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Assurance of Microbiological Safety in a University Feeding System

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ABSTRACT

The sanitation surveillance system was developed with standards and follow-up actions as a part of an assurance program for microbiological safety in a university feeding system. The surveillance is based upon an adhesive contact and transfer tape system for surface monitoring and a micropore filter system for monitoring efficiency of the associated laundry operation. Results compiled from 3 years of operation generally show continued reductions in numbers of items testing below fully satisfactory. Specific systems of microbiological data analysis for detection of some mechanical or procedural breakdowns were developed. The overall cost for the entire laboratory part of the food safety assurance program was less than 0.5 cent per meal served.

INTRODUCTION

The major objective of a food safety and protection program is to insure preventive practices such that a food safety breakdown does not occur. To achieve such a state requires a level of effort greater than is required to correct a deficiency which has been exposed through an outbreak of food borne disease. The reward of prevention is much greater since the reputation of the establishment is maintained and the potential law suits are avoided. The complete confidence of the customers should be a major objective of an establishment. A single breakdown of the system is long remembered while the usual day to day successes are expected and go seemingly unnoticed.

The university feeding system is no different from any other in its safety needs but is often considerably different in its clientele. The customer is usually in a high state of physical well-being and at an age of high resistance to disease. However, the customer is often a regular 2 or 3 meal per day, 5 to 7 days per week consumer, thereby creating a great demand for a very large variety of items on the menu, and a relatively long menu cycle. The customer is generally free to leave the system. Many university feeding systems continue to have subscription eaters but almost all have an active cash activity to provide the students with greater freedom of choice. The university student can be vociferous and often has a ready and willing press waiting in the form of numerous student publications, always eager to criticize a university operated or controlled activity.

[1]*Presented in a Seminar on Microbiology of Mass Feeding Systems held at the 75th Annual Meeting of the American Society for Microbiology, New York, N.Y., April 27-May 2, 1975.*

This paper will describe a microbiological safety assurance program which was developed, activated, and is now completing its third year of operation. The program was designed to provide regular surveillance, evaluation, and presentation of facts to persons at all operational and managerial levels to insure that each and every person knows exactly what is expected of them.

The system is based upon strong laboratory support in terms of analyses, interpretation, and communication; and strong support from a convinced management through a trained sanitarian with organizational power. The organizational structure may be seen in Fig. 1. The

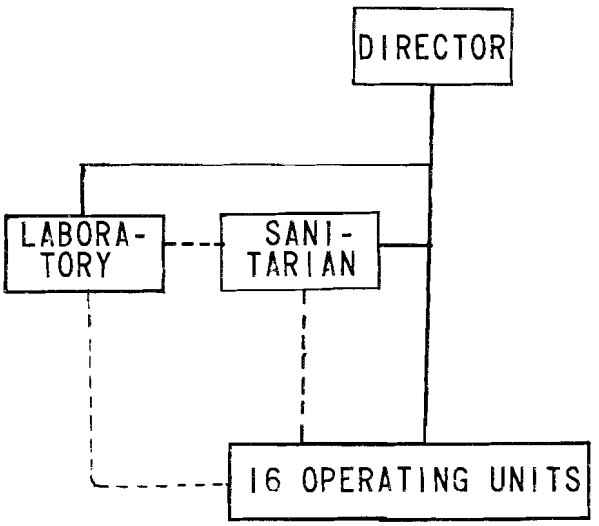

Figure 1. *Organizational chart showing the position of the laboratory and the sanitarian with respect to the operating units and the director of all feeding operations.*

sanitarian is in direct communication with the supervisors of the 16 operating units and with the director whose support is available in every move made with respect to food safety. The success of the system is a function of the combined activities of the laboratory's communications effectiveness which presents interpretations of results with recommended actions to the sanitarian and the sanitarian who then communicates effectively with the operations managers and the operations personnel. The sanitarian also ensures that corrective action is taken as required.

