EMERGING PATHOGENS – CHALLENGES TO FOOD CATERING AND FRANCHISING BUSINESS

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ABSTRACT

FOOD SAFETY is a major concern for consumers, food producers, processors and regulatory agencies. It is concerned with ensuring food that is safe or free from disease causing agents such as microorganisms, biological toxins and chemicals from the **FARM TO THE TABLE**, or throughout the **FOOD CHAIN**.

Foodborne diseases are widespread and of growing public health concern problem, both in developed and developing countries. The Center for Disease Control (CDC), USA, estimates about 250 different foodborne pathogens. The global incidence of foodborne disease is difficult to estimate, but it has been reported that in the year 2000 alone, 2.1 million people died from diarrhoeal diseases. The latest edition of the WHO Quarterly Statistics indicates that, the incidence of foodborne diseases may be 300-350 times more frequent than those reported. About 1.5 billion global episodes of diarrhea occur annually, mainly in developing countries, resulting in 3 million deaths among children less than 5 years of age. The WHO estimates that 70% of diarrhoeal episodes are caused by biologically contaminated food. Epidemiological data from both developed and developing countries indicates that the incidence of food poisoning is on the increase. This increase can be attributed to globalization, changing life styles, urbanization, demographic changes, increase international trade and tourism, microbial adaptation, technology and innovation in food processing, food handling, marketing and retail. Changes in Agricultural practices such as intensive farming, use of pesticides, growth hormones and antibiotics have also contributed to the increase in the incidence of food poisoning and the emergence of food pathogens.

In addition to human suffering, caused by foodborne diseases in terms of death and ill-health, substantial economic costs are involved, affecting individuals, families, industries, health care systems and entire communities. At the national level, epidemics of foodborne disease affect tourism, trade and economic development.

Introduction:

Food Safety is a major concern for consumers, food producers and processors and regulatory agencies. It is concerned with ensuring that food is safe or free from disease causing agents such as microorganisms, biological toxins and chemicals from the **FARM TO THE TABLE** or throughout the **FOOD CHAIN**. Food producers and processors strive very hard to provide safe food by adopting Good Agricultural Practices (GAPs), Good Manufacturing Practices (GMPs) and continuously monitoring on-line quality, to maintain their reputation and preserve market share. The regulatory agencies by means of legislation, surveillance, inspection and education strive to ensure that safe food is provided from farm to table.

Consumers demand food that is safe, wholesome and nutritious. Discerning consumers do not only demand food that is safe, wholesome and nutritious but consistent in quality with sensory and physical attributes such as taste, color, texture, flavor and aroma that should be similar to the fresh food. Ensuring food safety is a complex and difficult task as the food chain is long with many vulnerable nodes or links. The food chain is an extensive network of activities and can be divided into six stages: production (at the farm), processing or manufacturing, distribution, retailing and households. Each of this stage can be considered as independent or linked to each other as food from one stage to another have to be stored and transported from one stage to another. At each of these stages different strategies have to be formulated to ensure food safety. Food undergoes many transformations from production till it is served on the dining table.

Epidemiological data from both developing and industrialized countries indicates that the incidence of food poisoning is on the increase. Industrialization does not mean that there is a reduction in the risks of food poisoning because new variables and processes are introduced which lengthens the food chain and thereby creating more opportunities for contamination and growth of pathogens.. Many factors have contributed to the increase in food-borne diseases. Urbanization and changing lifestyles has revolutionalised the food supply system, resulting in mass production and an explosive increase in the number of food service establishment and food outlets.

Mass production, environmental factors, and inadequate knowledge on the part of the food handlers have contributed to increased contamination of primary foodstuffs. The increase in international trade has increased the risk for cross-border transmission of infectious diseases. Food, a major trade commodity while offering many benefits and opportunities, also presents new risks. As food production, manufacturing and marketing are now global, infectious agents can be disseminated from the original point of processing and packaging to locations thousands of miles away. Currently, world food trade is valued at US$500 billion per year and is expected to grow every year.

