APIC 27th Annual Educational Conference
and International Meeting
Minneapolis, Minnesota
June 18 - 22, 2000

EFFICACY OF A SILVER ION-IMPREGNATED TRANSPARENT DRESSING IN REDUCING MICROBIAL SKIN FLORA AND CENTRAL VENOUS CATHETER-RELATED INFECTIONS

*Brooks KL**
Dauenhauer SA
Evans JT
Overton Brooks VAMC, Shreveport, LA

BACKGROUND: Since the late 1800s, silver, because of its broad-spectrum antimicrobial activity, has been used in clinical settings. In 1996, a silver ion-impregnated transparent dressing (SITD), which releases silver at a continuous, controlled rate, was introduced. A prospective study was conducted at Overton Brooks VAMC from October 1998-March 1999 to determine the efficacy of a SITD versus a non-treated transparent dressing (NTD) in decreasing microbial flora at the central venous catheter (CVC) insertion site and subsequently reducing CVC-related infections.

METHODS: Sixteen (16) patients in the Medical Intensive Care Unit and 15 patients in the Surgical Intensive Care Unit comprised the study population. The protocol consisted of: 1) SITD and NTD sites prepared with chlorhexidine; 2) SITD applied to CVC site and NTD applied to opposing body site (control); 3) at seven days, SITD and NTD removed and sites cultured.

RESULTS: Thirty-nine (39) NTD and 35 SITD sites were cultured. NTD sites 16/39 (41%) were colonized with Gram-positive bacteria, compared with SITD sites 9/35 (26%). NTD sites 2/39 (5%) were colonized with Gram-negative bacteria, compared with SITD sites 1/35 (3%). NTD sites 2/39 (5%) were colonized with yeast compared with none at SITD sites. NTD sites 19/39 (49%) showed no growth compared with SITD sites 25/35 (71%). Data indicate NTD sites may be a risk factor for increased skin colonization. (Fischer's exact test p=0.039, Chi-square=3.060, df=1, p=0.080, odds ratio=2.631, and 95% confidence limits: 0.890 and 7.780.)

CONCLUSIONS: During the five-month study period, a 62% reduction in bloodstream infections (BSI) was noted. In the five months post-study, there was a 233% increase in BSI, with an estimated additional cost of $30,714. Use of SITD may result in decreased skin colonization leading to fewer CVC-related infections and a significant cost savings.

in the group. Indeed, the low serum levels were unlikely to be diet-related since very restricted diets are needed to yield such low cholesterol values in normally responsive individuals. It is much more likely that these were non-responders or poor responders, with respect to serum lipids, to the usual high-fat, high-cholesterol diets. Susceptibility to disease, perhaps especially the major chronic disease, is affected by both genetics (the host factor) and the environment. Therefore, for reasons unknown, these poor responders or non-responders are likely to be especially susceptible to some cancers. In view of the epidemiological evidence, especially from investigations of immigrants which show an increasing frequency of cancer as a western type diet is adopted, these susceptible individuals may be those most likely to benefit, with respect to cancer, from consumption of a prudent diet that lowers serum cholesterol. The genetics and metabolism of the hypercholesterolaemias has been widely investigated. Similar study of individuals with hypocholesterolaemia might indicate why this group seems to be especially susceptible to some cancers.

It is unlikely, although not impossible, that diet/cancer relations will be resolved by the study of populations with homogeneous dietary habits.[2,3] We have (a) very little capacity to quantify the consumption of individuals within such groups; (b) almost no ability to estimate dietary practice in the past; and (c) very little capacity to distinguish various degrees of susceptibility. Thus, the epidemiological data, especially of populations whose diets have changed or are changing, is of great importance.

One Pine Hill Drive,
Southborough,
Massachusetts 01772, USA — D. M. HEGSTED

1. Isles CG, Hole DJ, Gillis CR, et al. Plasma cholesterol, coronary heart disease, and cancer in the Renfrew and Paisley survey. *Br Med J* 1989; 298: 920–24.
2. Hegsted DM. Methodologic considerations in investigating the diet-cancer link. *Am J Clin Nutr* 1988; 48: 1522–24.
3. Hegsted DM. Errors of measurement. *Nutr Cancer* 1989; 12: 105–07

. These letters have been shown to Professor Shekelle and Professor Stamler, whose reply to them and earlier letters follows.—ED. L.

SIR,—Dr Skrabanek (July 8, p 110) and Dr Totman (July 8, p 111) are mistaken with respect to the evidence on which we based our conclusion about dietary cholesterol. Extensive data, recently reviewed by the National Research Council's Committee on Diet and Health,[1] show that change in intake of dietary cholesterol affects the concentration of serum cholesterol, especially low-density-lipoprotein (LDL)-cholesterol. The magnitude of the effect has large intraindividual and interindividual variation, but the mean effect for groups is predictable. This has led many workers to recommend limiting of dietary cholesterol intake— eg, to under 300 mg daily. In addition, dietary cholesterol may affect risk of atherosclerotic cardiovascular disease independently of its effect on serum LDL-cholesterol.[2,3] Results supporting this hypothesis have come not only from the Western Electric study but also from three independent prospective epidemiology investigations. On the basis of all the evidence, these results do "reinforce the recommendation that intake of dietary cholesterol should be low in people without overt hyperlipidaemia as well as those with raised serum cholesterol".

Dr Goldstein (July 8, p 111) noted that age-adjusted total mortality was higher for men who consumed 81–186 mg per 1000 kcal of dietary cholesterol than for those who consumed 187–214 mg per 1000 kcal (16·7 *vs* 14·1 deaths per 1000 person-years of observation), and suggested relaxing dietary guidelines for dietary cholesterol from 300 to 600 mg/day. His suggestion assumes, of course, that the extra 2·6 deaths per 1000 person-years can be attributed directly to the lower intake of cholesterol. At least two other hypotheses should also be considered. Since the difference in rates was small and not statistically significant, it may have resulted simply from random sampling error. It may also have been attributable to alcoholism, a condition associated with decreased nutrient intake and with increased risk of death from various causes. We tried to minimise this difficulty by omitting men who reportedly consumed 50 ml or more of ethanol daily and by including intake of ethanol in the multivariate analyses; but some men may have misrepresented their intake of alcohol and others may have begun or resumed consumption of large amounts of alcohol after the initial examination. Data are insufficient to decide conclusively about these possibilities but, all in all, we think that alcoholism is a more likely explanation for the small number of excess deaths, rather than low intake of dietary cholesterol.

With respect to Professor Hawthorne's question, serum cholesterol in the Western Electric study was not significantly associated with risk of death from cancer ($p = 0{\cdot}483$) although it was positively associated with risk of death from coronary disease ($p < 0{\cdot}001$). We agree with Professor Hegsted that there is little or no reason to think that decreasing intake of saturated fatty acids and of cholesterol alone will increase the risk of cancer. On the contrary, such changes are an integral part of an overall set of dietary recommendations that may substantially reduce both the risk of cancer and of coronary heart disease.[1]

School of Public Health,
University of Texas,
Houston, Texas 77225, USA — RICHARD B. SHEKELLE

Department of Community Health
and Preventive Medicine,
Northwestern University School of Medicine,
Chicago, USA — JEREMIAH STAMLER

1. Committee on Diet and Health. Diet and health: implications for reducing chronic disease risk. Washington DC: National Academy Press, 1989.
2. Zilversmit DB. Atherogenesis: a postprandial phenomenon. *Circulation* 1979; 60: 473–85.
3. Stamler J, Shekelle R. Dietary cholesterol and human coronary heart disease: the epidemiologic evidence. *Arch Pathol Lab Med* 1988; 112: 1033–40.

SCHOOL OUTBREAK OF GASTROENTERITIS DUE TO ATYPICAL ROTAVIRUS

SIR,—We have investigated an outbreak of gastroenteritis in a primary school affecting 28 of the 130 children aged 4–10 years and 1 adult. New cases occurred over 7 days and the illness lasted 2–10 days and was characterised by profuse vomiting. All children at the school eat the same food prepared in one kitchen, the school milk is pasteurised, and no problems were reported with the water supply. There are no school pets and no special school events took place in the days preceding the outbreak. It seems likely that the source of the outbreak was an index case who was ill 36 hours before the main onset of cases and who vomited in the main corridor 24 hours before the next case presented.

Laboratory investigation of faecal specimens from 24 cases failed to reveal bacterial pathogens. Specimens from 10 were examined by electron microscopy and rotavirus particles were seen in 1 case: no other viral agents were detected. All of the specimens were negative in a modified Dakopatts group A rotavirus ELISA. The 10 specimens were also examined by polyacrylamide gel electrophoresis (PAGE): 9/10 specimens had an identical rotavirus electrophoretic profile differing from a control (group A subgroup II rotavirus) pattern by a longer profile of segments 1–11 and by transposition of segment 7. This profile is suggestive of group C rotavirus and preliminary immune electronmicroscopy studies support this classification.[1] These findings suggest that a group C rotavirus was causally associated with the outbreak.

Interest has focused on atypical rotavirus infections since epidemics of diarrhoea due to group B rotavirus were reported from China in 1984.[2] However, only sporadic atypical rotavirus infections have been identified outside China, and a very low prevalence (0·25%) has been reported in cases of infantile diarrhoea.[3] Most human atypical rotaviruses reported from outside China have a similar electrophoretic pattern[4–6] and the few that have been serologically typed are all group C.[3,7,8]

This is the first report of a substantial outbreak of gastroenteritis associated with group C rotavirus infection. We were able to interview nine families with children involved in this outbreak, but in only one family were the home contacts clinically ill. Taken together with the spread of new cases over 7 days, these findings suggest only limited secondary spread of infection. Although the index case owned two pet cats and one rabbit we were unable to identify a clear animal source for these infections. The prevalence of

antibody to group C rotavirus has been reported as 11% in adult sera collected in the UK[7] but there have been few isolates in infantile diarrhoea, despite the extensive investigations by electron-microscopy and PAGE. This suggests that attempts to isolate virus should be directed at older children and adults rather than infants.

Virus Reference Laboratory,
Central Public Health Laboratory,
London NW9 5HT — D. W. G. BROWN

Department of Microbiology,
Bradford Royal Infirmary, Bradford — LESLEY CAMPBELL, D. S. TOMKINS

Public Health Laboratory, Leeds — M. H. HAMBLING

1. McCrae MA, Bridger J, Holmes I, McNulty S, Saif L. Criteria for non-group A rotaviruses. *Ciba Found Symp* 1987; 128: 250–51.
2. Tao H, Gaoguzu C, Changan W, et al. Waterborne outbreak of rotavirus diarrhoea in adults in China caused by a novel rotavirus. *Lancet* 1984; i: 1139–42.
3. Brown DWG, Mathan M, Matthew M, Beards GM, Mathan VI. Rotavirus epidemiology in Vellore, S India: group, sub-group, serotype and electropherotype. *J Clin Microbiol* 1988; 27: 2410–14.
4. Rodger SM, Bishop RF, Holmes IH. Detection of a rotavirus like agent associated with diarrhoea in an infant. *J Clin Microbiol* 1983; 16: 724–26.
5. Espejo RT, Puerto F, Soler L, Gonzalez W. Characterisation of a human pararotavirus. *Infect Immun* 1984; 44: 112–16.
6. Snodgrass DR, Herring AJ, Campbell I, Inglis JM, Hargreaves FD. Comparison of atypical rotaviruses from calves, piglets, lambs and man. *J Gen Virol* 1984; 65: 909–14.
7. Bridger J, Pedley S, McCrae MA. Group C rotaviruses in humans. *J Clin Microbiol* 1986; 23: 760–63.
8. von Bonsdorff CH, Svensson L. Human serogroup C rotavirus in Finland. *Scand J Infect Dis* 1988; 20: 475–78.

APACHE-II SCORE FOR ASSESSMENT AND MONITORING OF ACUTE PANCREATITIS

SIR,—Mr Larvin and Mr McMahon (July 22, p 201) have used the Acute Physiology and Chronic Health Enquiry (APACHE-II) score to assess and monitor acute pancreatitis. We report our experience.

Over the past four years the clinical and laboratory data for 318 patients presenting with acute pancreatitis to our department have been evaluated prospectively. The Imrie (Glasgow) multiscoring system[1] has proved to be no more effective in predicting a severe attack of pancreatitis than the admission values of urea, glucose, or the two variables together, identified by discriminant analysis.[2]

APACHE-II[3] and the Medical Research Council (MRC) sepsis[4] scores were obtained at admission and 48 hours later. These scores were compared with the outcome of each patient's attack of acute pancreatitis, as in Larvin and McMahon's study. These scoring systems were devised to recognise patients who had a high risk of dying and we have therefore examined mortality as well as the prediction of recovery without complication.

