HAZARD ANALYSIS CRITICAL CONTROL POINT EVALUATIONS

A GUIDE TO IDENTIFYING HAZARDS AND ASSESSING RISKS ASSOCIATED WITH FOOD PREPARATION AND STORAGE

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World Health Organization
Geneva
1992

WHO Library Cataloguing in Publication Data
Bryan, Frank L.
Hazard analysis critical control point evaluations: a guide to identifying hazards and assessing risks associated with food preparation and storage / Frank L. Bryan.

1. Food handling – standards 2. Food contamination – prevention & control 3. Food microbiology I. Title

ISBN 92 4 154433 3 (NLM Classification: WA 695)

Typeset in India
Printed in England
91/8764—Macmillan/Clays—5000

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	*Price** (Sw. fr.)
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M. Jacob. **Safe food handling. A training guide for managers of food service establishments** 1989 (148 pages)	25.–
Health surveillance and management procedures for food-handling personnel Report of a WHO Consultation WHO Technical Report Series, No. 785, 1989 (47 pages)	6.–
T. Williams et al. **Food, environment and health. A guide for primary school teachers** 1990 (138 pages)	23.–
Food irradiation. A technique for preserving and improving the safety of food 1988 (84 pages)	16.–
R. H. G. Charles. **Mass catering** WHO Regional Publication, European Series, No. 15, 1983 (80 pages)	13.–
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PREFACE

Foodborne diseases cause considerable morbidity and mortality throughout the world, even though the principles for controlling most of these diseases are well established. Traditional approaches may therefore be considered to have failed to deal with the problem.

A relatively new approach to the prevention and control of foodborne diseases is the hazard analysis critical control point (HACCP) system. This system seeks to identify the hazards associated with any stage of food production, processing, or preparation, assess the related risks, and determine the operations where control procedures will be effective. Thus, control procedures are directed at specific operations that are crucial in ensuring the safety of foods.

This publication is intended for use by public health personnel who have been trained in food microbiology and technology and who are concerned with food safety and the prevention of foodborne disease. Drawing on principles used by a number of food-processing companies, it provides guidance on the assessment of risks that occur during the processing, preparation and storage of foods in homes, schools, food service establishments, cottage industries, and street markets. Emphasis is placed on assessing hazards and risks and identifying critical control points, rather than on control criteria and monitoring. This has been done because many of the places where HACCP evaluations will be made (e.g., homes, cottage industries and street stalls) do not readily lend themselves to sophisticated monitoring. Follow up of the hazard analyses should therefore focus on educating the people who prepare and store the foods.

This guide will assist in the planning of food safety and health education activities that focus on the hazards and technologies associated with the types of food commonly eaten and on foods that are processed and prepared by local inhabitants. Use of this approach should result in the best possible health protection at the lowest cost.

Many of the ideas presented here have been developed as a result of discussions with colleagues from the International Commission on Microbiological Specifications for Foods (ICMSF). The procedures for collecting clinical specimens and water samples have been taken from publications by the International Association of Milk, Food and Environmental Sanitarians (IAMFES).[a] The author is grateful to ICMSF and IAMFES for stimulation in this endeavour.

[a] Bryan, F.L. et al. *Procedures to investigate foodborne illness*, 4th ed. Ames, IA, International Association of Milk, Food and Environmental Sanitarians, 1987.

Thanks are also expressed to the following people, who reviewed early drafts of this guide:

Professor M. Abdussalam, formerly World Health Organization, Geneva; Dr R.H. Charles, Senior Medical Officer, Food and Hygiene, Department of Health, London, England; Dr L. Cox, Quality Assurance Department, Nestec, Vevey, Switzerland; Dr S. Michanie, Food Protection, Pan American Zoonoses Center, Buenos Aires, Argentina; Dr B.A. Munce, Microbiologist/Food Technologist, Qantas Airways Ltd, Qantas Jet Base, Mascot, New South Wales, Australia; Dr F. Quevedo, Head, Food Protection, Pan American Health Organization, Washington, DC, USA; Dr P. Teufel, Institute of Veterinary Medicine, Berlin, Germany; Dr M. van Schothorst, Head, Quality Assurance Department, Nestec, Vevey, Switzerland; Dr J.I. Waddington, WHO Regional Office for Europe, Copenhagen, Denmark.

Particular thanks are due to Dr T.A. Roberts, Head, Microbiology Department, AFRC Institute of Food Research, Reading, England, for detailed technical review.