The mass feeding system is composed of 16 units; 15 are feeding operations and the 16th is a laundry. The feeding units vary in size from 1,000 meals per week to approximately 40,000 meals per week. Six of the units are snack bar operations with limited menus. The others are capable of full-scale feeding. During an average week, approximately 140,000 meals are served.

Each unit is visited on a regular basis for microbiological evaluation. The frequency of visitation is regulated by the number of meals being served. Thus, the units which have the greatest number of contacts with customers get the most attention and usually need the most coverage due to the pressures of the larger operations.

TABLE 1. *A breakdown of feeding units by size, frequency of microbiological evaluation and level of samplings based upon meals served*

Evaluation frequency	Activity level (meals/week)	Number of feeding units	Samplings per 1,000 meals
Weekly[a]	> 40,000	1	0.75
Every 2 weeks	12,000-20,000	3	1.00
Every 4 weeks	8,000-12,000	2	1.00
Every 6 weeks	< 8,000	9	0.67-4.25

[a]Double sampling on a biweekly basis due to logistical considerations.

Table 1 relates the size of the unit to the frequency of visitation and classifies each of the currently active, 15 feeding units into a category. There are no units which serve between 20,000 and 40,000 meals weekly. Within the units serving less than 8,000 meals weekly, there are some as low as 1,200 meals weekly and others as high as 7,600 meals weekly. In this category, five of the nine units are small enough to be placed in a less than every 6 weeks evaluation category but it was arbitrarily decided that a lesser frequency would sacrifice too much in effectiveness.

The surveillance targets included in the program are the physical facilities, operational practices, raw materials, and end products. These objectives are accomplished through inspection, training, and testing. Periodic inspections based upon the Retail Food Establishment Code, which is part of the state statutes, are conducted. The sanitarian is trained to do this phase of the program. Equivalent inspection is also accomplished by the state or local health officials on an annual or more frequent basis. Testing procedures include microbiological, instrumental, and sensory evaluations. The instrumental tests are primarily concerned with temperatures of foods and storage facilities. The sensory tests involve observations of the general status of equipment, supplies, and facilities. The personnel training is carried out by formal classroom presentations, of the 1 day or 2 day program type, several times during the year. This, too, is conducted and organized by the sanitarian and takes advantage of the slow periods which occur during student vacations and breaks between regular teaching periods. Lectures, slides, film strips, films, and teaching aides of many types are used. A test has been developed to evaluate the degree of learning which has taken place. This test is composed of a general section and a specialized section. The general section covers aspects of such significance that workers at all levels and in all jobs should know these facts. There are specialized sections for food handlers, including dish and pot washers; and for non-food handlers, such as porters, truck drivers, and maintenance persons. All managerial personnel are examined in all sections of the test.

The remaining functions are those which intimately involve the laboratory and are microbially oriented. Included are testing and the development of microbiological specifications. The laboratory is organized in accordance with Fig. 2. The program may

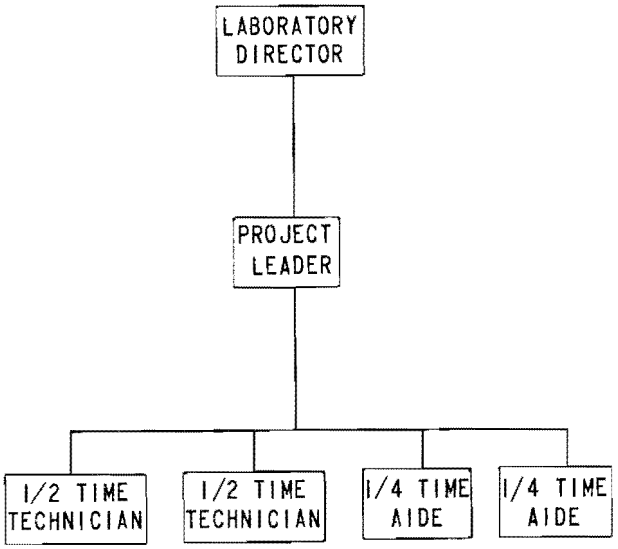

Figure 2. *The organizational chart for the laboratory operations of the food safety assurance program.*