The table shows the accuracy, sensitivity, and specificity of the scoring systems. We used the same cut-off points as Larvin and McMahon (ie, APACHE-II over 9, MRC over 3). Outcome was defined as complicated if the patient died, had systemic complications (cardiac, respiratory, or renal failure, gastrointestinal bleeding, disseminated intravascular coagulation), had pancreatic complications (necrotising pancreatitis, pseudocyst formation, pancreatic abscess, or phlegmon), or needed urgent surgery. APACHE-II and MRC scores differed significantly at admission and 48 hours later in all patient groups:

Patient group	*APACHE-II**		*MRC**	
	0 h	*48 h*	*0 h*	*48 h*
Straightforward recovery ($n = 227$)	7·3 (0·3)	4·8 (0·2)	4·6 (0·1)	4·2 (0·1)
Complications ($n = 71$)	10·5 (0·7)	7·9 (0·7)	7·3 (0·7)	8·5 (0·7)
Died ($n = 20$)	13·3 (1·3)	9·9 (0·9)	9·1 (0·7)	10·6 (0·7)

*Mean (SEM). All groups $p < 0.001$ (Student's t test), APACHE-II *vs* MRC.

From information obtained with the Imrie (Glasgow) system it is clear that the data from Hong Kong patients with pancreatitis are similar to those of Larvin and McMahon's patients.[1,2] However, we cannot account for some of the discrepancies. Larvin and McMahon's prediction of severe attacks of acute pancreatitis is much more accurate than ours, and some of our sensitivities and predictive values of a positive score are especially disappointing. A different cut-off value might reduce these discrepancies, but only at the expense of a lower overall accuracy and specificity.

PREDICTION OF DEATH AND OUTCOME OF ACUTE PANCREATITIS AT ADMISSION AND 48 H LATER (%)

—	Overall accuracy	Sensitivity	Specificity	Predictive value +ve	Predictive value −ve
At admission					
Death					
APACHE II > 9	73·3	70·0	73·5	15·0	97·3
MRC > 3	61·0	100	58·4	13·9	100
Complications					
APACHE II > 9	65·4	38·0	73·3	29·0	80·4
MRC > 3	58·8	59·1	58·7	29·2	83·3
48 h after admission					
Death					
APACHE II > 9	85·5	60·0	87·2	24·0	97·0
MRC > 3	62·6	100	60·1	14·4	100
Complications					
APACHE II > 9	73·3	25·4	87·0	36·0	80·2
MRC > 3	63·5	66·2	62·8	33·8	86·6

APACHE-II and the MRC systems were more accurate in the prediction of mortality in our patients (which was, of course, the main reason for their design). A high prediction of mortality may identify patients for early intensive resuscitation and therapy.

Acute pancreatitis is a capricious disease and it is unlikely that any single predictive system will provide 100% accuracy. Application of a disease-specific logistic regression may improve accuracy, as Larvin and McMahon suggest, but a combination of several systems may be an alternative, provided the period for complete data collection is not too long.

Department of Surgery,
University of Hong Kong,
Queen Mary Hospital,
Hong Kong — S. AL-HADEEDI, S. T. FAN, DAVID LEAPER

1. Imrie CW, Benjamin IS, Ferguson JE, et al. A single-centre double blind trial of Trasylol therapy in primary acute pancreatitis. *Br J Surg* 1978; 65: 337–41.
2. Fan ST, Choi TK, Lai ECS, Wong J. Prediction of severity of acute pancreatitis: an alternative approach. *Gut* (in press).
3. Knaus WA, Draper EA, Wagner DP, et al. APACHE II: a severity of disease classification. *Crit Care Med* 1985; 13: 818–29.
4. Elebute EA, Stoner HB. The grading of sepsis. *Br J Surg* 1983; 70: 29–31.

MANAGEMENT OF ASTHMA IN THE COMMUNITY

SIR,—Your July 22 editorial gives clear guidance for the treatment of asthma, but does not mention the difficulties encountered in practice. It is very difficult to make any progress in the asthmatic who smokes, and there is no quicker cause of chronic airways obstruction. Some patients do not accept the need for treatment and would rather deal with their disease "naturally". This idea is prevalent among the young who find it difficult to accept any physical disability. The bogey of steroid side-effects still discourages patients and general practitioners from using an adequate dose of steroids: and steroid treatment is even confused with the use of anabolic steroids by athletes.

Correct treatment of asthma is time consuming and calls for good clinical judgment. Ultimately it is the patient who should be educated sufficiently to manage his own disease. He should be able to respond to changing symptoms (or fall in peak flow rate) by adjusting his own treatment. In the short time available for consultation in the National Health Service a check list of points to cover, similar to an antenatal card, may help.

We have been using an asthma record card in our practice to record symptoms (eg, night wheeze, exertional asthma) which, if present, will prompt the doctor to increase prophylactic treatment until the symptoms and signs of hyperreactivity disappear. This approach has proved successful in the "stabilisation" of most of our asthmatics and in reducing the overall workload—especially emergencies out of hours. I would be pleased to send a card to anyone interested.

The only unwelcome side-effect is the increase in our prescribing costs since inhaled steroids are expensive.

33 Goffs Park Road,
Crawley,
West Sussex RH11 8AX — GEORGE STRUBE

Conditions, Procedures, and Practices Affecting Safety of Food In 10 School Food Service Systems with Satellites

Nancy E. Brown, Marjorie M. McKinley, Kirsi Laiho Aryan, and Bryon L. Hotzler

Nancy E. Brown is associate professor of Institution Management, Iowa State University. She earned her Ph.D. degree at Iowa State University with co-majors in Institution Management and Economics. A registered dietitian, she has been employed in college food service and college teaching at Kansas State University, the University of Tennessee, as well as Iowa State University.

Marjorie M. McKinley, Ph.D., R.D., Iowa State University, is professor of Institution Management. Much of her time is concerned with direction of research and other activities related to school food service management.

Kirsi Laiho Aryan is manager of Hennepin County Government Center Cafeteria in Minneapolis, Minn. She received her undergraduate education in Finland, and an M.S. in Institution Management in 1976 from Iowa State University.

Bryon L. Hotzler has been employed by ARA Food Services since receiving his M.S. in Institution Management in 1976 from Iowa State University. He currently is a district manager for Hospital Food Management. He received his B.S. degree in Institution Management from Southwest Minnesota State College.

Abstract

Conditions, procedures, and practices relating to storage, preparation, handling, transportation, and service of food that might affect safety and subsequent quality of food served in school food service systems were studied. Data were collected in five small and five large school food service systems in Iowa in which lunches were transported from a central production facility to separate service units in schools.

Although many desirable conditions, procedures, and practices were observed, improvements are needed to ensure safety and subsequent quality of food. Storage conditions, manual warewashing procedures, equipment availability and usage, handwashing practices, and timing of production and subsequent activities are areas identified in this study as needing increased attention.

This research is part of an ongoing study that contributes to the USDA North Central Regional Project, NC-120: Quality and Safety of Foods in Households and Foodservice Systems, and is published as Journal Paper No. J-10302 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa, Project No. 2332. Data for this paper were collected by Bryon Lee Hotzler and Kirsi Helka Marketta Laiho in partial fulfillment of the requirements for the degree of Master of Science.

The authors gratefully acknowledge the assistance of Paul A. Hartman, Ph.D., distinguished professor, Department of Microbiology, Iowa State University.

INTRODUCTION

Satellite food service involves the preparation of food in a central production kitchen and distribution of the food to outlying units for service in satellite food service systems. The period of time between preparation and consumption of food usually is extended beyond the time necessary when food is prepared on premise. The transporting and handling of potentially hazardous food items and additional handling of food that is involved in a satellite system make it critical for food service personnel to use proper food handling practices and procedures to avoid foodborne disease outbreaks.

The mere presence of pathogenic bacteria in foods usually is not enough to cause hazards; they must have favorable conditions to multiply to significant numbers or produce significant amounts of toxin in foods before danger develops (1). To minimize bacterial growth during holding of food, control of temperature and time is critical. According to Longree (2), the longest accumulated period during which potentially hazardous food may safely remain in the danger zone of 45°F-140°F is four hours; food should not be held at temperatures of 60°F-120°F longer than two hours.

Reported foodborne disease outbreaks in the United States during 1961-1976 have been summarized by Bryan (1). Common factors cited as contributing to the outbreaks, in order of importance, were: inadequate cooling of food, a lapse of one or more days between preparation and service of food, contamination of food by infected persons and no further heating of the food, inadequate time/temperature control during heating of food, and insufficiently high temperatures during hot holding of prepared foods.

Few instances of reported foodborne disease outbreaks have occurred in schools. From 1975 to 1978 less than 6 percent of reported outbreaks were attributed to schools (3, 4).

The potential for a foodborne disease outbreak exists in any food service system, including school food service systems. The potential seems greatest in those food service systems with satellite units. Data are not available on the extent to which satellite food service is used in child nutrition programs. A recent survey of public school districts in Iowa indicated that some transportation of hot foods to satellites is done in one-third of the districts (5).

Data were collected in 10 school food service systems that prepared food in a central production facility and transported it ready-to-serve to separate service units in schools (6, 7). The primary objective of the study was to determine existing conditions, procedures, and practices relating to storage, preparation, handling, transportation, and service of food in these school food service systems that might affect the safety and subsequent quality of food served. This study provides a data base for further investigation of relationships between safety of food and

different food handling procedures under realistic conditions in a research laboratory. Data from on-going operations and from studies conducted under controlled laboratory conditions are needed to develop recommended procedures and conditions for the preparation and service of safe food in school food service systems.

METHODS AND PROCEDURES

Surveys were conducted in 10 satellite school food service systems in central Iowa during spring and fall of 1975. School food service systems serving 301 to 500 and 1,001 to 2,000 Type A lunches per day from the production facility were selected as representative of small and large school food service systems, respectively. Satellite systems within a defined geographical area were identified; five systems were chosen at random from each group of schools that served the number of meals specified. One school food service system from each group was used for pretesting the data collection forms and procedures. No major changes in the forms or procedures had to be made as a result of the pretest; thus, data from these systems are included in the findings.

Each school food service system was visited by two researchers during three consecutive school days: Friday, Monday, and Tuesday. Instruction to describe and provide background information about each school food service system was obtained by interview with the manager of the system on the first day. All other data were obtained through observation by the researchers during the three days. Some data were collected in the central production kitchen throughout production and service each day by at least one researcher. One researcher accompanied the food and observed service and other activities in one satellite unit for two days in the small systems and in two satellite units for one day each in the large systems. Responsibility for assessments made during the three-day period was divided between the two researchers.

Areas covered by the proposed uniform requirements in food service sanitation [8] were sampled to evaluate conditions, procedures, and practices believed to affect safety and subsequent quality of food. When possible, objective data were collected such as time and temperature assessments and swab samples and food samples for microbial assessments. When objective measurements were not available and judgment had to be exercised, rating scales and check sheets were developed to guide observations and reduce the subjectivity of assessments. Data were evaluated against recommended sanitation standards found in the literature [2, 8, 9].

Five-point rating scales were developed and used to record visual assessments of the degree to which specific sanitary conditions were met in food production and food storage areas. Observation check sheets with sanitation standards stated as questions requiring a "yes" or "no" response with explanation were developed to record visual assessments of structural aspects of the building in preparation, storage, and service areas; potential sources of nonmicrobial contamination; waste treatment; utensil handling procedures; and employee hygiene and food handling practices.

Temperatures in two refrigerators in each central production kitchen were obtained by using a continuous recording thermograph[1] in each refrigerator. Temperatures were recorded during a five-day period in each facility. Temperatures in one freezer in each production kitchen were obtained with a maximum/minimum self-registering thermometer.[2] Readings were taken at the end of each work day after which the indices were reset. Units were selected in which the largest volume of potentially hazardous foods was stored. Temperatures of machine and manual warewashing solutions were recorded[3] by a researcher in the central production kitchen on one day in each school food service system and of warewashing solutions, if any, in the satellite units on two days. Temperatures were recorded during the lunch period, 10 and 20 minutes after warewashing started.

Swab samples were taken on each of two days in each school food service system [10]. Six swabs were taken on each of these days, three each in the production kitchen and one satellite unit. Three samples each day were of equipment and food production surfaces and three of utensils. Items to be swabbed were selected from eight items in food production areas listed in order of priority for sampling (kitchen table or surface on which food was prepared or handled, cutting board, can opener, slicer, etc.) and from five items of preparation and service utensils, tableware, and disposable ware listed by priority (plate or tray on which food was served, disposable ware, eating utensil, serving utensil, etc.). Aerobic plate counts (APC) of two colonies per cm² for surfaces and 100 colonies per utensil were considered acceptable [10]. A sample of tap water was collected in each central production kitchen to determine the quality of water used for food production in these kitchens; samples were analyzed for coliforms by the state hygienic laboratory.

The entree that was served in the satellite unit each of the last two days the researchers were in each school food service system was observed from pre-preparation through service. All 20 of these entrees included potentially hazardous foods. Data related to the entrees included time-temperature recordings and microbial assessments. Time-temperature data were recorded at the beginning and end of pre-preparation, preparation, transportation, and service of the entrees. Internal temperatures were taken at the center and outer edges of the food product.[4] Total time, time for each activity (such as transportation), and time between activities (such as between preparation and transportation), as well as temperatures of the entrees were recorded. One 50-gram sample of each entree was collected immediately after preparation and two 50-gram samples were collected after service. Samples were collected aseptically and refrigerated. One sample taken at the end of service was held at room temperature for six and one-half hours to simulate mishandling. An adaptation of the APHA Standard Methods for the Examination of Dairy Products [11] was used to determine the microbial population of the samples. An acceptable upper limit was 100,000 APCs per gram [12].