Increased trade in food, international travel, migration, economic and technological developments have changed dietary habits. New foods and preparation techniques together with dietary habits are introduced into different regions, and consequently, food-borne diseases are emerging or reemerging. Dietary habits are also changing as a result of nutritional recommendations and campaigns or may be influence by food policy, production systems, or environmental changes that lead to increased access to certain foods. In the U.S.A., for example, public information campaigns on the health benefits of fruits and vegetables in the diet have lead to the increase consumption of fruits and vegetables. To meet this increased demand, these products have to be imported on a seasonal basis. At certain times of the year more than 75% of the fresh fruits and vegetables available in the grocery stores and restaurants are imported. Epidemiologic data have shown that, partly as a consequence of the increased consumption of fruits and vegetables, the proportion of food-borne disease outbreak has doubled.

In the U.S.A., which has one the best infrastructure to ensure food safety, it is estimated that as many as 9000 deaths and 6.5 to 33 million illness each year are of food related. The Centre for Disease Control (CDC), USA, estimates that medical costs and productivity losses for 7 specific pathogens range between US$6.5 billion and US$34.9 billion annually. Total costs for all food-borne illness are likely to be much higher. The estimates do not include the total burden placed on society by the chronic illness caused by some food-borne pathogens.

Definition of Foodborne Illness: Food-borne illness is defined as any disease usually infectious or toxic in nature caused by agents that enter the body through the ingestion of food or water. Every person is at risk of foodborne illness.

Magnitude of Foodborne Illness: Food-borne diseases are widespread and of growing public health problem, both in developed and developing countries. The United States Center for Disease Control and Prevention (CDC) has estimated about 250 different foodborne pathogens. Many pathogens, including *Salmonella*, *E. coli* 0157:H7, *Campylobacter*, and *Yersinia enterocolitica*, have reservoirs in healthy food animals, from which they spread to an increasing variety of foods

Catering is the preparation or provision of food for someone else to serve; or preparing, delivering and serving food at the premises of another person or event. There has been an increase in the catering and franchising industry over the past few years as there has also been the increase in the number of people eating outside away from home.

In the US about 80% of people eat out at least once a week, and 46% of the US food dollar is spent on food away from home. (http://www.cdc.gov/foodnet/pub/2002/ jones_t.htm).
However, data from the US National Restaurant Association shows that, about 50 billion meals are prepared in restaurants and school/work cafeterias each year, and 250 billion meals are prepared at home or similar places (Thayer, 1999).

Table 1: Food spending both at and away from home in the USA

Expenditures	**1990**	**1996**	**1997**	**1998**	**1999**	***Percent* Change 1990-99**
	----------------------------*Billion Dollars*-----------------					
Total food and beverages	638.4	780.9	817.7	842.0	884.7	5.1
Total food (excluding alcohol)	565.4	697.1	729.7	751.5	788.6	4.9
At –home food	316.8	376.5	390.5	398.9	413.9	3.8
Away-from home food	248.7	320.6	339.2	352.6	374.7	6.3

Clausen, 2000

Over the last 40 years or so, food and our eating habits have changed considerably. Here are just a few of these changes:

- We produce food differently.
- We eat more convenience foods.
- We eat more fast food.
- We eat out more often.
- New ‘germs’ have appeared (*E coli 0157*)
- New diseases have emerged (BSE and nvCJD).

Epidemiological investigations of food-borne illness have identified the kinds of error in food production, distribution, or preparation that allow microbial pathogens to contaminate food. Some food handling errors introduce pathogens into uncontaminated food. Other errors permit the pathogenic organism already present in raw food to survive or multiply to dangerous levels in prepared foods. Potential errors include:

- The use of contaminated food,
- Cross-contamination of prepared food by contaminated raw food
- Poor personal hygiene by infected food handlers
- Inadequate cleaning of equipment
- Inadequate cooking or reheating
- Improper holding temperatures
- Cooling food too slowly after heating
- Eating food too long after preparation (Buzby *et al*. 2001)

Eating outside the home in restaurants and other food service outlets have been identified as one of the risk factor for foodborne illness.