be divided into two segments, each requiring approximately 50% of the work hours available. The first part includes the testing of raw materials, finished product, and development of microbial specifications. This finished product part of the program serves as an audit of the overall effectiveness of the entire microbiological food safety assurance program. Most of the raw material testing is evaluation of new suppliers or new products being proposed for addition to the menu. All of the food evaluation testing has examined products for the common indicators, including total aerobic plate count, coliforms, and *Escherichia coli,* as well as the common food pathogens; *Staphylococcus aureus, Clostridium perfringens,* and *Salmonella.*

The second sgement of the laboratory operation is called the "surveillance program." The surveillance program involves the microbial evaluation of sanitary operation through testing food contact surfaces, ancillary surfaces, and laundry or linen.

PROCEDURES

Surface testing is accomplished with a transparent,

sticky tape (Birko Chemical Co., Denver, Colorado) contact technique utilizing Plate Count Agar (PCA) as the culture medium. Incubation is carried out at 37 C for 20-24 h. Plastic petri dishes are stamp-printed on the bottoms with fast drying ink to divide the dishes into five squares each measuring 1 in^2 and each labeled with a letter from A through E, as may be seen in Fig. 3. The

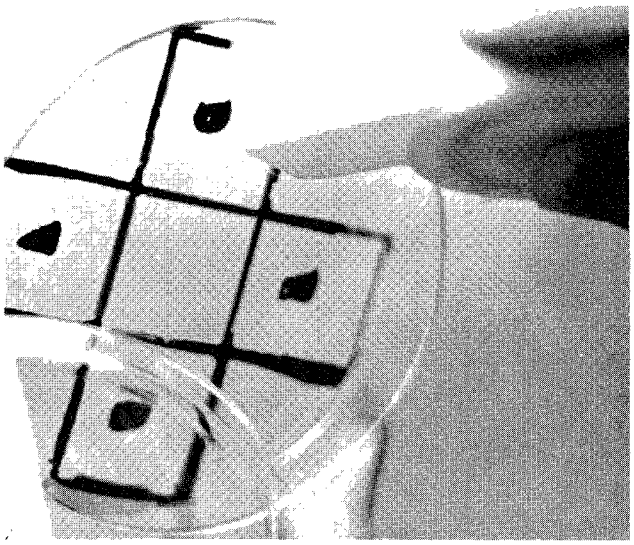

Figure 3. *The adhesive contact tape dispenser and the subdivided Petri dish containing Plate Count Agar.*

petri dishes are prepoured, 18-24 h before use and left inverted at room temperature until they are taken from the laboratory to the test site. The gas sterilized contact tape is ¾inch wide and is in a dispenser designed to permit the tape to be drawn out of the dispenser, looped over a ¾in^2 finger-like protrusion on the dispenser, and then placed on the surface to be tested. If the surface being evaluated is not flat, it is easy to carefully place a finger on the back of the tape and press it onto the irregular surface. This procedure can even be accomplished upon the tines of a fork or on the surface of a beverage spout, a strainer or any other device. The used surface of the tape is then replaced on the dispenser finger and placed in contact with the PCA surface within one of the lettered squares. Each petri dish is numbered on its cover, and a record is kept of each sampling on the "Sanitation Evaluation Survey Report" sheet (see Fig. 4). The petri dish number is placed in column 1. Column 4 is filled in with the actual physical location of the equipment or the implement when it was tested. The part or section of the item being tested is entered in column 5, and a check (√) is placed in column 6 if the item was in use as opposed to clean and ready for use. The remainder of the form is self-explanatory. This system is used for evaluation of both food contact surfaces and ancillary surfaces, such as trays, tables, carts, cabinets, walls, ceilings, and others.