RESULTS AND DISCUSSION

Description of School Food Service Systems

The number of satellite service units in the five large school food service systems ranged from five to 14; all five small school food service systems had only one satellite service unit. Nine of the 10 school food service systems transported ready-to-serve food in bulk to the satellite service units. One of the large systems preportioned food into styrofoam containers at the production site before transportation.

Production kitchens in the five large school food service systems and in four small school food service systems were located in high school buildings. One production kitchen was located in an elementary school. A la carte service was provided for high school students only in large school food service systems. Participation by students in the Type A lunch program ranged from 28 to 59 percent in the large school food service systems in spring 1975 and from 45 to 96 percent in the small systems in fall 1975.

[1] Taylor Thermograph, Model No. 2350, Range: 0° to 100° F, Seven days.
[2] Taylor Maximum-Minimum Self-registering Fahrenheit Thermometer, Model
[3] YSI Tele-Thermometer, Model No. 42SF, Range: -40° F to +300° F, Probe Model No. 418, T2660, Yellow Springs Instrument Company, Yellow Springs, Ohio.
[4] Rochester, 15-inch Stem Thermometer, Model No. 1768-00542, Crepaco, Inc., Minneapolis, Minn.

According to the managers, transporting food did not affect, to any great extent, the selection of food items offered on the menus. Food items that were difficult to transport, such as grilled cheese sandwiches and french fried potatoes, usually were transported in spite of possible losses in quality of products. Students' preferences for certain food items influenced the variety of food items offered on the menus.

Use of standardized recipes helps ensure consistent preparation of food items in food service institutions so that quality and nutrient content are comparable from one time to the next. Standardized recipes were used in the five large systems and one small system.

Training of school food service employees usually was provided by the manager. Eight managers had recently participated in education programs on quantity food production and service. In small systems the manager assisted in the actual food preparation and service as well as serving as manager.

Conditions and Procedures in Production and Satellite Service Units

Opportunities for introducing pathogenic microorganisms into food are numerous. Many conditions, procedures, and practices that might have an adverse effect on the safety and subsequent quality of food are common to all food service systems, not just those that transport food. Many desirable conditions, procedures, and practices were observed in the school food service systems studied; however, only those aspects that might have an adverse effect on the safety and subsequent quality of food are reported.

The facilities, equipment, and condition of the production kitchens varied among the school food service systems. Lack of space in food production areas was a common problem in older production facilities in small systems. The satellite service kitchens, however, were generally new in all school food service systems studied. This situation may be a result of fairly recent adoption of the satellite concept in these systems.

The limited storage space available in production facilities posed problems for management. Conditions were observed that might contribute to introduction of harmful bacteria or substances to food or hasten deterioration of food quality. For example, in one system, the limited storage space available in the production facility resulted in overcrowding of storage areas, storing food items directly on the floor, poor air circulation around food containers, and storing cleaning supplies and chemicals with food products. Chemicals and cleaning materials were stored separately from food in only half of the schools. Trash containers in production and service areas were not covered in any of the schools.

Cleanliness of the refrigerated storage cabinets for half pints of milk and rotation of milk were problem areas in all school food service systems studied. Storage temperatures in refrigerators and freezers generally were below the maximum recommended temperatures, except during the automatic defrost cycle in some of the units.

Manual warewashing was done in seven school systems. Only two-compartment sinks were available in three schools. Manual warewashing temperatures usually were within the recommended range of 110 to 120°F. Only one school used a satisfactory sanitizing rinse. Towel drying was observed in all schools where manual warewashing was done. Wash temperatures in the warewashing machines were 160°F in most schools. A final rinse of 180°F was not achieved in four schools and results were inconsistent in two schools.

Swab samples were taken from utensils, work surfaces, and equipment. Only one of 12 samples from eating utensils exceeded the acceptable limit of 100 APCs per utensil; most counts were very low. Thirteen of 17 surface samples in large school food service systems and 14 of 26 surface samples in small school food service systems were above the acceptable limit of two APCs per cm^2. Wood surfaces, such as cutting boards and work counters, had considerably higher counts than nonwood surfaces. Chemical sanitizers were used on work surfaces and stationary equipment in only one school food service system. Results of the microbiological examination of water samples taken at each central production kitchen indicated that the water supplies were not contaminated by coliforms.

Proper use of equipment suited to the food production task can contribute to reduced preparation and holding times and assist in maintaining quality of the finished product. In one of the small systems, food was cooked in several stock pots on the range instead of being prepared in a steam-jacketed kettle provided in the kitchen. In another small school food service system, all heating of cream-style corn was done in a hot well at the steam table in the production unit over a period of one and one-half hours. Hot wells were not used, however, for keeping food hot during the service period in the same unit.

Equipment capable of maintaining safe temperatures is desirable when transporting or holding cold (45°F or below) or hot (140°F or above) food. Three school food service systems did not have either insulated or heated equipment for transporting hot food items. Even when equipment was available that could be heated, it was not always used to best advantage. For example, holding and transporting equipment was not preheated before transportation of the two entrees studied in one small system, although the cart was constructed for electrical heating. In each of two other small systems, one potentially hazardous food item was transported in equipment that could not be heated; equipment was available that could be heated. While products were held in transporation equipment, the internal temperature of food declined considerably from the end of production to the beginning of transportation. Additional losses in the internal temperature of food occurred during transportation. Food was either kept warm in the transportation equipment or put into ovens and reheated before service. Heated serving units were provided for serving food in two of the 15 satellite kitchens studied.

Employee Hygiene and Food Handling Practices

Proper employee hygiene and food handling practices are necessary to avoid introduction of pathogenic microorganisms into food. Toilet facilities were conveniently located in nine of the 10 schools. Handwashing facilities were provided in food production areas in four of the five large systems and in one small system. Poor hand hygiene, especially insufficient washing of hands, was observed among most food service employees in all school food service systems studied. Picking up food with the fingers to taste or eat during food preparation was a fairly common practice observed among employees. Eating and drinking during food preparation was especially evident in schools that did not have designated times for coffee and lunch breaks.

Data on Selected Entrees

Time and Temperature. Entrees usually were prepared and transported well in advance of service. In the large school food service systems, the number and location of the satellite service units influenced transportation scheduling. The small school food service systems each had only one satellite service unit that usually was located fairly close to the production unit. Nevertheless, the total holding time from end of production to end of service for two entrees in each system did not vary greatly between the small and large school food service systems (Table 1). For eight entrees prepared in large systems and six entrees prepared in small systems, total time from end of production to end of service was two hours or more.

Table 1. Total Holding Time from End of Preparation to End of Service of Entrees Served in Satellite Units in Each of 10 School Food Service Systems on Two Days

School food system	Entree 1	Entree 2
	Hours	Hours
Large systems		
I	3.60	3.21
II	2.17	1.23
III	3.20	4.29
IV	3.27	2.94
V	1.40	2.88
Small systems		
VI	1.83	3.00
VII	3.85	3.22
VIII	2.13	3.1
IX	1.98	3.73
X	2.07	1.77

Time and temperature recordings taken at the beginning and end of preparation, transportation, and service of entrees served in satellite units in each of the 10 school food service systems on two days are given in Table 2. A different satellite service unit was selected on each of the two days in the large school food service systems; the one satellite unit in each small school food service system was visited twice.

Total time for preparation of the entrees ranged from 0.92 hour for ravioli to 5.38 hours for beef stew (as shown in Table 2). Some pre-preparation of food was involved for four of the entrees studied (barbecue weiner, spaghetti and meat sauce, beef stew, and scalloped potatoes with ham and cheese).

Managers can be expected to control the length of time food is held between production and transportation. The scheduling and length of certain activities, especially transportation and service, often are determined by persons other than the school food service manager. Five entrees in four school food service systems were held more than one hour between the end of preparation and beginning of transportation. The total transportation time of three entrees in two large systems exceeded one hour. Eight entrees in seven school systems were held more than one hour between the end of transportation and the beginning of service.

The total time between activities exceeded three hours for two entrees (macaroni and cheese and charbroiled beef patties); these two entrees also had the longest total time between end of production (4.25 and 4.39 hours). Internal temperatures of the two main dishes were 140°F or above when temperatures were recorded. Assume that these temperatures were maintained throughout the total period, the possibility of bacterial growth in these foods was reduced by adequate holding temperatures.

The food to be transported in school food service systems II was proportioned into styrofoam containers at the production site. Entree temperatures were lower at the end of service than the temperature of food transported in bulk; however, temperatures of foods at the end of preparation were only 143° and 120°F. Five other entrees had

Table 2. Time and Temperature at Beginning and End of Preparation, Transportation, and Service of Entrees Served in Satellite Units in Each of 10 School Food Service Systems on Two Days

School food system	Entree	Activity	Total time of activity	Time between activities	Temperature: Beginning internal	Temperature: Ending internal	Fall(+) or decline(−)
			Hours	Hours	°F	°F	°F
Large systems[1]							
I	barbecue beef/bun	preparation	1.67	0.00	37	163	+126
		transportation	1.10	0.87	176	178	+ 2
		service	0.18	1.45	176	170	- 6
	chili con carne	preparation	1.83	0.00	46	197	+151
		tansportation	1.51	0.75	189	176	- 13
		service	0.62	0.33	174	155	- 19
II	pizza pattie/bun	preparation	1.20	0.00	frozen[2]	143	+143
		portion	0.67	0.67	NR[4]	NR[4]	—
		transportation	0.37	0.05	144	NR[4]	—
		service	0.08	1.67	NR[4]	114	—
	barbecue weiner	preparation	2.58	96.00	frozen[3]	120	+120
		portion	0.50	0.17	NR[4]	NR[4]	—
		transportation	0.47	0.00	116	NR[4]	—
		service	0.23	0.53	NR[4]	110	—
III	pizzaburger	preparation	1.95	0.00	30	135	+105
		portion	1.63	0.00	NR[4]	NR[4]	—
		tranportation	1.32	0.28	107	143[5]	+ 36
		service	1.07	0.53	153[5]	155[5]	+ 2
	macaroni and cheese	preparation	1.50	0.00	38	148	+110
		transportation	0.25	1.65	156	161[5]	+ 5
		service	0.42	1.97	181[5]	166	- 15

Table 2. Time and Temperature at Beginning and End of Preparation, Transportation, and Service of Entrees Served in Satellite Units in Each of 10 School Food Service Systems on Two Days

School food service system	Entree	Activity	Total time of activity	Time between activities[1]	Temperature		
					Beginning internal	Ending internal	Rise/ decline[2]
			Hours	Hours	°F	°F	°F
Large systems[3] (continued):							
IV	beefburger/bun	preparation	1.25	0.00	frozen[4]	152	+142[5]
		transportation	0.35	1.60	142	118	- 24
		service	0.70	0.62	131[6]	171	+ 40
	spaghetti and meat sauce	preparation	1.87	24.00	42	148	+106
		transportation	0.60	.57	147	NR[7]	
		service	0.22	1.55	151[8]	150	- 1
	bologna cups	preparation	3.50	0.00	36	154	+118
		transportation	0.58	0.02	145	131[9]	- 14
		service	0.22	0.58	142[10]	133	- 9
	creamed chicken	preparation	2.82	0.00	86	150	+ 64
		transportation	0.28	0.28	153	153	0
		service	1.65	0.47	192[6]	156	- 36
Small systems[3]:							
VI	goulash	preparation	3.25	0.00	frozen[4]	359	+178
		transportation	0.17	0.08	158	158	0
		service	1.25	0.33	174[6]	187	+ 13
	turkey rib/gravy	preparation	2.17	0.00	frozen[4]	45	45
		transportation	0.08	0.00	45[6]	45	0
		service	1.17	1.75	155	153	- 2
	chopped beef patty	preparation	1.01	0.00	frozen[4]	185	+166
		transportation	0.20	2.10	162	162	0
		service	0.45	1.10	203[6]	177	- 26
	ravioli	preparation	0.92	0.00	78	176	+ 98
		transportation	0.20	1.38	163	165	+ 2
		service	0.47	1.17	151	140	- 11
VII	beef and rice au gratin	preparation	2.70	0.00	42	158	+116
		transportation	0.03	0.07	139	139	0
		service	0.97	1.08	168[6]	181	+ 13
	beef stew	preparation	1.67	21.33	45	142	+ 97
		transportation	0.10	1.30	160	161	+ 1
		service	1.00	0.77	210[6]	170	- 40
IX	weiner wrap	preparation	1.92	0.00	44	143	+ 99
		transportation	0.42	0.28	124	124	0
		service	0.93	0.35	125	132	+ 7
	scalloped potatoes/ ham and cheese	preparation	3.43	22.25	55	165	+110
		transportation	0.33	0.00	165	143	- 22
		service	1.00	0.40	133	122	- 11
X	chili	preparation	5.38	0.00	31	153	+122
		transportation	0.48	0.75	145	144	- 1
		service	0.57	0.27	143	114[9]	- 29
	goulash	preparation	4.75	0.00	frozen[4]	204	+204
		transportation	0.40	0.57	193	185	- 8
		service	0.43	0.37	179	177	- 2

[1] When three activities are involved, time covered is between preparation and pre-preparation, between transportation and preparation, and between service and transportation.

