majority of health institutions reportedly use out-dated visual observation and conventional methods to evaluate the cleanliness of food preparation surfaces. However, visual observation is an insufficient method of evaluation as it only focuses on the aesthetics of the health environment and does not consider the microbiological state of food contact surfaces. In hospitals and any other food preparation setting, the microbial quality of a surface or of an item is vital in the emergence and transmission of pathogenic microorganisms. In this regard, Law *et al*. (2015) proposes the use of the ATP hygiene system for the evaluation of environmental cleanliness as it is suitable for the detection of pathogens that are present even in low numbers. This proposal is supported by the current study. According to Nante *et al*. (2017), the ATP bioluminescence assay will assess hospital surface cleanliness using multiple ATP benchmark values relative to light units (RLU). Therefore, the feedback provided by the ATP bioluminescence can be quantified and results can easily be interpreted and communicated to all stakeholders.

It is important that surveillance systems are developed to identify ESBL production among pathogenic Enterobacteriaceae. Extended-spectrum beta-lactamase production is a major global concern; hence ESBL surveillance and tracking systems will provide information to be used in developing/contributing to the ESBL production global mapping system which is useful in predicting the occurrence and spread of particular resistance patterns among pathogenic bacteria. It is therefore important that antibiotic tests pertaining to ESBL production are included in routine monitoring protocols to ascertain the susceptibility of microorganisms to prescription antibiotics and to avoid treatment failure.

Cleaning and disinfection are practices implemented in the prevention and control of infectious diseases within both clinical and domestic environments. Various products are

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available in the market that contain chemical substances and they are known as detergents and disinfectants. However, determining the efficacy of cleaning and disinfection substances on bacterial isolates is important if the most suitable disinfectant or detergent is to be selected for use in a particular environment. To ascertain the efficacy of available chemical substances against pathogenic microorganisms, their efficacy should be continually investigated. This will assist in understanding the mode of action of various cleaning and disinfection substances and the resistance patterns of microorganisms against them, which will allow for an informed and adequate choice. It is vital that disinfectants are selected not only for their availability, but also for their efficiency in eradicating microorganisms on food preparation surfaces.

6.4 Conclusions

A kitchen is either a domestic or health facility environment where food is processed and meals are prepared to be served to consumers. During food preparation, food handlers are in contact with food in processes of reception and preparation before the food is finally served to consumers. This means that food handlers are the main custodians of safe food production. Food handlers' behaviour towards food should therefore include proper hand washing, proper storage, and maintaining a sanitary kitchen/food environment for safe food production and the control/eradication of foodborne infections.

This study has the potential to improve food handlers' food safety knowledge as well as their attitude and practices by informing them of the importance of appropriate food handling behaviours. Moreover, through continued food safety training, food handlers will remain informed of the advantages of improved food handling practices which will result in less food contamination and food poisoning. Through the publication of the findings in academic journals, the study also has the potential to influence hospital domestic cleaning programs through improved evaluation of cleanliness and informed decisions on the choice of disinfectants to be used. Additionally, the study has highlighted the importance of interventions to combat the emergence and spread of antibiotic resistant bacteria along the food production chain, with specific focus on ESBLs. Therefore, implementing and

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sustaining surveillance strategies to determine extended-spectrum beta-lactamase contamination using routine antibiotic evaluation tests will assist in deciding on appropriate treatment therapies. Such measures will also inform the food preparation industry in hospital settings of the importance of developing new treatment options when required.

APPENDICES

Appendix 1: Ethical Clearance

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Ministry of Health
PO Box 514
Maseru 100

REF: ID93-2017

Date: 25 July 2017

Category of Review:
[x] Initial Review
[ ] Continuing Annual Review
[ ] Amendment/Modification
[ ] Reactivation
[ ] Serious Adverse Event
[ ] Other ________________

To
Ms.M.S Maliehe
Masters of Science candidate in Environmental Health
Central University of Technology
Free State, RSA

Dear Ms.M.S Maliehe,

RE: Microbiological contamination of food contact surfaces in hospitals at Maseru, Lesotho

This is to inform you that on 18 July 2017 the Ministry of Health Research and Ethics Committee reviewed and **APPROVED** the above named protocol and hereby authorizes you to continue the study according to the activities and population specified in the protocol. Departure from the approved protocol will constitute a breach of this permission.

This approval includes review of the following attachments:
[x] Protocol dated 18 May 2017
[x] English consent forms
[ ] Data collection forms in Sesotho
[x] Data collection forms in English
[ ] Participant materials *[insert types, versions, dates]*
[x] Other materials: Checklist for PPE
This approval is **VALID** until 24 July 2018.

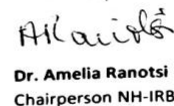
Please note that an annual report and request for renewal, if applicable, must be submitted at least 6 weeks before the expiry date.

All serious adverse events associated with this study must be reported promptly to the MOH Research and Ethics Committee. Any modifications to the approved protocol or consent forms must be submitted to the committee prior to implementation of any changes.

We look forward to receiving your progress reports and a final report at the end of the study. If you have any questions, please contact the Research and Ethics Committee at rcumoh@gmail.com (or) 22226317.

Sincerely,

Dr. Nyane Letsie
Director General Health Services



Dr. Amelia Ranotsi
Chairperson NH-IRB

Appendix 2: Food Handler Certificate

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FOOD HANDLER CERTIFICATE IN TERMS
OF PUBLIC HEALTH REGULATIONS 1973
GOVERNMENT GAZETTE NO. 27 OF 6 th JULY
1973. LEGAL NOTICE NO. 25 OF 1973.