Contamination levels are determined by counting the colonies formed using a Quebec Colony Counter. Routine sampling of a feeding unit involves 30 surface evaluations. There are approximately 50 different items which appear in the test reports. The number could be much larger but is kept small by grouping items which are used and cleaned similarly and which are made of similar materials. Evaluation of the contamination significance is based upon arbitrary standards which are presented in Table 2. For purpose of comparison, 10

TABLE 2. *Surveillance standards for surface contamination as applied for clean and in use items being evaluated by the adhesive contact tape method*

Condition	CFU[a]/3/4 $inch^2$	
	Clean	In use
Acceptable	< 5	< 20
Level of Concern	5-10	20-40
Potential Hazard	> 10	> 40

[a]Colony forming units

colonies from the adhesive contact transfer would be equivalent to 70-80 colonies on an agar contact plate (RODAC) which has a 4 in^2 surface. This relationship is based upon unpublished recovery data obtained using *Bacillus subtilis* spores, artificially inoculated on stainless steel surfaces which indicated approximately 42% recovery using contact tape as opposed to approximately 59% recovery using surface contact agar plates (personal communication with J. S. Rose, Birko Chemical Co., Denver, Colorado).

Table 2 also shows that there are different standards for clean surfaces as opposed to surfaces which are in use. The rationale employed in establishing these standards is that even "in use" equipment must be cleaned if the microbial build-up exceeds some reasonable limit. The actions which result from the evaluations are a routine report for all acceptable items, a special letter report for "level of concern" items with a routine follow-up which involves resampling of the item during the next regular surveillance, and a special report for "potential hazard" items with a special follow-up within 1 week. The special follow-up involves an extensive survey of the problem item or items. If this follow-up indicates a continuing problem, a systematic study will be initiated to determine the cause of the problem, and corrective action will be suggested. All special letter reports are given personal attention by the sanitarian, and the results are communicated to the operations personnel.

A centralized laundry handles all uniforms, aprons, towels, linen, etc. for 13 of the 15 feeding units. The two remaining units use an outside laundry service. The microbiological effectiveness of the laundering operation is monitored every two weeks. Sample items are selected from completed items ready for delivery to users. The samples are aseptically handled after collection. An area of significance, such as the front of an apron or coat, is selected and placed on top of a micropore filter which is in place on top of a fritted glass funnel base inserted into a 500-ml filter flask. A funnel top is placed on top of the garment and a clamp is fitted into place with care

Date of
test completion: _____

Food Science Department
Rutgers The State University
New Brunswick, New Jersey 08903

Initials:
Tester: _____
Facility
representative: _____

SANITATION EVALUATION SURVEY REPORT

Facility _____ Date: _____ Time: _____ Tester(s): _____

(1)	Sample code (2)	Equipment nomenclature (3)	Location (4)	Area sampled (5)	In use (6)	Physical appearance and comments (7)	Contamination level organisms/3/4in^2 (8)	Remarks (9)
	A							
	B							
	C							
	D							
	E							
	A							
	B							
	C							
	D							
	E							
	A							
	B							
	C							
	D							
	E							

Figure 4. *The sanitation evaluation survey report form which is prepared by the laboratory and submitted to the sanitarian for subsequent dissemination to the operational units.*

taken to minimize the amount of fabric within the clamp. The micropore filter is a 47-mm diameter disc with a 0.45-μ pore size (Millipore Corp., Bedford, Mass.), and the filter assembly is the appropriate one from the same source. One hundred milliliters of 0.1% sterile peptone water is poured through the fabric and the filter with suction supplied by a water aspirator. The filter is then removed and placed upon the surface of a prepoured Petri dish containing Tryptone Glucose Extract agar, which is then incubated at 37 C for 20-24 h before counting the colonies formed. Arbitrary standards were set up at ≤ 6 colonies being acceptable. Results are reported to the sanitarian who communicates them to the operations personnel.