[2] Food transported to several satellite service units; transportation time is based on time to one satellite service unit.

[3] Frozen items assumed to be 0° F.

[4] Not recorded.

[5] Holding/transportation time increased internal temperature of food during tranportation and service.

[6] Food heated in satellite service unit oven and during service.

[7] Holding time increased internal temperature of food during holding in satellite service unit.

[8] Food transported to one satellite service unit.

[9] Food transported cold and reheated in satellite service unit.

temperatures of 140°F or lower at the end of preparation. These items had an opportunity for exposure to heat at later periods, however, which was not true of the preportioned foods in school food system II.

Internal temperatures of nine of the 20 entrees were between 45° and 140°F at one or more times when temperatures were recorded at the end of preparation and at later intervals. If one assumes that temperatures moved progressively from one reading to the next, it would seem that at least two entrees (barbecue weiners and pizzaburgers) were held within the danger zone for almost two hours after preparation was completed.

Microbial assessment. Aerobic plate counts for five entrees were above the acceptable limit of 100,000 per gram of sample. The entrees were bologna cups, creamed chicken, ravioli, beef and rice au gratin, and scalloped potatoes with ham and cheese. Counts above 100,000 per gram were found in all three samples collected from four of the entrees. The creamed chicken sample, obtained immediately after preparation, was the only sample of that item exhibiting an unacceptably high count.

Only aerobic plate counts were determined; identification of the types of microorganisms in the samples would be necessary before the safety of the foods could be determined. Cheeses are reclaim in four of the five entrees that had high aerobic plate counts. Fowler et al. (12) suggested that different microbiologic limits be established for foods such as cheeses and luncheon meats that are produced with bacterial cultures. Counts for the other 15 entrees were low. The two entrees that seemed to be held within the danger zone for almost two hours were among the entrees with low aerobic plate counts. On the basis of the data, no clear relationship could be found between the number of microorganisms in the samples and the internal temperature of food during preparation, transportation, and service.

RECOMMENDATIONS

On the basis of the findings from surveys in 10 school food service systems, the following recommendations were developed: (a) continuous training of food service employees is needed to improve hand hygiene, cleaning and sanitization procedures, food handling practices and food preparation, transportation, and service procedures; (b) the timing of food production, transportation, and service in school food service systems should be evaluated and, where needed, revised to avoid extended holding of food; and (c) heated and/or insulated transportation and holding equipment should be provided in satellite school food service systems unless circumstances ensure that food will be transported and served within a very short period of time and safe temperatures will be maintained.

Many desirable conditions, procedures, and practices were observed in the school food service systems studied. Procedures and practices needing improvement usually were within the control of food service personnel.

References

(1) Bryan, F.L. 1978. Factors that contribute to outbreaks of foodborne disease. *J. Food Protection* 41:816 (Oct).

(2) Longree, K. 1972. *Quantity food sanitation.* 2nd ed. New York: Wiley Interscience.

(3) Center for Disease Control. DHEW. 1979. *Foodborne and waterborne disease surveillance: Annual summary 1977.* HEW Pub. No. (CDC)79-8185.

(4) Center for Disease Control. DHEW. 1979. *Foodborne disease surveillance: Annual summary 1978.* HEW Pub. No. (CDC)80-8185.

(5) Hemphill, C.A. 1981. Selected conditions and practices related to safety and quality of food in Iowa school food service programs. Master's thesis, Iowa State Univ., Ames.

(6) Hotzler, B.L. 1978. Practices and conditions in large school food service systems in preparing lunches, in relation to quality and safe food. Masters thesis, Iowa State Univ., Ames.

(7) Laiho, K.H.M. 1978. Practices and conditions in selected small school food service systems in transport lunches, in relation to quality and safety of food. Masters thesis, Iowa State Univ., Ames.

(8) DHEW. 1974. *Food service sanitation manual with uniform requirements.* Publ. [illegible]

(9) Longree, K., and Blaker, G.G. *Sanitary techniques in food service.* [illegible] Sons, Inc.

(10) Public Health Serv. DHEW. [illegible] *bacterial examination of food and [illegible] equipment surfaces.* DHEW [illegible]

(11) Am. Public Health [illegible] *the examination of [illegible]* Am. Public Health Assoc. [illegible]

(12) Fowler, [illegible] *coagulase-positive [illegible] program and its [illegible] microbiol. Dec. 1).*

temperatures of 143°F or lower at the end of preparation. These items had an opportunity for exposure to heat at later periods, however, which was not true of the proportioned foods in school food system II.

Internal temperatures of nine of the 20 entrees were between 45° and 140°F at one or more times when temperatures were recorded at the end of preparation and at later intervals. If one assumes that temperatures moved progressively from one reading to the next, it would seem that at least two entrees (barbecue weiners and pizzaburgers) were held within the danger zone for almost two hours after preparation was completed.

Microbial assessment. Aerobic plate counts for five entrees were above the acceptable limit of 100,000 per gram of sample. The entrees were bologna cups, creamed chicken, ravioli, beef and rice au gratin, and scalloped potatoes with ham and cheese. Counts above 100,000 per gram were found in all three samples collected from four of the entrees. The creamed chicken sample, obtained immediately after preparation, was the only sample of that item exhibiting an unacceptably high count.

Only aerobic plate counts were determined. Identification of the types of microorganisms in the samples would be necessary before the safety of the foods could be determined. Time was an ingredient in four of the five entrees that had high aerobic plate counts. Fowler et al. (12) suggested that microbiologic limits be established for foods, such as cheese, and luncheon meats that are processed with bacterial cultures. Counts for the other 15 entrees were low. The two entrees that seemed to be held within the danger zone for almost two hours were among the entrees with low aerobic plate counts. On the basis of the data, no clear relationship could be found between the number of microorganisms in the samples and the internal temperature of food during preparation, transportation, and serving.

RECOMMENDATIONS

On the basis of the findings from surveys in 10 school food service systems, the following recommendations were developed: (a) continuous training of food service employees is needed to improve hand hygiene, cleaning and sanitizing procedures, food handling practices and food preparation, transportation, and service procedures; (b) the timing of food production, transportation, and service in school food service systems should be evaluated and, where needed, revised to avoid extended holding of food; and (c) heated and/or insulated transportation and holding equipment should be provided in satellite school food service systems unless circumstances ensure that food will be transported and served within a very short period of time and safe temperatures will be maintained.

Many desirable conditions, procedures, and practices were observed in the school food service systems studied. Procedures and practices needing improvement usually were within the control of food service personnel.

References

(1) Bryan, F.L. 1978. Factors that contribute to outbreaks of foodborne disease. *J. Food Protection* 41:816 (Oct).

(2) Longree, K. 1972. *Quantity food sanitation*. 2nd ed. New York: Wiley Interscience.

(3) Center for Disease Control. DHEW. 1979. *Foodborne and waterborne disease surveillance: Annual summary 1977*. HEW Pub. No. (CDC)79-8185.

(4) Center for Disease Control. DHEW. 1979. *Foodborne disease surveillance: Annual summary 1978*. HEW Pub. No. (CDC)80-8185.

(5) Hemphill, C.A. 1981. Selected conditions and practices related to safety and quality of food in Iowa school food service programs. Masters thesis. Iowa State Univ., Ames.

(6) Hotzler, B.L. 1976. Practices and conditions in selected large school food service systems that transport lunches, in relation to quality and safety of food. Masters thesis. Iowa State Univ., Ames.

(7) Laiho, K.H.M. 1976. Practices and conditions in selected small school food service systems that transport lunches, in relation to quality and safety of food. Masters thesis. Iowa State Univ., Ames.

(8) DHEW. 1974. Food service sanitation. Proposed uniform requirements. *Federal Register* 39(193):35439.

(9) Longree, K., and Blaker, G.G. 1971. *Sanitary techniques in food service*. New York: John Wiley & Sons, Inc.

(10) Public Health Serv., DHEW. 1961. *Procedure for the bacterial examination of food utensils and/or food equipment surfaces*. DHEW Pub. No. (PHS)1631.

(11) Am. Public Health Assoc. 1967. *Standard methods for the examination of dairy products*. 12th ed. New York: Am. Public Health Assoc., Inc.

(12) Fowler, J.L., Buckle, R.D., and Numans, T.S. 1974. A computerized food microbiologic data collection program and its potential in formulating data for microbiologic standards. *J. Am. Vet. Assoc.* 165:1000 (Dec. 1).

temperatures of 143°F or lower at the end of preparation. These items had an opportunity for exposure to heat at later periods, however, which was not true of the preportioned foods in school food system II.

Internal temperatures of nine of the 20 entrees were between 45° and 140°F at one or more times when temperatures were recorded at the end of preparation and at later intervals. If one assumes that temperatures moved progressively from one reading to the next, it would seem that at least two entrees (barbecue weiners and pizzaburgers) were held within the danger zone for almost two hours after preparation was completed.

Microbial assessment. Aerobic plate counts for five entrees were above the acceptable limit of 100,000 per gram of sample. The entrees were bologna cups, creamed chicken, ravioli, beef and rice au gratin, and scalloped potatoes with ham and cheese. Counts above 100,000 per gram were found in all three samples collected from four of the entrees. The creamed chicken sample, obtained immediately after preparation, was the only sample of that item exhibiting an unacceptably high count.

Only aerobic plate counts were determined. Identification of the types of microorganisms in the samples would be necessary before the safety of the foods could be determined. Cheese was an ingredient in four of the five entrees that had high aerobic plate counts. Fowler et al. (12) suggested that different microbiologic limits be established for foods such as cheeses and luncheon meats that are produced with bacterial cultures. Counts for the other 15 entrees were low. The two entrees that seemed to be held within the danger zone for almost two hours were among the entrees with low aerobic plate counts. On the basis of the data, no clear relationship could be found between the number of microorganisms in the samples and the internal temperature of food during preparation, transportation, and service.

RECOMMENDATIONS

On the basis of the findings from surveys in 10 school food service systems, the following recommendations were developed: (a) continuous training of food service employees is needed to improve hand hygiene, cleaning and sanitization procedures, food handling practices, and food preparation, transportation, and service procedures; (b) the timing of food production, transportation, and service in school food service systems should be evaluated and, where needed, revised to avoid extended holding of food; and (c) heated and/or insulated transportation and holding equipment should be provided in satellite school food service systems unless circumstances ensure that food will be transported and served within a very short period of time and safe temperatures will be maintained.

Many desirable conditions, procedures, and practices were observed in the school food service systems studied. Procedures and practices needing improvement usually were within the control of food service personnel.

References

(1) Bryan, F.L. 1978. Factors that contribute to outbreaks of foodborne disease. *J. Food Protection* 41:816 (Oct).

(2) Longree, K. 1972. *Quantity food sanitation*, 2nd ed. New York: Wiley Interscience.

(3) Center for Disease Control, DHEW. 1979. *Foodborne and waterborne disease surveillance: Annual summary 1977*. HEW Pub. No. (CDC)79-8185.

(4) Center for Disease Control, DHEW. 1979. *Foodborne disease surveillance: Annual summary 1978*. HEW Pub. No. (CDC)80-8185.

(5) Hemphill, C.A. 1981. Selected conditions and practices related to safety and quality of food in Iowa school food service programs. Masters thesis, Iowa State University, Ames.

(6) Hotzler, B.L. 1978. Practices and conditions in selected large school food service systems that transport lunches, in relation to quality and safety of food. Masters thesis, Iowa State University, Ames.

(7) Laiho, K.H.M. 1978. Practices and conditions in selected small school food service systems that transport lunches, in relation to quality and safety of food. Masters thesis, Iowa State University, Ames.

(8) DHEW. 1974. *Food service sanitation ordinance and code with uniform requirements*. Federal Register, [illegible]

(9) Longree, K., and Blaker, G.G. 19[illegible] *Techniques in food service*. New York: John Wiley & Sons, Inc.

(10) Public Health Service, DHEW. 19[illegible] *bacterial examination of food and food service equipment swabs*. DHEW Pub. No. (CDC)[illegible]

(11) Am. Public Health Assoc. [illegible] *The Standard Methods of the Examination of Dairy Products*. Am. Public Health Assoc., [illegible]

(12) Fowler, J.L., [illegible] computerized food [illegible] program and its potential [illegible] microbiologic standards. [illegible] (Dec. 1)

temperatures of 143°F or lower at the end of preparation. These items had an opportunity for exposure to heat at later periods, however, which was not true of the preportioned foods in school food system II.

Internal temperatures of nine of the 20 entrees were between 45° and 140°F at one or more times when temperatures were recorded at the end of preparation and at later intervals. If one assumes that temperatures moved progressively from one reading to the next, it would seem that at least two entrees (barbecue weiners and pizzaburgers) were held within the danger zone for almost two hours after preparation was completed.

Microbial assessment. Aerobic plate counts for five entrees were above the acceptable limit of 100,000 per gram of sample. The entrees were bologna cups, creamed chicken, ravioli, beef and rice au gratin, and scalloped potatoes with ham and cheese. Counts above 100,000 per gram were found in all three samples collected from four of the entrees. The creamed chicken sample, obtained immediately after preparation, was the only sample of that item exhibiting an unacceptably high count.