Table 2: Implication of food service institutions in the cause of foodborne illness

Source	%
Home	60
Food Service institution	35
Processing Plants	5

According to FDA Retail Food Program Steering Committee Report (2000) a study was conducted by the FDA in US to establish the occurrence of food-borne illness risk factors in food service establishments such as hospitals, nursing homes, elementary schools(Institutional), fast food restaurants, full-service restaurants, deli departments, meat and poultry retail outlets, seafood departments and salad bars. The risk factors identified were food from unsafe sources, inadequate cooking, improper holding temperatures, contaminated equipment and poor personal hygiene.. The study involved 895 inspections with 17,477 observations.

The results from the study show that 58% (59 out of 102) of fast food restaurants and 75% (79 out of 105) full service restaurants where out of compliance with the prevention of hand contamination. 33% of fast food restaurant and 47% of full service restaurants did not comply with good hygiene practices. Higher percentage of full service restaurants (81%) did not practice or comply with proper adequate hand washing than fast food restaurants (53%). Out of compliance for surfaces/utensils clean/sanitized was also found to be higher in full service restaurants (70%) than in fast food restaurants (38%).

In hospitals, it was realized that 39% and 35% of hospitals studied were out of compliance when it came to proper, adequate hand washing and surface/utensils clean/sanitized, respectively.

In nursing homes, out of compliance levels were 38% and 33% for proper, adequate hand washing and surface/utensils clean/sanitized, respectively. In elementary schools, 47% and 34% out of compliance were true for the same risk factors.

It was concluded from this study, that food service establishments obtained food from safe sources and foods were cooked or processed adequately. In terms of other risk factors such as improper holding/time-temperature, contamination and personal hygiene, these were below FDA expectations.

Figures 1 to 3 (**reproduced from FDA Retail Food Program Steering Committee, 2000**) below summaries the Percent of Observations Out Compliance for selected risk factors (Improper Holding/Time and Temperature, Poor Personal Hygiene and Contaminated Equipment/Protection from Contamination).

Guzewich & Ross (1999) reviewing published literature on food poisoning outbreaks caused by food workers for the period 1975-1998 reported that 81 outbreaks involving 16 different pathogens were identified. Viral agents especially hepatitis A and Norwalk-like virus accounted for 60% (49) of the outbreaks. 93% (75) of the outbreaks involved food workers who were ill either prior to or at the time of the outbreak, depending on the organism involved. In most of the remaining outbreaks, asymptomatic food workers were believed to be the source of infection. 89% (72) of the outbreaks occurred in food service establishments as compared to 11% (9) that were attributed to foods prepared in domestic settings. Sandwiches, salads, and miscellaneous hot food items that required extensive hand contact during preparation accounted for the majority of foods involved in the outbreaks (Guzewich & Ross, 1999)

Fig 1: IMPROPER HOLDING/TIME AND TEMPERATURE

FIG 2: POOR PERSONAL HYGIENE

FIG 3: CONTAMINATED EQUIPMENT/PROTECTION FROM CONTAMINATION

Emerging pathogens

Rapid expansion food of the service industry, changing life styles and demographics, changing food habits, demand for prepared and ready to eat foods, global food market, technological innovations resulting in centralized mass processing, production, distribution and retailing and extensive use and reliance on the cold chain has contributed to the emergence of new pathogens. These transformations have brought about changes in microbial ecological niches resulting in selection and adaptation of pathogens as a result of ever-changing food-microbial environment. The emerging pathogens give rise to diseases that are far more serious than the uncomfortable but relatively temporary inconvenience of diarrhea and vomiting, which are the most common symptoms of so-called food poisoning caused by traditional pathogens such as *Salmonella, Bacillus. cereus, Staphylococcus aureus*, *Clostridium perfringens,* and *Vibrio parahaemolyticus.* The emerging pathogens such as *Listeria monocytogenes,* Enterohaemorrhagic *E. coli 0157, Campylobacter fetus ssp. fetus* and V*ibrio vulnificus* can cause infections that can result in very serious immediate consequences, such as spontaneous abortions, as well as long-lasting conditions, such as reactive arthritis, Guillsin-Barre syndrome (the most common cause of acute paralysis in adults and children), and hemolytic uremic syndrome (HUS), which can lead to kidney failure and death, particularly in young children.