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INTRODUCTION

From the earliest religious edicts concerning food, innumerable ordinances, codes of practice, and laws concerning processing, handling and sale of foods have been promulgated by local, national and international bodies with the intention of protecting the public from adulterated food, fraud and foodborne illness. Several approaches have been used to implement these laws and to reduce the risks of foodborne diseases. These approaches can be classified into six categories (Bryan, 1986):

- surveillance of foodborne diseases;
- surveillance of foods;
- surveillance and training of people who handle foods;
- surveillance of facilities and equipment used for production or preparation of food;
- surveillance of food operations;
- education of the public.

Each of these approaches has its merits and its limitations. The degree of usefulness varies with time, place, and type of food operation (production, processing, preparation, storage, distribution, etc.).

Surveillance of foodborne diseases is essential to any rational control programme. Preventive and control measures must be based on the problems commonly found in the community, region or country. Surveillance data can indicate the prevalent foodborne diseases, common causative agents, places where mishandling occurs, and factors that contribute to outbreaks. In many developing countries, there are no such surveillance activities, and the information available may be scanty and unreliable. In that case, reliance must be put on data collected elsewhere for similar foods.

Surveillance of foods employs organoleptic evaluations, measurements of physical properties, chemical analyses, and microbiological testing. Microbiological testing, as a means of assessing whether a product is hazardous, is a relatively recent innovation (ICMSF, 1986a). It has been successfully used to evaluate the quality of drinking-water, but there are few examples of its successful application to food control. The primary limitations of this approach are:

(*a*) the difficulty of collecting and examining enough samples to obtain meaningful information;
(*b*) the time required to obtain results (usually several days); and
(*c*) the high cost.

A number of approaches have been used by health and food regulatory agencies to detect infected food workers and to prevent them from

contaminating food. These have been based on medical history, physical examination, blood analysis, X-rays, and examination of faeces for parasites, shigellae, *Salmonella typhi* and other salmonellae. There are significant limitations to each of these examinations (WHO, 1989). People diagnosed as free from infection on the day of an examination may be in the incubatory phase of a disease, or may have mild, abortive, or atypical illness. Furthermore, infections may be acquired and terminated between examinations, which can never be scheduled at a frequency sufficient to prevent the spread of pathogens. Except for epidemiological purposes, such tests are unacceptably costly. Many microorganisms that are transmitted by foods are seldom, if ever, sought during routine examination of specimens from food handlers. Other conditions (e.g., tuberculosis and venereal diseases) that may be sought during examinations are not, in fact, transmitted by food.

An alternative to clinical examination of food handlers or the testing of specimens from them is training in safe food-handling practices. Understanding of such practices would give a far greater assurance of food safety than clinical examination. Managers of food-handling establishments have the primary responsibility for preventing conditions that can lead to outbreaks of foodborne disease stemming from their establishments. They have daily supervisory control of operations, whereas public health personnel may inspect each establishment only infrequently, and spend a relatively short period of time at each visit. Because of their policy-setting and supervisory responsibilities, managers can effect improvements in their establishments. They must, therefore, be aware of the kinds of operations that can lead to outbreaks of foodborne disease and insist that appropriate preventive measures be taken and monitored routinely. Food handlers must also be aware of hazards associated with faulty food-handling practices. They should understand the principles of food safety and the importance of specific food-handling practices associated with their job. Food hygiene professionals and specialists in food safety need to understand the epidemiology of foodborne diseases and the microbial ecology of foods and food-processing operations, so that measures to prevent diseases and spoilage can be devised or selected and given appropriate emphasis.

History has taught us that certain facilities — potable running water, adequate plumbing systems, toilet and hand-washing facilities, and functioning sewage disposal systems — are essential for preventing contamination and promoting personal hygiene in food-handling establishments. In many such establishments in developing countries, there is a need to improve the physical facilities; however, it is even more important to ensure the safety of food processing, preparation and storage operations, many of which can lead to proliferation of microorganisms, e.g., if food is prepared several hours before serving, or kept at room temperature.

Inspections for food safety should focus on the processes that the foods undergo, with particular attention to (*a*) possible sources of contamination to which foods are exposed, (*b*) modes of contamination, (*c*) effects of the process on the level of contamination, (*d*) probability of microorganisms surviving processing, and (*e*) chances that bacteria or moulds will multiply during processing or storage. Hence, food safety rests on controlling food operations from receipt of ingredients until the processed or prepared foods are distributed, sold, or eaten. Surveillance should emphasize operations rather than physical facilities.

Education of the public is essential to food safety. Teachers and students who are preparing to teach must be given information about food safety which they can introduce into their lessons at school. For immediate impact, however, adults must also be informed of hazardous practices associated with preparation and storage of the common foods in the area and appropriate measures to counter the hazards.