RESULTS AND DISCUSSION

A summary of results, broken down by year of operation, appears in Table 3. The first year (1972/1973) was one of gradual buildup with units being added to the program as the procedures and personnel became ready for them. The follow-up totals expressed in percent of total samples are indicative of the effectiveness of the overall program in establishing an awareness of problem areas and the need for continual vigilance on the part of operations level personnel. The steady drop in follow-up total percent may be seen in Fig. 5 with a projected point for the 1975/1976 year. The shift during 1974/1975 of items out of the "hazard" level and into the "concern" level and into the "acceptable" level is evident from Table 3. There is some bias towards higher numbers in these analyses since many of the results are problem area follow-ups which would be more likely to repeat as problems, than would other routine samplings.

TABLE 3. *A three year summary of sanitation surveillance results for approximately 50 categories of surfaces tested expressed in terms of the established standards and the total of items requiring follow-up testing*

Tests and results	72/73		73/74		74/75	
	Number	%	Number	%	Number	%
Tests	3,138	—	6,048	—	5,285	—
Concern	236	7	267	4	234	4
Hazard	466	15	612	10	344	7
Follow-up, total	702	22	879	15	578	11

TABLE 4. *The number of substandard samples encountered during testing of various specific items expressed on an annual basis*

Equipment	% Requiring follow-up		
	72/73	73/74	74/75
Vegetable cutter	88	12	11
Slicers	75	17	8
Scales	67	27	13
Cutting boards	66	23	25
Rubber	—	24	26
Wooden	—	10	22
Plastic	—	33	20
Trays-fiberglass	41	21	10
Student	—	9	11
Kitchen	—	36	9
Mixing bowls-st. st.	26	17	11

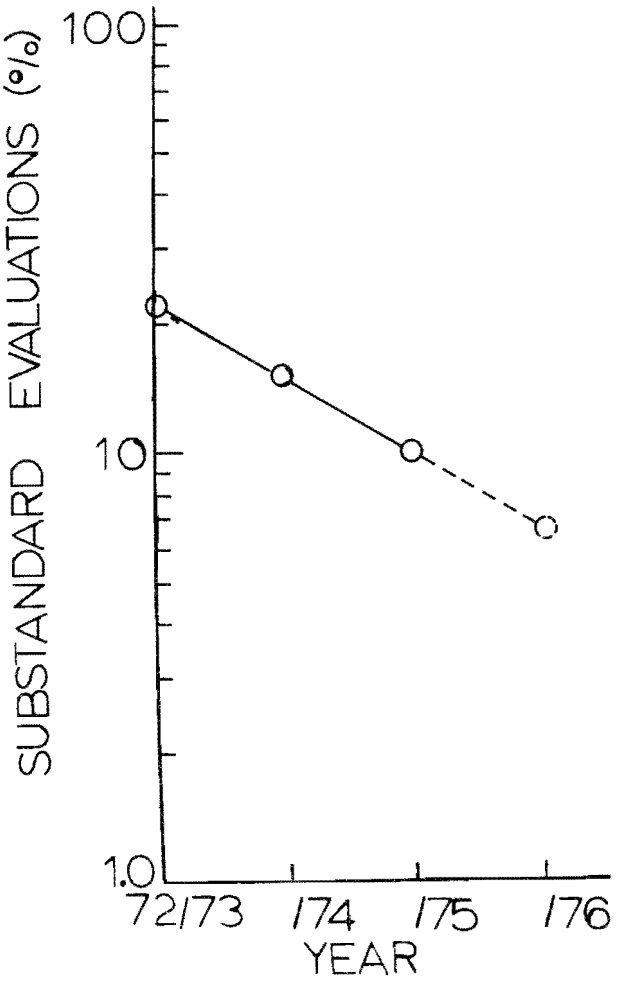

Figure 5. *The percentage of substandard surface surveillance samples encountered on an annual basis with a projection for one year in the future.*