Only aerobic plate counts were determined. Identification of the types of microorganisms in the samples would be necessary before the safety of the foods could be determined. Cheese was an ingredient in four of the five entrees that had high aerobic plate counts. Fowler et al. (12) suggested that different microbiologic limits be established for foods such as cheeses and luncheon meats that are produced with bacterial cultures. Counts for the other 15 entrees were low. The two entrees that seemed to be held within the danger zone for almost two hours were among the entrees with low aerobic plate counts. On the basis of the data, no clear relationship could be found between the number of microorganisms in the samples and the internal temperature of food during preparation, transportation, and service.

RECOMMENDATIONS

On the basis of the findings from surveys in 10 school food service systems, the following recommendations were developed: (a) continuous training of food service employees is needed to improve hand hygiene, cleaning and sanitization procedures, food handling practices and food preparation, transportation, and service procedures; (b) the timing of food production, transportation, and service in school food service systems should be evaluated and, where needed, revised to avoid extended holding of food; and (c) heated and/or insulated transportation and holding equipment should be provided in satellite school food service systems unless circumstances ensure that food will be transported and served within a very short period of time and safe temperatures will be maintained.

Many desirable conditions, procedures, and practices were observed in the school food service systems studied. Procedures and practices needing improvement usually were within the control of food service personnel.

References

(1) Bryan, F.L. 1978. Factors that contribute to outbreaks of foodborne disease. *J. Food Protection* 41:816 (Oct).

(2) Longree, K. 1972. *Quantity food sanitation.* 2nd ed. New York: Wiley Interscience.

(3) Center for Disease Control. DHEW. 1979. *Foodborne and waterborne disease surveillance: Annual summary 1977.* HEW Pub. No. (CDC)79-8185.

(4) Center for Disease Control. DHEW. 1979. *Foodborne disease surveillance: Annual summary 1978.* HEW Pub. No. (CDC)80-8185.

(5) Hemphill, C.A. 1981. Selected conditions and practices related to safety and quality of food in [illegible] food service programs. Masters thesis, Iowa State Univ., Ames.

(6) Hotzler, B.L. 1978. Practices and [illegible] large school food service systems that [illegible] lunches, in relation to quality and safety of [illegible] Masters thesis, Iowa State Univ., Ames.

(7) Laiho, K.H.M. 1978. Practices and [illegible] selected small school food service [illegible] transport lunches, in relation to [illegible] food. Masters thesis, Iowa State Univ., Ames.

(8) DHEW. 1974. Food service sanitation: Recommended uniform requirements. Parts I and II.

(9) Longree, K., and Blaker, G.C. [illegible] techniques in food service. New [illegible] Sons, Inc.

(10) Public Health Service, Division of [illegible] bacterial examination of food [illegible] equipment surfaces. DHEW Pub. [illegible]

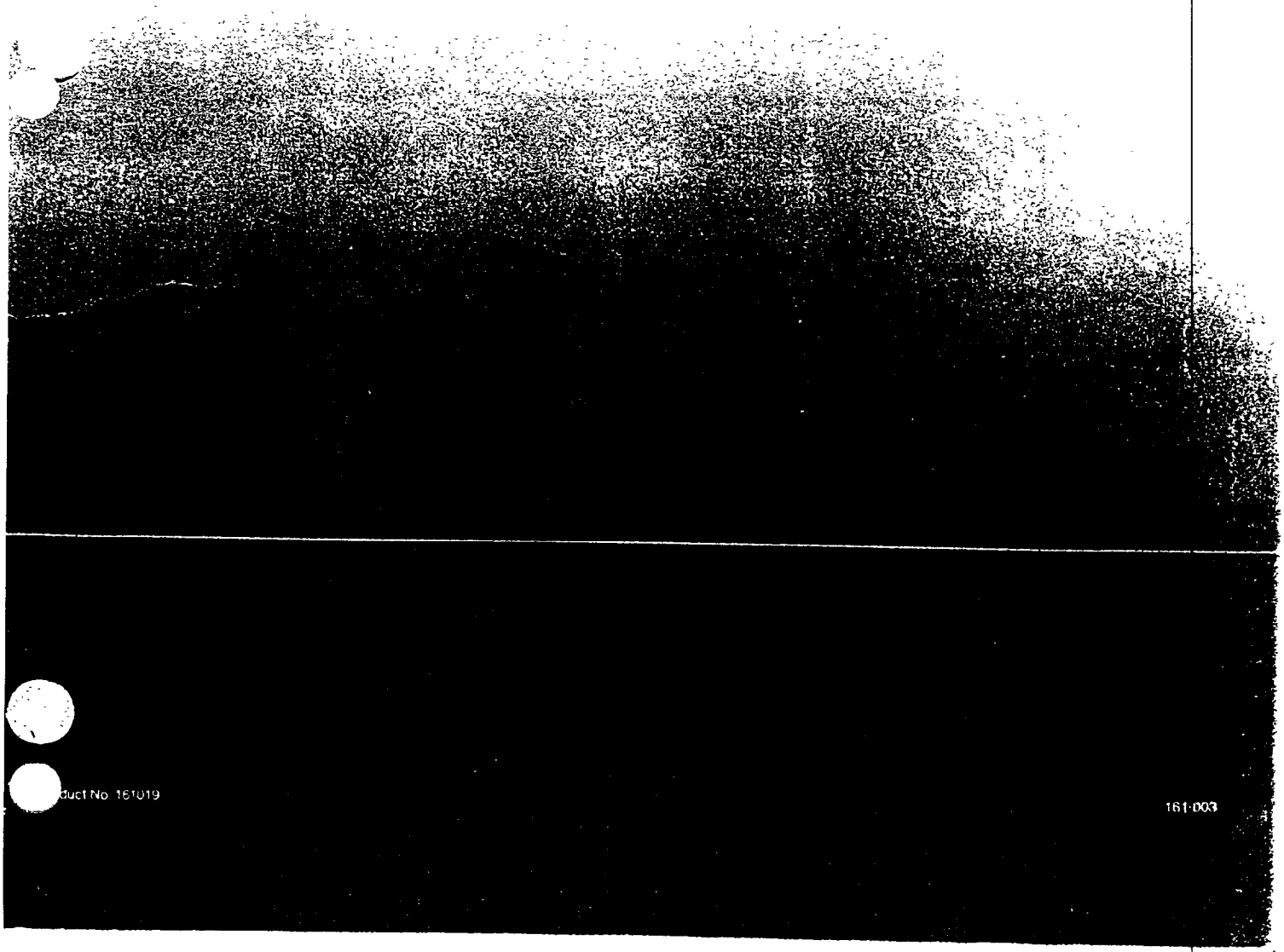
(11) Am. Public Health Assoc. [illegible] the examination of [illegible] Am. Public Health Assoc., [illegible]

(12) Fowler, J.L., Twedt, R.M., and [illegible] computerized food [illegible] program and its potential in [illegible] microbiologic standards. [illegible] (Dec. 1).

UNICIDE 128

UNICIDE 128
Germicidal Detergent

BIOCIDAL QUALIFICATION TESTING
and
TECHNICAL INFORMATION



UNICIDE 128
GERMICIDAL DETERGENT

TABLE OF CONTENTS

INTRODUCTION

Unicide 128 is a non-alkaline tuberculocidal and germicidal detergent concentrate. When it is diluted 1 part with 128 parts of tap water it is an effective one-step disinfectant and cleaner for use on inanimate surfaces not harmed by water. Its formulation represents a significant new advance in germicides which combines modern quaternary ammonium compounds and detergents into a system that is uniquely non-alkaline and tuberculocidal. As a result, the use-solutions are significantly milder to human skin than are phenolics and other quaternary ammonium chlorides with a high pH. Additionally, **Unicide 128** shows biocidal activity against Mycobacterium tuberculosis — thus allowing the use of a single germicide for general and critical care areas where solutions effective against T.B. and other significant pathogens are desirable.

The detergent systems in **Unicide 128** remove not only dirt and dust — but are also formulated to remove hard water scale, soap scums and body fluids such as blood, mucus, and dried urine.

Unicide 128 can be used to clean all inanimate surfaces not harmed by water. It is recommended that Unicide 128 be used on a daily basis to clean, disinfect, and deodorize such surfaces as floors, walls, commodes, sinks, tubs, and showers. Unicide's non-alkaline formulation makes it truly possible to have a one product system of sanitation by eliminating or diminishing the need for glass cleaners, cleansers, soap scum removers, bright work cleaners, and other germicides. Thus, everything that is cleaned is disinfected and deodorized without the secondary need or step of using a germicide. The low pH makes this product milder to floor finishes in that it does not show the stripping tendencies associated with germicides of a much higher pH.

BASIC BACTERICIDAL DATA

Unicide 128 is a one-step broad spectrum tuberculocide, virucide, fungicide, and bactericide as has been demonstrated by its performance in tests that are prescribed and regulated by the federal government under the Federal Insecticide, Fungicide, and Rodenticide Act.

Unicide 128 has been proven to pass the A.O.A.C. Use-Dilution Confirmation Tests, current edition, for effectiveness in water of 400 ppm hardness (as $CaCO_3$) plus 5% organic serum.

QUALIFICATION TESTING FOR GERMICIDAL CLAIM

Solution analyzed: **Unicide 128** at a 1:128 dilution in 400 ppm hard water (as $CaCO_3$) plus 5% organic serum.
Method: A.O.A.C. Use-Dilution Confirmation Method, current edition
Objective: To test bactericidal activity for conformance to A.O.A.C. requirements.
Time: 10 minutes
Test Temperature: 20°C.
Subculture Media: Letheen Broth

ORGANISM	PHENOL RESISTANCE	NO. OF CARRIERS	NO. SHOWING GROWTH
S. aureus, ATCC 6538	1:60	60	0
S. aureus, ATCC 6538	1:60	60	0
S. aureus, ATCC 6538	1:60	60	0
S. choleraesuis, ATCC 10708	1:90	60	0
S. choleraesuis, ATCC 10708	1:90	60	0
S. choleraesuis, ATCC 10708	1:90	60	0
Ps. aeruginosa, ATCC 15442	1:80	60	0
Ps. aeruginosa, ATCC 15442	1:80	60	0
Ps. aeruginosa, ATCC 15442	1:80	60	0

Conclusion: No growth shows biocidal conformance to A.O.A.C. and E.P.A. requirements. Unicide 128 is a hospital grade germicide in the presence of hard water at 400 ppm (as $CaCO_3$) plus 5% fetal bovine serum to simulate an organic load.

BROAD RANGE, NON-SELECTIVE ACTIVITY

Federal regulations specify that a germicide must pass the A.O.A.C. Use-Dilution Test against a basic group of organisms. While it is impossible to test a germicide against all known pathogens, Brulin believes that it is a must for the germicide to show that it exhibits a broad range of non-selective activity against a representative variety of other bacteria, including clinically significant organisms.

Solution analyzed: **Unicide 128** at a 1:128 dilution in 400 ppm hard water (as $CaCO_3$) plus 5% fetal bovine serum.
Method: A.O.A.C. Use-Dilution Confirmation Test, current edition
Objective: To test for additional bactericidal activity in conformance to A.O.A.C. requirements using two separate samples.
Time: 10 minutes
Test Temperature: 20°C
Subculture Media: Letheen broth

ORGANISM	PHENOL RESISTANCE	NO. OF CARRIERS	NO. OF CARRIERS SHOWING GROWTH
Staphylococcus aureus* phage type 80, ATCC 14154	1:60, 1:60	10, 10	0, 0
Staphylococcus aureus* phage type 81, ATCC 14154	1:60, 1:60	10, 10	0, 0
Escherichia coli, ATCC 11229	1:80, 1:80	10, 10	0, 0
Staphylococcus epidermidis, ATCC 17917	1:60, 1:60	10, 10	0, 0
Proteus vulgaris, ATCC 8472	1:100, 1:100	10, 10	0, 0
Klebsiella pneumoniae, ATCC 4352	1:80, 1:80	10, 10	0, 0
Streptococcus pyogenes, clinical isolate	1:100, 1:100	10, 10	0, 0
Proteus mirabilis, ATCC 9921	1:95, 1:95	10, 10	0, 0
Serratia marcescens, ATCC 29633	1:85, 1:85	10, 10	0, 0
Enterobacter aerogenes, ATCC 13048	1:90, 1:90	10, 10	0, 0
Shigella sonnei, ATCC 20930	1:95, 1:95	10, 10	0, 0
Shigella flexneri, ATCC 25929	1:95, 1:95	10, 10	0, 0
Shigella dysenteriae, ATCC 29026	1:75, 1:75	10, 10	0, 0
Salmonella typhi, ATCC 6539	1:80, 1:80	10, 10	0, 0
Streptococcus faecalis, ATCC 8043	1:60, 1:60	10, 10	0, 0
Brevibacterium ammoniagenes, ATCC 6871	1:65, 1:65	10, 10	0, 0
Salmonella schottmuelleri, ATCC 10719	1:80, 1:80	10, 10	0, 0
Staphylococcus aureus, phage 42B/52/81	1:60, 1:60	10, 10	0, 0
Enterobacter cloacae, ATCC 27508	1:75, 1:75	10, 10	0, 0

*Antibiotic resistant

Conclusion: "No growth" shows that when **Unicide 128** is used at a 1:128 dilution, it exhibits a complete kill against not only the official E.P.A. required bacteria, but also other clinically significant bacteria tested against as well. Its activity is broad and non-selective, even in the presence of hard water up to 400 ppm (as $CaCO_3$) and 5% fetal bovine serum to simulate an organic load.