This guide describes a system for ensuring food safety — the hazard analysis critical control point (HACCP) system — which combines several of these approaches (in particular, surveillance of diseases, foods, and operations, and education) into an action-oriented programme to identify and reduce the foodborne disease problem. It concentrates mainly on the hazard analysis portion, since monitoring is often impracticable in the places for which this guide is intended (homes, street markets, etc.).

THE HACCP SYSTEM

The hazard analysis critical control point (HACCP) concept is a systematic approach to the identification, assessment and control of hazards. The system offers a rational approach to the control of microbiological hazards in foods, avoids the many weaknesses inherent in the inspectional approach and circumvents the shortcomings of reliance on microbiological testing. By focusing attention on the factors that directly affect the microbiological safety of a food, it eliminates wasteful use of resources on extraneous considerations, while ensuring that the desired levels of safety and quality are met and maintained.

Components of the system and definitions of terms

The HACCP system (Fig. 1) comprises the following sequential steps:

1. *Identification of hazards and assesssment of the severity of these hazards and their risks (hazard analysis), associated with growth, harvesting, processing, manufacture, distribution, marketing, preparation and/or use of a raw material or food product.*

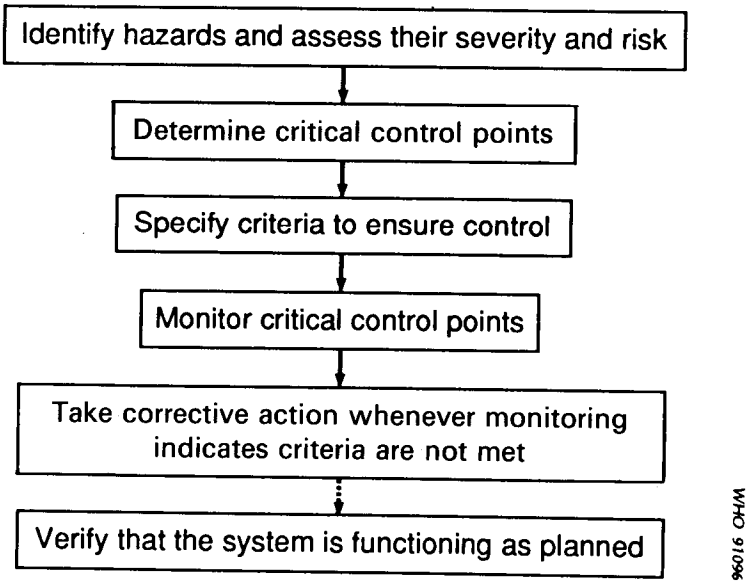

Fig. 1. Components of the HACCP system.

- **Hazard** means the unacceptable contamination, growth or survival in food of microorganisms that may affect food safety or lead to spoilage, and/or the unacceptable production or persistence in foods of products of microbial metabolism, e.g., toxins and enzymes.
- **Severity** is the magnitude of the hazard, or the seriousness of the possible consequences.
- **Risk** is an estimate of the probability of a hazard occurring.

Hazard analysis consists of an evaluation of all procedures concerned with the production, distribution and use of raw materials and food products to: (1) identify potentially hazardous raw materials and foods that may contain poisonous substances, pathogens, or large numbers of food spoilage microorganisms, and/or that can support microbial growth; (2) identify the potential sources and specific points of contamination; (3) determine the probability that microorganisms will survive or multiply during production, processing, distribution, storage and preparation for consumption; and (4) assess the risks and severity of the hazards identified.

2. *Determination of critical control points (CCPs) at which the identified hazards can be controlled.*

   - A **CCP** is an operation (practice, procedure, location or process) at which control can be exercised over one or more factors to eliminate, prevent or minimize a hazard.

   In some food processes, control of a single operation (CCP) can completely eliminate one or more microbial hazards, e.g., in pasteurization. It is also possible to identify control points at which a hazard can be minimized but not completely eliminated. Both types of CCP are important and must be controlled.

3. *Specification of criteria that indicate whether an operation is under control at a particular critical control point.*

   - **Criteria** are limits of characteristics of a physical (e.g., time or temperature), chemical (e.g., concentration of salt or acetic acid), biological or sensorial nature.

   It is important to select appropriate means to check that the hazard has been controlled at the CCP. Factors to be monitored may include: time and temperature for thermally processed foods; water activity (a_w) of certain foods; pH of fermented foods; chlorine level in can cooling water; humidity in storage areas for dry products; temperature during distribution of chilled foods; depth of product in trays to be chilled; instructions on labels of finished products describing recommended procedures for preparation and use by the consumer. All criteria selected should be documented or specified clearly and unambiguously, with tolerances where appropriate. Choice of control criteria will depend on usefulness, cost, and feasibility but they must provide high assurance of control.