Table 4 considers some specific items which are among the most troublesome ones encountered. Early in the program, it was observed that fiberglass trays, which are used by students to carry their food from the serving counters to the tables, were showing high contamination levels at a higher than expected frequency. Study of the problem showed that worn trays were the principal offenders. Once these were replaced, the problem diminished considerably. The fiberglass trays provided an additional quantity of unexpected information. The trays are washed in the dish-washing machines in each unit. The fiberglass tray is probably among the least conductive materials washed in the machines. When the trays from one unit yielded a spreading type colony which was a gram positive sporeformer, an operations study was conducted. The study led to the observation that the dish-machine had several clogged spray heads. On another occasion, the isolation of similar organisms led to an improperly functioning mixing valve in a dish-machine. The observance of spreading colonies from tray sampling has become an indicator of dish-machine maintenance problems. Since the trays

probably get the least heat treatment in the washer due to their low thermal conductivity, they provide a margin of safety to other materials going through the same machine. This has been evident since isolations of these typical spreading organisms has not been observed on dishes or silverware passing through the same machine.

All of the most troublesome items from the first year of the surveillance program were substantially reduced in frequency of required follow-up activity during the second operational year. In the 1972/1973 year, there were few fiberglass trays in use within kitchen areas. As the reports showed the continued high level of cleanliness of the trays, the operations personnel began using more and more of the trays for storage of foods, resulting in much higher soil levels and many more unacceptable microbial evaluations. Control was achieved over this problem by discouraging use and requiring that all fiberglass trays used within the kitchen area had to be wrapped in clean saran.

The dramatic change in follow-up frequency for vegetable cutters resulted from the replacement of machines containing pitted aluminum cutting bowls with new machines manufactured with stainless steel cutting bowls. The marked improvements in sanitary quality of slicers and scales is attributed to the surveillance program and the resulting increased awareness for proper cleaning and maintenance of such equipment since no new equipment purchases were involved.

Cutting boards showed dramatic reductions in the frequency of unacceptable samplings between 1972/1973 and 1973/1974 and a slight increase between 1973/1974 and 1974/1975. The overall improved conditions are the result of constant testing and development of improved cleaning procedures. Cutting boards are now scrubbed by brush with detergent, washed in the dish-machines, sprayed or soaked in sanitizing solution and rinsed clean before storage for subsequent use. Most of the wooden cutting boards were replaced during 1972/1973. It is evident that more of these became worn and uncleanable with additional use. In 1973/1974, a new plastic cutting board was introduced. It was touted as being a super board, and the result was that operating personnel did not give it the attention needed to insure microbial quality maintenance. The problem was brought under control by demonstrating that cleaning processes for this item were as critical as for any other cutting board. During the 1974/1975 year, the plastic cutting boards were in line with the rubber cutting boards.

The data given were selected from the significant problem areas. The lesser problem areas demonstrate similar overall trends. This is evident from Table 3 when it is recognized that approximately 50% of the follow-up total is in items other than those listed in Table 4. Results of surveillance in the laundry operation demonstrate that approximately 80% of all samples are within the acceptable region of ≥ 6 colonies per micropore filter disc. This result was not surprising since the facility was new and all of the equipment was new. The results in the 1974/1975 year showed a sudden increase in unacceptable samples during one month. This was traced to a change in detergent made by the supplier due to a shortage at one time during the year. The entire problem disappeared when the regular detergent was put back into use. This occurance has established a certain level of respect for the surveillance program from the laundry operations personnel who now want to know how good a job they are doing on a more regular basis.

The real effectiveness of the program can be measured only in terms of the safety of the food being served to the customers. Three years of total freedom from illness attributable to food borne pathogens has been the result. The microbiological surveillance program contributed to the food safety through the establishment and continual reinforcement of operations personnel awareness and through the detection of procedural breakdowns so that corrective action can be taken before a serious problem can occur.

The entire cost of the laboratory program including food sampling and sanitation surveillance is less than 0.5 cent per meal served.