Salmonella

Salmonella, a leading cause of food poisoning in many countries around the world. In England and Wales, during the last ten years, incidences of Salmonella have hovered around 30,000 cases per year. In the United States of America, it is the second leading cause of bacterial food pathogens. There are over 2400 serovars of *Salmonella*, these serovars belong to *Salmonella enterica.* The other species of *Salmonella* are *Salmonella typhi, Salmonella paratyphi* and *Salmonella choleratris*. Serovars of *Salmonella enterica* causes gastroenteritis and *S. typhi* and *S. paratyphi* causes enteric fever. *S. Cholera-Suis* causes an invasive systemic disease.

Although there are 2400 serovars of *S. enterica*, the predominant serovars causing gastroenteritis are *S. Enteritidis* and *S. Typhimurium* especially *S. Typhimurium* DT 104. *S. Enteritidis* is responsible for almost 50 % of foodborne salmonellosis. Poultry products and eggs are the principal vehicle of transmission of *Salmonella*. In 1994, the UK Public Health Laboratory reported that 41 and 33 % of frozen and chilled chicken produced in the UK were contaminated with *Salmonella*, respectively. The report also observed that the incidence of *Salmonella* decreased from 80% in 1979 to 30-40 % in 1994.

The table below shows foodborne illness outbreaks due to *salmonella enteritidis* in the US as related to different food source locations.

Table 3: Foodborne illness outbreaks due to *Salmonella enteritidis* (1998-2000)

		Year	
Source Location	1998	1999	2000
Community	43 (3)	138 (12)	-
Restaurants	353 (39)	287 (30)	551
Home	136 (31)	46 (4)	182
Cafeteria	-	176 (3)	-
Prison	5 (0)	5 (0)	20
Others*	126 (17)	377 (16)	180
Total	666 (90)	1093 (65)	942

http:/www.cdc.gov/foodborneoutbreaks/us_outb

* include hospitals, schools, nursing homes, water (lake or swimming pool), church, etc.

Figures in brackets are the number hospitalized.

S. Typhimurium DT104 is primarily associated with cattle but it has spread to other food animals, such as pigs, sheep and poultry. *S. Typhimurium* DT104 is now the most commonly reported phage type of *S. Typhimurium* in England and Wales. *S. Typhimurium* DT104 is resistant to many of the commonly used antibiotics, including ampicilin, chloroamphenicol, streptomycin, sulphonamides and tetracycline. Strains resistant to these antibiotics (designated as R type ACSSuT) accounts for 58% of all isolates of *S. Typhimurium* DT104. Recent evidence indicate that some of *S. Typhimurium* DT104 strains are also becoming resistant to ciprofloxacin.

The natural habitat of *Salmonella* is the intestinal tract of warm-blooded animals. The organism can exits in the intestinal tract without causing any illness. The major route of *Salmonella* transmission is direct or indirect fecal contamination of foods throughout the food chain.

Most *Salmonella* serovars are to a certain extent resistant to food processing conditions, such as acids, drying, preservatives or surfactants, as they have regulatory mechanisms that enable them to adapt or overcome stress conditions.

In Malaysia, although salmonellosis is not a reportable disease, the incidence of *Salmonella* isolated from human has doubled (Jegathesam, 1984; Jegathesam *et al.,* 1993). The prevalence of *Salmonella* in Malaysia has been reported by a number of investigators (Yee and Ayob, 1994; Son *et al.,* 1995; Rusul *et al.,* 1996, 1998, Arumugaswamy *et al*., 1994).

In a comprehensive study on the prevalence of *Salmonella* in chicken, Rusul *et al*. (1996) reported that 35.5% (158/445) and 50% (52/104) broiler carcasses obtained from wet markets and processing plants respectively were positive for *Salmonella*. The results are presented in Table 4. In this study, a total of 230 *Salmonella* isolates belonging to 15 serovars were isolated (Table 5). The predominant serovars were *S. Enteritidis* (81/230), *S. Muenchen* (46/230), *S. Kentucky* (33/230), *S. Blocky* (24/230) and *S. Chincol* (12/230). 96.4% of the isolates examined were resistance to at least one antibiotic and 55 % of the isolates were resistant to 3 or more antibiotics. 110 of the isolates harbored plasmids. 3 different plasmid profiles were observed among the 110 isolates (Rusul *et al*., 1998).