4. *Establishment and implementation of procedures to monitor each critical control point to check that it is under control.*

   - **Monitoring** involves the systematic observation, measurement and/or recording of the significant factors for control of the hazard. The monitoring procedures chosen must enable action to be taken to rectify an out-of-control situation, either before or during an operation.

   The monitoring must detect any deviation from the specification (loss of control) in time for corrective action to be taken before the product is sold or distributed. Five main types of monitoring are employed: observation, sensory evaluation, measurement of physical properties, chemical testing and microbiological examination.

5. *Implementation of appropriate corrective action when monitoring indicates that criteria specified for safety and quality at a particular critical control point are not met.*

6. *Verification, i.e. the use of supplementary information and tests to ensure that the HACCP system is functioning as planned.*

   Verification may be done by either quality control staff or health or regulatory agency personnel. It includes a review of the HACCP plan to determine whether all hazards have been detected, all critical control points identified, criteria are appropriate, and monitoring procedures are effective in evaluating operations. Records are reviewed and supplementary tests done to evaluate the effectiveness of the monitoring.

APPLICATION OF THE HACCP APPROACH

The HACCP approach can be applied to food safety in homes as well as in food processing and food service establishments (WHO/ICMSF, 1982). A Joint FAO/WHO Expert Committee on Food Safety recommended that studies using the HACCP approach be carried out in homes in developing countries, so that more information about the causes of food-associated hazards and preventive measures could be obtained (FAO/WHO, 1984). Such information could be used to focus health education and food safety programme activities on the factors of greatest importance in causing foodborne illness.

Unlike most traditional food-inspection activities, the HACCP approach is based on an understanding of the factors that contribute to outbreaks of foodborne disease and on applied research on the ecology, multiplication, and inactivation of foodborne pathogens. Even where data are not available, a hazard analysis can detect potential problems and identify the critical control points of an operation. Thus, food safety agencies can target their resources on the greatest public health risks in an establishment, rather than on general sanitation and superficial improvements. Although the initial hazard analysis will take longer than an inspection, valuable information about the food process will be obtained. Follow-up inspections to verify that the operators are monitoring the critical control points take less time. The benefits derived from greater assurance of food safety should offset the time spent on the initial hazard analysis and verification. Additional benefits will ensue from inspections of potentially hazardous operations to determine whether they are being monitored effectively, rather than from random inspections, when only a few high-risk operations may be in progress.

Experience has shown that the HACCP system provides a greater assurance of food safety than other approaches, such as traditional quality control by testing the end product. Furthermore, monitoring of critical control points is less costly and more effective than analysis of samples and inspection of processing plants.

In attempting to identify potential hazards, it is necessary to consider three areas:

- the raw materials used,
- processing procedures,
- the manner in which the product is used.

Food processing operations

In any particular processing plant, the hazards will depend upon:

- the source of ingredients,
- the formulation,
- the processing equipment,
- the duration of the process and storage, and
- the experience and/or attitudes of the personnel.

Hazard analyses should be carried out on all existing products and processing lines, and on any new products that a processor intends to manufacture. Changes in the source of raw materials, product formulation, processing procedures, packaging, distribution, or use of a product indicate the need for re-evaluation, because any of these changes might adversely affect safety or shelf-life.

The HACCP approach can be applied to foods processed in cottage industries as well as to those processed in complex, technically advanced manufacturing plants. In the former, it may be necessary to use simple monitoring procedures, but they must be sufficiently accurate and reproducible to provide unambiguous and quantifiable results.

Food service operations

A wide variety of foods are prepared in food service establishments. The main food service systems can be classified as cook/serve, cook/hold hot, cook/chill, cook/freeze or assemble/serve. The HACCP system is applicable to food prepared by any of these systems. Critical control points are similar in any one system, but more than one system may be in operation in an establishment.

Raw foods of animal origin, freshly caught fish, shellfish, raw products of vegetable origin, cereals, fruits, dairy products, ices, juices and iced drinks are sold on streets and in markets in many countries. Some of these foods are cooked on the street, or are processed, prepared and cooked in cottage industries, food service establishments or homes long before they are sold or eaten. Risks will vary depending on:

- the food source;
- the methods used to freshen, preserve, process and prepare the foods;
- the duration and conditions of holding and display; and
- the interval between heating and consumption.

The HACCP approach can be used to identify hazards and evaluate risks associated with the preparation and holding of foods sold on the street (Bryan et al., 1988). Preventive measures can then be applied at the most hazardous stages of preparation, storage or display and wherever control is feasible.