QUALIFICATION TESTING FOR FUNGICIDAL CLAIM

Solution analyzed: Unicide 128 at a 1:128 dilution in 400 ppm hard water (as $CaCO_3$) plus 5% fetal bovine serum.
Method: A.O.A.C. Use-Dilution Confirmation Test, current edition
Objective: To test the fungicidal activity for conformance to A.O.A.C. requirements using two separate samples.
Time: 10 minutes
Test Temperature: 20°C
Medium: Glucose-Neopepton

ORGANISM	PHENOL RESISTANCE	NO. OF CARRIERS	NO. OF CARRIERS SHOWING GROWTH
Trichophyton interdigitale, ATCC 9533	1:60, 1:60	10, 10	0, 0
Candida albicans, ATCC 10231	1:60, 1:60	10, 10	0, 0

Conclusion: Unicide 128 is a fungicide at 1 oz. per gallon of water for hospital use in the presence of hard water up to 400 ppm (as $CaCO_3$) and 5% fetal bovine serum to simulate an organic load.

QUALIFICATION TESTING FOR TUBERCULOCIDAL CLAIM

Solution analyzed: Unicide 128 at a 1:128 dilution in 400 ppm hard water (as $CaCO_3$) plus 5% fetal bovine serum.
Method: A.O.A.C. Use-Dilution Confirmation Test, current edition
Objective: To test the tuberculocidal activity for conformance to A.O.A.C. requirements using two separate batches/samples.
Time: 10 minutes
Test Temperature: 20°C
Incubation: 90 days at 37°C

ANTIMICROBIAL EVALUATED	DILUTION	TB BROTH MEDIUM (Mod. DuBos)	MIDDLEBROOK 7H9 BROTH	KIRCHNER BROTH
UNICIDE 128	1:128	0/10 0/10	0/10 0/10	0/10 0/10

Conclusion: Unicide 128 is effectively tuberculocidal in 400 ppm hard water (as $CaCO_3$) plus 5% fetal bovine serum.

QUALIFICATION TESTING FOR VIRUCIDAL CLAIMS

Solution analyzed: Unicide 128 at a 1:128 dilution in 400 ppm hard water (as $CaCO_3$) plus 5% v/v fetal bovine serum.

VIRUSES	SERIAL DILUTION	TOXICITY CONTROL	TEST VIRUS CONTROL (Untreated)	TEST VIRUS PLUS UNICIDE AT 1:128
Canine Parvovirus	10^1	T T O O	+ + + +	T T O O
	10^2	O O O O	+ + + +	O O O O
	10^3	O O O O	+ + + +	O O O O
	10^4	O O O O	+ + + +	O O O O
	10^5	O O O O	+ + + +	O O O O
	10^6	O O O O	+ + + +	O O O O
	10^7	O O O O	O O O O	O O O O
	10^8	O O O O	O O O O	O O O O
Bovine Parvovirus	10^1	O O O O	+ + + +	O O O O
	10^2	O O O O	+ + + +	O O O O
	10^3	O O O O	+ + + +	O O O O
	10^4	O O O O	+ + + +	O O O O
	10^5	O O O O	+ + + +	O O O O
	10^6	O O O O	+ + O O	O O O O
	10^7	O O O O	O O O O	O O O O
	10^8	O O O O	O O O O	O O O O
Adenovirus Type 2	10^1	T T T T	+ + + +	T T T T
	10^2	O O O O	+ + + +	O O O O
	10^3	O O O O	+ + + +	O O O O
	10^4	O O O O	+ + + +	O O O O
	10^5	O O O O	+ + + +	O O O O
	10^6	O O O O	+ + + +	O O O O
	10^7	O O O O	O O O O	O O O O
	10^8	O O O O	O O O O	O O O O
Herpes Simplex Type I	10^1	O O O O	+ + + +	O O O O
	10^2	O O O O	+ + + +	O O O O
	10^3	O O O O	+ + + +	O O O O
	10^4	O O O O	+ + + +	O O O O
	10^5	O O O O	+ + + +	O O O O
	10^6	O O O O	+ + + +	O O O O
	10^7	O O O O	+ + + +	O O O O
	10^8	O O O O	O O O O	O O O O

VIRUSES	SERIAL DILUTION	TOXICITY CONTROL	TEST VIRUS CONTROL (Untreated)	TEST VIRUS PLUS UNICIDE AT 1:128
Influenza Type A	10^1	O O O O	+ + + +	O O O O
	10^2	O O O O	+ + + +	O O O O
	10^3	O O O O	+ + + +	O O O O
	10^4	O O O O	+ + + +	O O O O
	10^5	O O O O	+ + + +	O O O O
	10^6	O O O O	+ + + +	O O O O
	10^7	O O O O	+ + + +	O O O O
	10^8	O O O O	+ + O O	O O O O
Vaccinia	10^1	T T T T	+ + + +	T T T T
	10^2	T T T T	+ + + +	T T T T
	10^3	O O O O	+ + + +	O O O O
	10^4	O O O O	+ + + +	O O O O
	10^5	O O O O	+ + + +	O O O O
	10^6	O O O O	+ + + +	O O O O
	10^7	O O O O	+ + + O	O O O O
	10^8	O O O O	O O O O	O O O O
Adenovirus Type 4	10^1	T T T T	+ + + +	T T T T
	10^2	O O O O	+ + + +	O O O O
	10^3	O O O O	+ + + +	O O O O
	10^4	O O O O	+ + + +	O O O O
	10^5	O O O O	+ + + +	O O O O
	10^6	O O O O	+ + O O	O O O O
	10^7	O O O O	O O O O	O O O O
	10^8	O O O O	O O O O	O O O O
Herpes Simplex Type II	10^1	T T T T	+ + + +	T T T T
	10^2	O O O O	+ + + +	O O O O
	10^3	O O O O	+ + + +	O O O O
	10^4	O O O O	+ + + +	O O O O
	10^5	O O O O	+ + + +	O O O O
	10^6	O O O O	+ + + +	O O O O
	10^7	O O O O	+ + O O	O O O O
	10^8	O O O O	O O O O	O O O O
Rubella	10^1	T O O O	+ + + +	T O O O
	10^2	O O O O	+ + + +	O O O O
	10^3	O O O O	+ + + +	O O O O
	10^4	O O O O	+ + + +	O O O O
	10^5	O O O O	+ + + +	O O O O
	10^6	O O O O	+ + + +	O O O O
	10^7	O O O O	+ + O O	O O O O
	10^8	O O O O	O O O O	O O O O

VIRUSES	SERIAL DILUTION	TOXICITY CONTROL	TEST VIRUS CONTROL (Untreated)	TEST VIRUS PLUS UNICIDE AT 1:128
Avian Infectious Bronchitis	10^1	O O O O	+ + + +	O O O O
	10^2	O O O O	+ + + +	O O O O
	10^3	O O O O	+ + + +	O O O O
	10^4	O O O O	+ + + +	O O O O
	10^5	O O O O	+ + + +	O O O O
	10^6	O O O O	+ + + +	O O O O
	10^7	O O O O	+ + + O	O O O O
	10^8	O O O O	O O O O	O O O O
Avian Influenza	10^1	O O O O	+ + + +	O O O O
	10^2	O O O O	+ + + +	O O O O
	10^3	O O O O	+ + + +	O O O O
	10^4	O O O O	+ + + +	O O O O
	10^5	O O O O	+ + + +	O O O O
	10^6	O O O O	+ + + +	O O O O
	10^7	O O O O	+ + + +	O O O O
	10^8	O O O O	+ + O O	O O O O
Infectious Bovine Rhino-tracheitis	10^1	O O O O	+ + + +	O O O O
	10^2	O O O O	+ + + +	O O O O
	10^3	O O O O	+ + + +	O O O O
	10^4	O O O O	+ + + +	O O O O
	10^5	O O O O	+ + + +	O O O O
	10^6	O O O O	+ + + +	O O O O
	10^7	O O O O	O O O O	O O O O
	10^8	O O O O	O O O O	O O O O

EXPLANATION OF SYMBOLS
T - Toxic
+ - indicates virus present
O - indicates no virus present

Conclusion: Unicide 128 inactivated the viruses tested against in 400 ppm hard water (as $CaCO_3$) plus 5% v/v fetal bovine serum.

STABILITY DATA

Solution analyzed: Unicide 128 at a 1:128 dilution in 400 ppm hard water (as $CaCO_3$) plus 5% fetal bovine serum.
Method: A.O.A.C. Use-Dilution Confirmation Method, current edition
Objective: To test bactericidal activity for conformance to A.O.A.C. requirements using samples aged longer than 60 days.
Time: 10 minutes
Test Temperature: 20°C
Subculture Media: Letheen broth

SAMPLE	ORGANISM	NO. OF CARRIERS	NO. OF CARRIERS SHOWING GROWTH
1	S. aureus, ATCC 6538	60	0
2	S. aureus, ATCC 6538	60	0
3	S. aureus, ATCC 6538	60	0
1	S. choleraesuis, ATCC 10708	60	0
2	S. choleraesuis, ATCC 10708	60	0
3	S. choleraesuis, ATCC 10708	60	0
1	Ps. aeruginosa, ATCC 15442	60	0
2	Ps. aeruginosa, ATCC 15442	60	0
3	Ps. aeruginosa, ATCC 15442	60	0

Conclusion: No growth shows biocidal conformance to A.O.A.C. requirements for hospital use after a 60 day shelf life in 400 ppm hard water (as $CaCO_3$) plus 5% fetal bovine serum to simulate an organic load.

Solution analyzed: Unicide 128 at a 1:128 dilution in 400 ppm hard water (as $CaCO_3$) plus 5% fetal bovine serum.
Method: A.O.A.C. Use-Dilution Confirmation Method, current edition
Objective: To test bactericidal activity for conformance to A.O.A.C. requirements using samples of the diluted Unicide 128 that were sealed in a one gallon plastic jug for six months prior to testing.
Time: 10 minutes
Test Temperature: 20°C
Subculture Media: Letheen broth

ORGANISM	PHENOL RESISTANCE	NO. OF CARRIERS	NO. OF CARRIERS SHOWING GROWTH
S. aureus, ATCC 6538	1:60	60	0
S. choleraesuis, ATCC 10708	1:90	60	0
Ps. aeruginosa, ATCC 15442	1:80	60	0

Conclusion: Unicide 128, diluted 1 oz. per gallon of water for a storage period of six months at room temperature is a bactericide for hospital use.

USE ON ALL HARD SURFACES

The 1:128 use-dilution of **Unicide 128** is suitable for use on all hard surfaces not harmed by water. Use it on floors, walls, mirrors, glass, metal surfaces, conductive flooring, painted surfaces, exterior bowl surfaces, empty basins, showers, tubs, and lavatory fixtures. This product is for institutional use only such as hospitals, nursing homes, schools, colleges, industrial plants, and other public areas.

CLEANING AND DISINFECTING WASHABLE HARD NON-POROUS SURFACES: Add one ounce of **Unicide 128** to each gallon of water used. Always add Unicide 128 to premeasured water. Gently mix for a uniform solution. Apply solution by normal methods with brush, mechanical spray devices, sponge, cloth or mop. Thoroughly wet all surfaces to be cleaned, then remove excess solution with a wrung out applicator. Treated surfaces should remain wet for ten minutes. Remove gross filth mechanically by sweeping before cleaning begins. Discard solution when it becomes dirty and replace with fresh solution. Rinsing is not necessary on floor surfaces unless floors are to be waxed. **Unicide 128** is a complete product. Do not add other chemicals. Use only as directed.

PRECAUTIONARY STATEMENTS

Use-solution

Under Federal regulations the 1:128 use-dilution of Unicide 128 is not considered toxic or corrosive. However, the use of rubber gloves is recommended when using this and all germicides.

Concentrate

The acute oral toxicity of Unicide is sufficient to require its classification as a toxic substance — however, it is relatively low when compared to many 13th Edition or newer quaternary ammonium compounds. The oral LD_{50} of the concentrate for male and female albino rats is 7.41 grams per kilogram. This approximates a 15 fluid ounce dose for a 150 pound adult human.

With respect to the skin and eyes, the concentrate should be regarded as extremely corrosive so exposures should be avoided. Wear goggles or face shield and rubber gloves when handling. Can cause eye and skin damage. Wash thoroughly with soap and water after handling. Remove and wash contaminated clothing before reuse. Harmful if swallowed. Avoid contamination of food, water, and feed.

STATEMENT OF PRACTICAL TREATMENT: In case of skin contact, wash thoroughly with soap and water. In case of eye contact, immediately flush eyes with water for 15 minutes and get prompt medical attention. If swallowed, drink promptly a large quantity of milk, egg whites, gelatin solution or if these are not available, drink large quantities of water. Avoid alcohol. Call a physician immediately.

NOTE TO PHYSICIAN: Probable mucosal damage may contraindicate the use of gastric lavage. Measures against circulatory shock, respiratory depression and convulsion may be needed.