The study also demonstrates that the prevalence of *S. Enteritidis* has increased drastically in a relatively short period. The increase of the incidence of *Salmonella Enteritidis* has attributes to the increase of consumption of poultry and eggs. Intensive poultry farming has lead to establishment of *Salmonella Enteritidis* in poultry farm. A risk assessment model developed by FDA predict that about one in every 20,000 eggs produced are contaminated. The model also predicts the contaminations of eggs will result in 661,000 human illnesses.

In an ongoing research at the Department of Food Science, Faculty of Food Science and Biotechnology, Universiti Putra Malaysia, *Salmonella* was isolated from 16/43, 8/20, 8/25, and 8/18 samples of Selom (*Oenanthe stolonifera*), Pegaga (*Ceutella asiatica*), Kangkong (*Ipomoea aqualitica*) and Kesum (*Poly gonum minus*), respectively. These samples were obtained from wet-markets in Puchong, Kajang and Sungai Besi. A total of 184 isolates belonging to 30 serotypes were isolated from these 4 different types of condiments.

Results of these two studies suggest that prevalence of *Salmonella* is a serious problem. The diversity of serovars isolated in these studies also reflects on the overall hygienic conditions under which poultry or these condiments are produced. The condiments examined are usually eaten raw; the presence of *Salmonella* on these condiments presents a serious health hazard.

Table 4: Salmonella in broiler production and processing

Sample type	No. of samples	No. of positive samples (%)
Poultry carcass		
Wet Market	445	158(35.5)
Processing plant	104	52(50.0)
Total	549	210(38.3)
Intestinal content		
Market	54	6(11.0)
Processing plant	44	8(18.2)
Total	98	14(14.3)
Litter		
Broiler farms	40	8(20.0)
Breeder farms	10	2(20.0)
Total	50	10(20.0)
Feed		
Broiler farms	17	0
Breeder farms	6	0
Grand Totals	**720**	**234(32.5)**

Rusul *et al.,* 1996

Table 5: Salmonella serovars isolated from broiler production and processing

Serovar	Type of sample				
	Poultry carcass		Litter		
	Wet-markets	Processing plants	Broiler farm	Breeder farm	Total (%)*
S. Enteritidis	28	47	5	1	81(35.2)
S. Muenchen	46	-	-	-	46(20.0)
S. Kentucky	31	2	-	-	33(14.3)
S. blockley	19	-	-	-	24(10.4)
S. chincol	12	5	-	-	12(5.2)
S. Newport	9	-	-	-	9(3.9)
S. agona	5	-	-	-	6(2.6)
S. weltevreden	4	1	-	-	4(1.7)
S. hadar	2	-	-	-	2(<1)
S.bovismorbifican	1	-	-	1	2(<1)
S. breadney	1	-	-	-	1(<1)
S. Haifa	1	-	-	-	1(<1)
S. Nagoya	1	-	-	-	1(<1)
S. bardford	1	4	-	-	5(2.2)
S. Lomita	-	-	3	-	3(1.3)
Total	**161**	**59**	**8**	**2**	**230**

* Percent Positive

Rusul *et al.,* 1996

Listeria monocytogenes

Listeria monocytogenes gained prominence in 1985, when it caused miscarriage in pregnant women after consumption of Mexican-style cheese in California. In this incidence, 81 women were affected with 48 deaths (including 19 fetal and 10 neonatal). *L. monocytogenes* maybe present in the large intestines of humans. It is estimated that the fecal carriage rate in various populations of healthy adults range from < 1 % to 21 % (FDA, 2001).

L. monocytogenes is widespread in the environment and has frequently been found in meat, fish, poultry and their products. It is also found on vegetables and it is particularly prevalent in vegetation and grasses.

In developing a Risk Assessment model for *L. monocytogenes* (FDA, 2001), it was identified that dairy products, ranked number one, followed by meat products, then fish products and finally, vegetation. Together dairy and meat products were responsible for 70.8 % of the outbreaks for which a food vehicle was identified. When number of outbreak-associated cases were ranked, meat products were first and dairy products were second. Contaminated meat and dairy products were responsible for 92.4 % of the cases.