NAME………………… SURNAME………………

DATE………………… VILLAGE…………………

EMPLOYER…………... COMPANY………………

MEDICAL EXAMINATION (should include)
CHEST X-RAY, WIDAL, STOOL and OTHERS.

CERTIFIED TO WORK AS FOOD HANDLER

[yes] [no]

NAME OF MEDICAL OFFICER……………………..

SIGNATURE……………………………………….

DATE STAMP………………………………………

DATE OF EXPIRY OF CERTIFICATE……………..

Appendix 3: Consent form

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I acknowledge that I understand all the information that was provided by the researcher and I agree to participate in the study. I also understand that I am free to end my participation at any time and I will not be forced to do anything that may feel uncomfortable to me, harm my business in any way or put me in any danger. I am also entitled to total confidentiality through the study.

Signed ____________________on this day_________at___________

The Sesotho translation of the consent form

Ke nka kano ea hore ke utloisisa tsohle tseo monga lipatlisiso a nthlaloselitseng tsona, mm eke lumela ho ba karolo boitutong ba hae ele hona ho mo thusa. Ke utloisisa hore ke lokolohile ho emisa hob a karolo lipatlisisong tsena kaofela nako eohle ha ke utloa ke se ke sa khotsofala kapo hosena ts'ebelisano mmoho. Monga lipatlisiso o itlama ho boloka boitsebiso baka ele lekunutu hofihlela a qetile ka boithuto ba hae.

Tekeno________________kala ______________sebakeng sa___________________

Appendix 4: Food handler questionnaire

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Gender	M	F

Age	22-30	31-39	≥40

Educational Level	Primary	J.C	C.O.S.C	Tertiary qualification

Duration of working period	<1 year	1-5 years	6-10 years	11-20 years	>20 years

Employment status	Contractor	Part- time	Full-time

Hours of operation	Morning shift	Afternoon shift	Straight shift

Language	English	Sesotho	Both

Race	Black

Training	Yes	No

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Food handler knowledge	Correct	Incorrect	Don't know
Washing hands before work reduce the risk of food contamination.			
Using gloves while handling food reduces the risk of food contamination			
Proper cleaning and sanitization of utensils increases the risk of food contamination			
Eating and drinking at the workplace increases the risk of food contamination			
Food prepared in advance reduces the risk of food contamination			
Reheating cooked foods can contribute to food contamination			
Washing utensils with detergent leaves them free of contamination			
Children, healthy adults, pregnant women and older individual are at equal risk for food poisoning			
Typhoid fever can be transmitted by food			
AIDS can be transmitted by food			
Bloody diarrhoea can be transmitted by food			
Salmonella is among the food-borne pathogens			
Hepatitis A virus is among the food-borne pathogens			
Swollen cans may contain the microorganism, *Clostridium botulinum*, which causes botulism			
Microbes are on the skin, in the nose and mouth of healthy food handlers			
Clean is the same as sanitized			

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Cross contamination is when microorganisms from contaminated food are transferred by the food handler's hands or kitchen utensils to another food			
The correct temperature for storing perishable foods is 5 ^{0}C			
Hot, ready-to-eat foods should be kept at a temperature of 65 ^{0}C			
Freezing kills all the bacteria that may cause food-borne illness			
Contaminated foods always have some change in colour, odour or taste			
Raw vegetables are at high risk of contamination than undercooked beef			
During infectious diseases of the skin, it is necessary to take leave from work			
The health status of workers should be evaluated before employment			
The ideal place to store raw meat in the refrigerator is on the bottom shelf			

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Food Handler Attitude	Correct	Incorrect	Don’t Know
Well cooked foods are free of contamination			
Proper hand hygiene can prevent foodborne diseases			
When cleaning products are closed, they can be stored with cans and jars of food that are also closed			
Raw and cooked foods should be stored separately to reduce the risk of food contamination			
It is necessary to check the temperature of refrigerators/ freezers periodically to reduce the risk of food contamination			
Defrosted foods should not be frozen			
The health status of workers should be evaluated before employment			
the best way to thaw chicken is in a bowl of cold water			
Wearing masks is an important practice to reduce the risk of food contamination			
Wearing caps and adequate clothing is an important practice to reduce the risk of food contamination			
Safe food handling is an important part of my job responsibility			
Learning more about food safety through training courses is important to me			
Beards could contaminate food with foodborne pathogens			
Long and painted fingernails could contaminate food with foodborne pathogens			

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Food handlers can be a source of foodborne outbreaks			
Eggs must be washed immediately after delivery			
Dish towels can be a source of food contamination			
Knives and cutting boards should be properly sanitized to prevent cross-contamination			
Food handlers who have abrasions or cuts on their hands should not touch foods without gloves			
It is possible for infectious pathogens from the hospital wards to be imported into the kitchen and into the food			

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Food Handler practices	**Yes**	**No**
Do you use gloves during the distribution of unpackaged food?		
Do you wear an apron while working		
Do you wear a mask when you distribute unwrapped foods?		
Do you eat or drink at your workplace		
Do you wear nail polish when handling food		
Do you prepare a meal in advance (i. e., from one shift to another)?		
Do you properly clean the food storage area before storing new products?		
Do you use sanitizer when washing service utensils (plates, mugs and spoons)?		
Do you use the sanitizer when washing fruits?		
Do you check the shelf life of foods at the time of delivery?		

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