STORAGE AND DISPOSAL

PROHIBITIONS: Do not contaminate water, food or feed by storage or disposal. Open dumping is prohibited. Do not reuse empty container.

PESTICIDE DISPOSAL: Pesticide wastes are acutely hazardous. Improper diposal of excess pesticide, spray mixture, or rinsate is a violation of Federal Law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest E.P.A. Regional Office for guidance.

CONTAINER DISPOSAL • PLASTIC CONTAINERS: Triple rinse (or equivalent) then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

GENERAL: Consult federal, state or local authorities for approved alternative procedures.

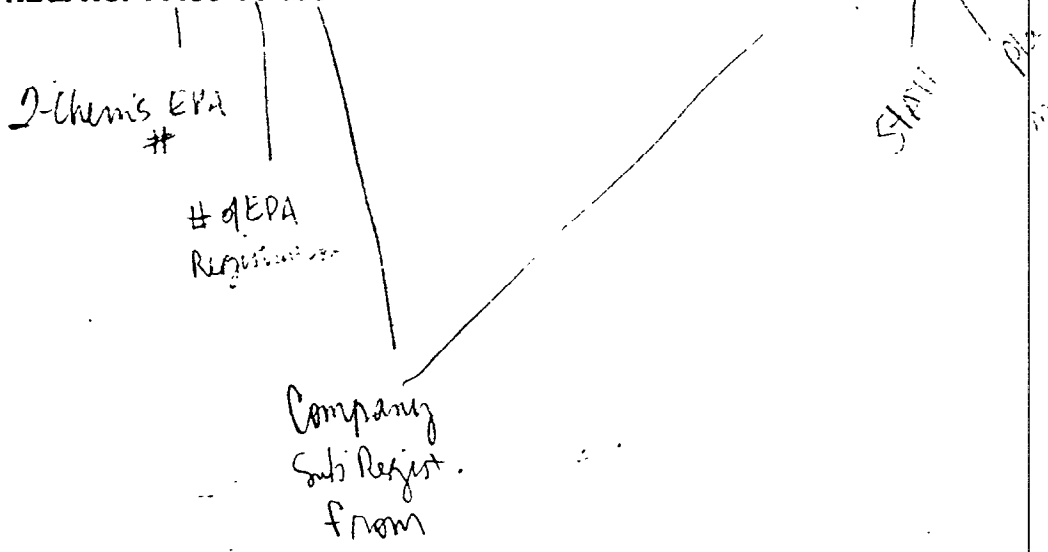
PHYSICAL AND CHEMICAL SPECIFICATIONS

Color	Light Blue
Odor	Mild Sassafras
pH of concentrate	2.00
pH at 1:128	4.15
Flash Point (TOC)	None to boiling
Biodegradable	Yes
Phosphate	None
Acute Oral LD_{50} in Rats	7.41 g/kg

ACTIVE INGREDIENTS:

Alkyl (C_{14}, 50%; C_{12}, 40%; C_{16}, 10%;) dimethyl benzyl ammonium chloride	2.680%
Octyl decyl dimethyl ammonium chloride	2.010%
Didecyl dimethyl ammonium chloride	1.355%
Dioctyl dimethyl ammonium chloride	1.005%

E.P.A. REG. NO. 44486-14-106 **E.P.A. EST. NO. 106-IN-1**



Creating A Safer Environment
The Brulin Corporation
HOME OFFICE/PLANT: P.O. Box 270 , Indianapolis, IN 46206-0270 • (317) 923-3211 • 1-800-428-7149 • INDIANA ONLY 1-800-423-0962
INDIANAPOLIS IN • WESTWOOD NJ • TAMPA FL • RICHMOND CA

THE JOURNAL OF INFECTIOUS DISEASES • VOL. 137, NO. 4 • APRIL 1978

MAJOR ARTICLES

Infections with Viruses and *Mycoplasma pneumoniae* during Exacerbations of Chronic Bronchitis

R. O. Buscho, D. Saxtan, P. S. Shultz, E. Finch, and M. A. Mufson

From the Veterans Administration West Side Hospital, and the Departments of Medicine and of Preventive Medicine and Community Health, Abraham Lincoln School of Medicine, University of Illinois at the Medical Center, Chicago, Illinois

The association of viral and *Mycoplasma pneumoniae* infections with acute exacerbations of chronic bronchitis was studied by serologic or isolation techniques in 46 adult men during the five years from 1964 through 1968. Serologic evidence of viral or *M. pneumoniae* infection was detected in 25% of 166 episodes of exacerbation and 14% of 138 remission periods ($P = 0.02$). Influenza A virus, parainfluenza virus type 3, and coronavirus OC43 predominated; infections with other viruses were infrequent. Infection with *M. pneumoniae* was detected serologically in four patients, but this organism was never isolated from sputum specimens. Rhinoviruses were isolated from frozen-stored sputum specimens in 2.7% of the episodes of exacerbation and from 0.55% of the remission intervals (P not significant). These data suggest that although exacerbations of chronic bronchitis may be accompanied by viral and *M. pneumoniae* infections, patients with chronic bronchitis also acquire such infections without a worsening of their respiratory status.

Most of the microorganisms that infect the respiratory tract can be recovered from individuals undergoing exacerbations of chronic bronchitis [1, 2]. However, the role of viral and mycoplasmal infections in exacerbations of chronic bronchitis has not been fully documented. Moreover, the observations regarding infections in chronic bronchitics in a designated patient population during any specified period may not be comparable to those in other populations. Because of the high prevalence and morbidity of chronic bronchitis among patients of Veterans Administration Hospitals, we have conducted surveillance of one of these groups to assess the impact of respiratory tract infections on the natural course of this disease and to investigate further the occurrence and relative importance of viruses and mycoplasmas in exacerbations [3]. Evidence of viral and *Mycoplasma pneumoniae* infections (obtained mainly by serologic testing and to a lesser extent by isolation of organisms) was correlated with the pattern of clinical disease in patients with chronic bronchitis.

Received for publication July 19, 1976, and in revised form November 14, 1977.

Please address requests for reprints to Dr. M. A. Mufson at his present address: Department of Medicine, Marshall University School of Medicine, Huntington, West Virginia 25701.

Materials and Methods

Design of study. Forty-six male adults with chronic bronchitis, outpatients at the Veterans Administration Hospital, Hines, Ill., constituted the study group. These patients all fulfilled the criteria for the diagnosis of chronic bronchitis, defined as a chronic or recurrent increase in the volume of mucoid or mucopurulent bronchial secretions sufficient to cause expectoration, during at least three months of each of the two years prior to entry into the study group. Their clinical and microbiological status was studied longitudinally during the five years from 1964 through 1968. Monthly or in alternate months and during periods of exacerbation, each patient reported to the outpatient clinic for examination. At each visit a symptom questionnaire was completed by the examiner, a physical examination was performed, pulmonary function tests were

done, a sputum specimen was collected for isolation of virus and *Mycoplasma*, and a serum specimen was obtained for serologic evaluation. The questionnaires and definitions of remissions and exacerbations were modeled after the guidelines reported by the Medical Research Council [4]. Exacerbations were defined as an increase in cough or sputum production since the patient's previous visit. Symptoms of upper airway infection were not included among these criteria.

An exacerbation was considered satisfactorily tested for viral and *M. pneumoniae* infections when serum pairs were obtained before and after this episode and a sputum specimen was collected for mycoplasmal and viral isolation. One hundred sixty-six (62%) of 270 exacerbations were tested in this manner. For comparison, 138 intervals when patients did not experience an exacerbation or were otherwise in remission were similarly tested.

Population characteristics. All patients were veterans who attended the pulmonary outpatient clinic on a regular basis. They visited the clinic for monthly follow-up an average of 10.3 months per year and made an average of 11.0 total visits per year. Persons who were habitual poor attenders were not included in the study population. The ages of the 46 patients at the beginning of the study period ranged from 31 to 79 years; the distribution of age was as follows: 30–39 years, two patients; 40–49 years, 13; 50–59 years, nine; 60–69 years, 13; and 70–79 years, nine. The median age decade was 50–59 years. All patients were or had been cigarette smokers. The range of pack-years (one pack per man per year) was five to 125 (median, 49 years). Pulmonary function tests on entry into the study disclosed a marked degree of obstructive pulmonary disease. The mean values of forced vital capacity (FVC), forced expiratory volume (FEV_1), and the ratio FEV_1/FVC were 2.45 liters, 1.31 liters, and 52%. Expressed as a percentage of normal, the FEV_1 for study patients ranged from 10% to 80%, but two-thirds of the group had values of ≤40%. Similarly, the FEV_1/FVC ratio ranged from 30% to 80% of normal, and two-thirds of the group had values of ≤50%.

Procedures for isolation of virus. Sputum specimens for viral isolation were stored at −70 C for five to eight years. When ready for use, specimens were rapidly thawed, and 0.4 ml was suspended in 2.0 ml of chilled veal infusion broth treated with 500 units of penicillin/ml, 500 μg of streptomycin/ml, and 0.02 mg of amphotericin B/ml of broth for 1 hr at 4 C. A volume of 0.2 ml of the treated sputum suspension was inoculated into each of two roller-tube cultures of human diploid fibroblasts (WI-38 strain) for recovery of picornaviruses, adenoviruses, herpesviruses, and coronavirus strain 229E. Because of the long period of storage of the sputum specimens, no attempt was made to isolate myxoviruses.

WI-38 roller-tube cultures were obtained from Flow Laboratories, Rockville, Md. Maintenance medium for these cell cultures consisted of Eagle's minimal essential medium supplemented with 2% inactivated fetal calf serum; the complete medium was adjusted to pH 7.0 with 7.5% $NaHCO_3$ [5].

Cultures were incubated on a rotating drum at 33 C for at least 21 days and often for as long as 28 days. Subpassages of negative cultures were not made. Cell cultures were examined three times a week for CPE, and the maintenance medium was changed at these times. Viral isolates were identified by procedures previously described [5].

Mycoplasma. A fresh agar medium consisting of pleuropneumonia-like organism agar (Difco, Detroit, Mich.), 20% horse serum, 10% yeast extract, penicillin G (2,000 units/ml), amphotericin B (5.6 μg/ml), and thallium acetate (0.05%) was used for the isolation of all mycoplasmas. Duplicate plates were inoculated with sputum. One plate was incubated aerobically and the other anerobically at 37 C for four weeks. Mycoplasma isolates were identified by growth inhibition procedures using specific hyperimmune antiserum [6]. Included in the test were antisera to *M. pneumoniae, Mycoplasma orale, Mycoplasma hominis, Mycoplasma fermentans, Mycoplasma arthriditis,* and *Mycoplasma salivarium.* Approximately one-half of the cultures were passaged on agar a second time from an area selected adjacent to the zone of inhibition in an attempt to identify mixed cultures of mycoplasmas. None were detected.

Serologic procedures. Serial serum specimens were tested by CF for antibodies to influenza A and B viruses, respiratory syncytial virus (RSV),

parainfluenza virus types 1, 2, and 3, adenoviruses, and coronavirus types 229E and OC43 and for *M. pneumoniae*. Microtiter CF tests containing 1.7–1.8 units of complement were employed after fixation overnight at 4 C. Four units of each viral and mycoplasmal antigen were used. Serologic evidence of infection was defined as a fourfold or greater rise in antibody titer between the acute- and convalescent-phase sera.

Results

Occurrence of acute respiratory illness in patients with chronic bronchitis. The total number of exacerbations experienced by each patient during their participation in this study ranged from one to 14 (mean, 5.9). The number of exacerbations of any one patient usually was directly proportional to the number of years of participation in the surveillance program. The mean number of years of patient participation was 3.7. Only one patient reported no exacerbations during the four-year period of the study. Exacerbations of chronic bronchitis tended to occur more often in the winter months than in the summer months, although they occurred frequently in all months of the year (table 1).

Serologic evidence of viral and M. pneumoniae infections. Infections with respiratory virus or *M. pneumoniae* were detected at least once in 40 of the 46 patients studied. The mean number of infections was 1.9 (range, 1-6). Although patients included in the study for a longer time experienced somewhat more virus and *M. pneumoniae* infections, the relationship was not linear, a finding suggesting that individual differences in rates of infection could not be attributed exclusively to the duration of participation in the study.

Fourfold or greater rises in titer of antibody to virus or *M. pneumoniae* were detected in 50 (30.1%) of 166 exacerbations of chronic bronchitis in the 46 adult patients studied (table 2). By comparison, viral and *M. pneumoniae* infections were detected in 38 (27.5%) of 138 remissions. These rates were not significantly different and suggest that patients with chronic bronchitis can undergo infections with these agents apparently without an acute worsening of their respiratory status. When rises in titers of antibody to multiple agents which occurred simultaneously during a single episode were excluded from this analysis, the distribution of single-agent infections could be assessed (table 3). Infections defined as a rise in titer of antibody to a single agent (a virus or *M. pneumoniae*) were detected in 41 (24.7%) of 166 exacerbations of chronic bronchitis and only 19 (13.8%) of 138 remissions, a difference which was significant ($P = 0.02$).