Dairy and Ready to Eat (RTE) meat products are most often implicated in *Listeria* outbreaks throughout world. The RTE meat products responsible are frankfurter, pate and pork tongue. The most commonly implicated dairy product was soft (fresh and mould ripened) cheese, especially when the cheese is made from unpasteurized milk.

Data in Table 6 shows the isolation of *L. monocytogenes* in food stored in refrigerators of patients with listeriosis (Pinner *et al.,* 1992)

Table 6: Isolation of *L. monocytogenes* in food specimens collected from the refrigerators of patients with listeriosis.

Food Category	No. of positive food (% positive)	No of food tested
Beef	50(36)	140
Poultry	33(31)	108
Pork	26(27)	95
Lunch meat	18(18)	98
Seafood	7(12)	57
Vegetables	72(11)	683
Fruit	5(3)	155
Dairy	9(2)	533
Other*	6(4)	144
Total	226(11)	2,013

*Included bread, pasta, eggs, lamb and miscellaneous anxieties of food.

(Pinner et al., 1992)

In Malaysia, Arumugaswamy *et al*. (1994) examined 234 food samples, consisting 158 and 76 samples of raw and ready to eat foods respectively. The results are summarized in (Table 7). The significant observation in this study was that 22 of the 76 samples of RTE foods were positive for *Listeria monocytogenes*. The detection of *L. monocytogenes* in a high proportion of RTE foods indicate that the community at large has been extensively exposed to *Listeria. L. monocytogenes* was isolated from 3/25 samples of salted fish by Endang *et al*. (1998).

L. monocytogenes causes non-invasive listeriosis with mild flu, the symptom (referred to as listerial gastroenteritis) in healthy individuals and invasive listeriosis in high-risk individuals. The manifestations of invasive listeriosis can be bacteremia, bacterial meningitis, conjunctivitis, central nervous system infection, cutaneous infections, encephalitis, endocarditis, miningoencephalitis, miscarriage, neonatal disease, osteomylitis, peritonitis, premature birth and stillbirth. High-risk individual are pregnant ladies, infants, elderly, individual with impaired immune system, those suffering from chronic disease, such as hepatitis or diabetes.

Studies have shown that *L. monocytogenes* is present in the environment and food in Malaysia. The extent of *Listeria* contamination in food suggest that human listeriosis may be prevalence in the community. It is important for food processors and regulatory agencies to consider the following factors in designing strategies to prevent growth and survival of *L. monocytogenes* commonly found in the environment, including food processing, distribution, and retail environments, in foods, and in the home.

It can grow slowly in many foods during refrigerated storage and this favors selection and outgrowth of *L. monocytogenes* over prolonged storage. It is more resistant than most bacteria to processing condition used to control other foodborne pathogens.

Table 7: Prevalence of *L. monocytogenes* in foods

Food	No. of samples	No. of sample positive
Raw foods		
Chicken Portions	32	19(60%)
Chicken Liver	17	10(60%)
Chicken gizzard	18	12(66%)
Beef	12	6(50%)
Fresh pawn	16	7(44%)
Kupang (dried oyster)	3	1(33%)
Leafy Vegetables	22	5(22%)
Bean Sprout	7	6(85%)
Bean Cake	8	2(25%)
Satay (Uncooked)	23	11(48%)
Ready to eat foods		
Satay	39	11(26%)
Squids, prawn, chicken and clams.	27	6(22%)
Cucumber (slices)	5	4(80%)
Peanut Sauces		1(20%)

(Arumugaswamy *et al*. 1994)

Escherichia coli 0157:H7

E.coli 0157:H7 was first recognized as a human major foodborne pathogen following two outbreaks of gastroenteritis in Michigan and Oregon in 1982, both of which were epidemiologically linked to the consumption of hamburgers (Riley *et al*., 1983)

In the US, this pathogen has emerged as a major cause of bloody diarrhea and non-bloody diarrhea, causing as many as 62,458 cases with 1,843 hospitalizations and 52 deaths annually (Mead *et al*., 1999). Its principal vehicles of transmission are beef, fruits, vegetables, water (both drinking and recreational), and contact with cattle (Doyle *et al.,* 1997; Griffin, 1998). Since *E.coli* is present in the intestinal tract of cattle, the pathogen's most frequent origin is direct or indirect contact with cattle manure. Manure can contaminate food when used as soil fertilizer, when it pollutes irrigation water, when cattle defecate near fruits, vegetables or foods of animal origin, and when intestinal contents or manure-laden hides contact carcass during slaughter and processing.

Table 8 shows foodborne illness outbreaks due to *E. coli* 0157:H7 in the US as related to different food source locations.

Table 8: Foodborne illness outbreaks due to *E. coli* 0157:H7 (1998-2001)

	Year			
Source Location	1998	1999	2000	2001
Community	234 (58)	194 (40)	145 (54)	13 (3)
Restaurants	181 (18)	158 (47)	971 (63)	62 (12)
Home	7 (2)	4 (1)	55 (9)	37 (14)
Day Care	58 (7)	36 (5)	30 (2)	52 (10)
Prison	98 (24)	-	45 (0)	60 (14)
Fairs	10 (4)	1041 (65)	38 (24)	346 (19)
Picnics	11 (6)	6 (1)	6 (2)	-
Others*	178 (34)	459 (42)	274 (36)	355 (54)
Total	777 (153)	1897 (201)	1564 (190)	925 (126)

http:/www.cdc.gov/foodborneoutbreaks/us_outb

* include hospitals, schools, nursing homes, water (lake or swimming pool), church, camp, etc.

Figures in brackets are the number hospitalized.

E.coli can survive in manure, water troughs, soil and water at ambient temperature for weeks (Faith *et al*., 1996; Sargent *et al.,* 2000; Manle, 2000; Rice and Johnson, 2000). *E.coli 0157:H7* strains are able to persists in cattle without causing disease because cattle lack a receptor for the illness-producing Shiga toxin (Pruimboom-Brees *et al*., 2000).

E.coli 0157:H7 also have been isolated from retail ground beef, pork, poultry and lamb (Doyle and Schoeni, 1987). *E.coli 0157:H7* causes illness such as hemorrhagic colitis, hemolytic uremic syndrome, and thrombotic thrombocytopenia purpura (Karmali, 1989). *E.coli 0157:H7* is able to cause the above-mentioned diseases because it produces Shiga toxins. The organism also encodes for attaching and effacing genes that enables the pathogen to attached and adhere to the epithelial cells and form a pedestal on the epithelial surface upon which the bacteria resides.

E.coli 0157:H7 is able to survive in a low pH environment. This facilitates the passage through the stomach, making it possible for *E.coli 0157:H7* to cause disease at low infection dose (10-100 bacteria). The organism's acid tolerance also allows it to survive within acid food, which was a major factor in the outbreaks of illness traced to unpasteurised apple juice, a product with a pH of approximately 3.5 that usually inhibits the less virulent strains of *E.coli* (Besser *et al,* 1993). Tauxe (1997) reviewing evolution of foodborne pathogen observed that *E.coli 0157:H7* has caused illness through an ever-broading spectrum of foods, beyond the beef and raw milk that are directly related to the bovine reservoir.

Prevalence of *E.coli 0157:H7* has been reported in United Kingdom, Europe, South Africa, Thailand and Malaysia. Son Radu *et al*. (1998) for the first time reported the prevalence of *E.coli 0157:H7* in imported beef in Malaysia. 12 strains of *E.coli 0157:H7* were isolated from 9 of 25 beef samples obtained from retail stalls in Malaysia. Seven of the 12 strains have the ability to produce both Stx1 and Stx2 (Stx, synonymous with verotoxin and Shiga-like toxin) toxins. The remaining five strains were capable of producing Stx2 toxin only. The 12 strains also had the eae gene and a 60-Mda plasmid. None of the 12 strains showed identical antibiograms.

The authors concluded that the differences in antibiogram, plasmid profile, and AP-PCR (arbitrarily primed PCR) suggest that the strains may have originated from diverse sources.

As *E.coli 0157:H7* causes illness in human being, research should be directed in identifying its role in clinical setting. There have been reports that incidence of renal diseases are on the rise, thus it is vital that an epidemiological study be conducted to determined whether there is any correlation between renal diseases in Malaysia and the prevalence of *E.coli 0157:H7* in foods.

Campylobacter

Although other *Campylobacter* spp. has been implicated in human gastroenteritis, it is believed that 99% of the cases are caused by *Campylobacter jejuni*.

Campylobacter jejuni, an emerging foodborne pathogen not recognized as a cause of human illness until the late 1970s, is now considered the leading cause of foodborne bacterial infection. An estimated four million *C. jejuni* infection occurs each year in the United States; most sporadic infections are associated with improper preparation or consumption of mishandled poultry products (Tauxe, 1992). Incidence of campylobacteriosis is particularly high among young men. The high incidence of disease in this group may reflect poor food preparation skills. Most *C. jejuni* outbreaks, which are far less common than sporadic illnesses, are associated with consumption of raw milk or unchlorinated water (Tauxe, 1992). *A Campylobacter infection is* followed by the Guillain-Barré syndrome, an acute paralytic illness that may leave chronic deficits (Mishu *et al*., 1992).

It is estimated that about 80% of poultry for human consumption is contaminated with *Campylobacter*. In 1999, 18% of human *Campylobacter* infections were due to fluoroquinolone-resistant organisms (http://www.cdc.gov/ncidod/dbmd/diseaseinfo/campylobacter_t.htm).

The infective dose of *Campylobacter jejuni* is considered to be small; human feeding studies suggest that about 400-500 cells of the bacteria is needed to cause illness in some individuals, whiles in others, greater numbers are required. Usually, outbreaks are small (less than 50 people), but in the US a large outbreak involving about 2,000 people occurred in a town while the town was temporary using a non-chlorinated water source as a water supply (www.vm.cfsan.fda.gov/~mow/chap4.html). Several outbreaks were reported among children who were taken on a class trip to a dairy and given raw milk to drink. 50% of infections have been reported to be associated with either eating inadequately cooked or recontaminated chicken meat or handling chickens.

Table 9 shows foodborne illness outbreaks due to *Campylobacter jejuni* in the US as related to different food source locations.

Table 9: Foodborne illness outbreaks due to *Campylobacter spp*[+] (1998-2001)

		Year	
Source Location	1998	1999	2000
Restaurants	319	13	38
Home	8	35	57
School	16	-	-
Others[*]	140	37	110
Total	483	85	205

http:/www.cdc.gov/foodborneoutbreaks/us_outb

[+]include *Campylobacter jejuni*

[*] multiple source locations

Conclusion

In Malaysia, food service establishments are increasing at a rapid pace as there is great demand for ready to eat foods. More people are eating out as there is less time to prepare meals at home. The demand is generated due to changing life styles, affluence, demographics and growth in the tourism industry. It is important that both the regulatory agencies and the food service operators recognized the risk factors associated with outbreaks of food poisoning at the food service establishment and institute the necessary measures to ensure food safety. Managers of food service establishments should play an active role in controlling all identified risk factors could have a significant impact on reducing the occurrence of both the traditional and emerging pathogens Improvements in industry's active managerial control of the risk factors will result in a greater level og consumer protection.

The FDA Retail Food Program Steering Committee (2000) recommends that the industry adopt the following strategies in ensuring production of safe foods at their establishments:

1. Develop and implement Standard Operating Procedures (SOPS) that address the risk factors. These SOPs should detail procedures specific to the operation for time/temperature control of potentially hazardous food, personal hygiene, and measure to prevent food from being contaminated

2. Provide all employees with specific training to implement the SOPs

3. Provide the necessary resources, equipment and supplies to implement the SOPs.

4. Assess SOPs to ensure control over all risk factors. Critical limits and measurable standards for control of the risk factors should be incorporated into SOPs. Critical limits provide a means for measuring the effectiveness of an establishment's food safety procedures.

5. Establish monitoring procedure that focus on critical processes and practices. Monitoring procedures will only be effective if employees are given the knowledge, skills, and responsibility for food safety.
6. Identify methods to routinely assess the effectiveness of the SOPs. This assessments approach could be based on an internal review, regulatory inspection results or third party evaluations.

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