The frequency of individual viral and *M. pneumoniae* infections was analyzed using only these single-agent antibody titer rises (table 4). Forty-one (82%) of 50 rises in antibody titer during

Table 1. Occurrence (by month) of total and tested exacerbations among patients with chronic bronchitis from 1964 through 1968.

Month	No. of exacerbations	No. of exacerbations tested (%)
January	27	22 (81.5)
February	20	10 (50.0)
March	26	17 (65.4)
April	18	10 (55.6)
May	23	13 (56.5)
June	18	11 (61.1)
July	18	13 (72.2)
August	22	16 (72.7)
September	23	17 (73.9)
October	21	12 (57.1)
November	27	16 (59.3)
December	27	9 (33.3)
Total	270	166 (61.5)

Table 2. Viral and *Mycoplasma pneumoniae* infections detected by serologic response alone in 46 patients with chronic bronchitis under surveillance from 1964 through 1968.

Clinical appraisal (no. tested)	No. with serologic evidence of nonbacterial infection (%)*
Exacerbation (166)	50 (30.1)†
Remission (138)	38 (27.5)

*Fourfold or greater rises in CF antibody titer to influenza A and B viruses, parainfluenza virus types 1, 2, and 3, respiratory syncytial virus, adenoviruses, coronaviruses, or *M. pneumoniae*. Single or multiple rises during a single episode were counted as one infection.

†No significant difference in infection rate between exacerbations and remissions ($\chi^2 = 0.24$; one degree of freedom; P not significant).

Table 3. Viral and *Mycoplasma pneumoniae* infections occurring as single-agent antibody titer rises among patients with chronic bronchitis under surveillance from 1964 through 1968.

Clinical appraisal (no. tested)	No. with serologic evidence of nonbacterial infections (%)*
Exacerbation (166)	41 (24.7)†
Remission (138)	19 (13.8)

*Fourfold or greater rises in CF antibody titer to influenza A and B viruses, parainfluenza virus types 1, 2, and 3, respiratory syncytial virus, adenoviruses, coronaviruses, or *M. pneumoniae*.

†The difference in infection rate between exacerbations and remissions was significant ($\chi^2 = 5.7$; one degree of freedom; $P = 0.02$).

exacerbation were single-agent antibody titer rises, and during remission 19 (50%) of the 38 rises were single-agent antibody titer rises. The higher incidence of multiple-agent antibody titer rises in remission intervals may be a reflection of the study design. More attention was paid to specimen collection during exacerbations with the result that the average intervals defined by available serum pairs were 1.5 months for exacerbation and 3.2 months for remission.

Myxovirus and coronavirus infections predominated (table 4). Influenza A virus, parainfluenza virus type 3, and coronavirus OC43 accounted for nearly two-thirds of all infections. In each instance these infections occurred more often in exacerbation than in remission, a finding that suggests their association with the occurrence of exacerbations of chronic bronchitis; however, the difference was significant only for influenza A virus and coronavirus OC43 ($P < 0.05$). All other viral infections occurred as often in exacerbation as in remission.

M. pneumoniae infection alone occurred in 2.4% of exacerbations but not in any remission. Fifteen additional rises in titer of antibody to *M. pneumoniae* occurred simultaneously with respiratory virus infections. These rises were equally distributed between periods of exacerbation and remission.

Viral infections among patients with chronic bronchitis occurred as defined outbreaks (figure 1). Epidemics due to influenza A virus occurred during three winters, in the years 1965, 1967, and 1968. Parainfluenza virus type 3 infection occurred also in the fall and winter months of 1964–1965 and 1967–1968 and in the fall of 1966. Coronavirus OC43 was detected predominately as one sharp cluster in the winter of 1965; *M. pneumoniae* was identified also during this time.

Table 4. Occurrence of viral and *Mycoplasma pneumoniae* infections determined only by single-agent rises in antibody titer among patients with chronic bronchitis.

Agent	Exacerbations ($n = 166$)*	Remissions ($n = 138$)*	z ratio†	P
Influenza virus				
A	15 (9.0)	5 (3.6)	1.88	0.030
B	2 (1.2)	4 (2.8)	1.00	NS‡
Parainfluenza virus				
Type 1	0	1 (0.7)	1.06	NS
Type 2	2 (1.2)	2 (1.4)	0.15	NS
Type 3	8 (4.8)	4 (2.9)	0.85	NS
Adenovirus	2 (1.2)	1 (0.7)	0.44	NS
Respiratory syncytial virus	0	1 (0.7)	1.06	NS
Coronavirus				
OC43	8 (4.8)	1 (0.7)	2.10	0.018
229E	0	0	0	NS
M. pneumoniae	4 (2.4)	0	1.84	0.033

*Number of episodes in which patients had fourfold or greater CF antibody rises as evidence of infection (percentage).

†Test of significance of proportions [7].

‡NS = not significant.

Recovery of viruses. Frozen sputum specimens were available from 113 episodes of exacerbations and from 183 remissions. More intervals were tested for recovery of virus than for CF antibody because of differences in the availability of frozen sputum and serum pairs. Rhinoviruses were recovered more often from the sputum of patients with chronic bronchitis during exacerbation (three [2.7%] of 113 exacerbations) than during remission (one[0.55%] of 183 remissions); this difference was not statistically significant. Rhinovirus infections occurred in the spring, summer, and fall. No other viruses were isolated.

Recovery of mycoplasmas. During the three years from 1966 through 1968, 36 of the 46 patients with chronic bronchitis were tested for infection by attempts at isolation of mycoplasmas from fresh sputum. All isolates were identified. *M. salivarium* was isolated from 215 (36.3%)

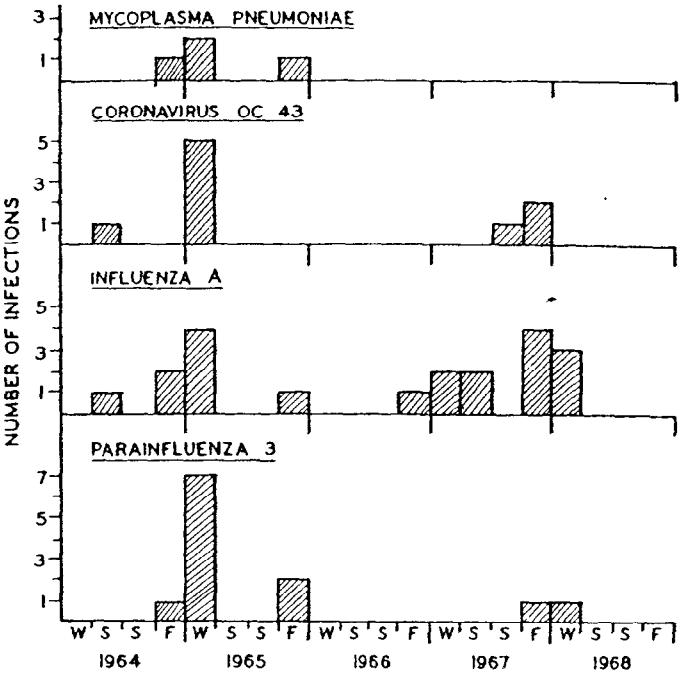


Figure 1. Temporal occurrence of fourfold or greater rises in titer of antibody to a single agent (i.e., influenza A virus, parainfluenza virus type 3, coronavirus OC43, or *Mycoplasma pneumoniae*) in patients with chronic bronchitis. WSSF = winter, spring, summer, fall.

of 593 cultures. The recovery of *M. salivarium* was not related to the exacerbation or remission status of the patient. No isolates of *M. pneumoniae* or *M. orale* were recovered.

Discussion

In this study, viral and *M. pneumoniae* infections were common in patients during exacerbation, but such infections occurred also in these patients without worsening of their respiratory status. We reported our findings in two ways: as rises in titer of antibody to a single agent and as rises in titer of antibody to two or more agents within the same interval. Rises in titers of antibody to multiple agents predominated in remission intervals, which tended to be longer than exacerbation intervals. This difference may have accounted for some variation in the antibody titer which was not indicative of specific viral infection. Antibody titer rises to multiple agents also may reflect heterotypic responses and overestimate the number of infections. By analyzing antibody titer rises to single agents in this report, we estimated the importance of infection with each specific virus, but the approach precluded assessment of the role of dual infection with two viruses or a virus and *M. pneumoniae* in exacerbations. Rises in titer of antibody to *M. pneumoniae*, however, were detected most often in association with a titer rise to one or more respiratory viruses. The possibility that *M. pneumoniae* can function as a secondary or synergistic pathogen in respiratory tract infections cannot be excluded and requires further investigation.

That viruses may play a role in exacerbations of chronic bronchitis is suggested by the finding that one-fourth of exacerbations were associated with viral infections. This rate was twice that of viral infection in remission. Infections with influenza A virus and coronavirus OC43 occurred significantly more often in exacerbations than in remissions.

Coronaviruses have been recognized recently as etiologic agents of respiratory illness in children and adults [8–10]. Gump and coworkers also reported association of these agents with exacerbations of chronic bronchitis [11]. They found that four of seven infections with coronavirus OC43 and two of seven infections with coronavirus 229E were associated with an exacerbation. Evidence of this relationship has accumulated very slowly because of the requirement for recovery of strain OC43 in human fetal trachea organ cul-

tures, a difficult procedure. Infection with coronavirus 229E was not detected either by isolation or rise in antibody titer in the patients in our study.

The finding in this study of rhinovirus infections in only 2.7% of exacerbations is considerably lower than the 23% recovery rate for rhinoviruses in exacerbations reported by Eadie et al. [12], the 43% by McNamara et al. [13], and the 14% and 12% by Stenhouse [14, 15]. Carilli et al., however, failed to isolate these agents [16]. In his controlled study, Stenhouse found that rhinovirus infection was not more common in subjects with bronchitis than in the control population, but that rhinovirus infection was more likely to be associated with the development of acute lower respiratory tract symptoms [14]. The extended period of frozen storage of specimens before tissue culture inoculation may have contributed to our low recovery rate of rhinoviruses.

Sommerville first detected RSV infection in 50% of 82 exacerbations [17]. Carilli et al. [16] and McNamara et al. [13] also found RSV associated with a significant number of exacerbations, 17% and 12%, respectively. Unlike these investigators, we detected RSV infection by serologic procedures in only one remission interval of only one of our patients.

The paucity of *M. pneumoniae* infections detected in exacerbations in this study agrees with the results of another recent report [18]. In a number of prospective studies, *M. pneumoniae* infections have been associated with 8.7% and 9.5% of exacerbations [12, 13] and with no exacerbations [19]. One consistent finding, however, has been the failure to recover the organism from sputum, even from patients with rising antibody titers. These results question the significance of serologic responses alone only in this infection and should be further investigated. *M. salivarium* seems ubiquitous in samples of expectorated sputum as well as in specimens obtained during bronchoscopy [20].

Our findings are similar to those reported in a number of other studies on viral and *M. pneumoniae* infections in exacerbations of chronic bronchitis (table 5). In various studies the rates of infection in exacerbations ranged widely (4%–64%). These data have been interpreted as constituting strong, but not conclusive, evidence for an etiologic role of viruses or *M. pneumoniae* in the pathogenesis of acute exacerbations of chronic bronchitis. However, the available data cannot be easily compared because different sampling procedures and methods were employed. In addition, individual authors often did not specify the number of remission intervals examined but reported only infections detected during exacerbations and compared patients with chronic bronchitis with healthy (control) populations. Furthermore, the definition of an exacerbation is a subjective judgment, and different interpretations of the criteria will affect the percentage of association with infection.

Two groups of investigators have derived a more striking correlation of infection with exacerbation by interpreting their findings in a time-weighted fashion. Thus Gump et al. found that the incidence of infection was 32% per patient week of exacerbation but only 0.9% per patient week spent in remission [11]. Similarly, Lamy et al. compared patient months spent in exacerbation and remission with an incidence of infection of 52% and 3.7%, respectively [24]. Our data did not permit a time-weighted analysis since the duration of exacerbation was not recorded. When

Table 5. Association of viral and *Mycoplasma pneumoniae* infections with exacerbations of chronic bronchitis.

Reference	No. of exacerbations tested	No. of agents tested by serologic procedures*	Percentage of exacerbations with infection
Sommerville [17]	82	1	50
Carilli et al. [16]	46	8	52
Eadie et al. [12]	75	6	21
Stark et al. [21]	185	3	7
Ross et al. [19]	125	9	16
Stenhouse [14]	56	1	14
Moffat and Sutherland [22]	68	12	4
Stenhouse [15]	64	11	12
McNamara et al. [13]	42	5	64
Fisher et al. [23]	63	7	14
Gump et al. [11]	116	11	34
Lamy et al. [24]	49	10	63
Present study	166	11	25

*Includes rhinovirus recovery when appropriate tissue cultures were used for isolation of these agents.

the duration of exacerbation was estimated using the interval between the collection of two samples of serum bracketing an exacerbation, we tested 257 months of exacerbation and 442 months of remission. The rate of viral infection was 15.4% per exacerbation month and 4.3% per remission month. This trend is similar to that in the data of Gump et al. [11].

A special problem in interpretation is posed by the detection of infection in patients with chronic bronchitis without an associated acute compromise in their respiratory status. In our study approximately one-third of all viral and *M. pneumoniae* infections detected belonged in this category. Whether subclinical infections contribute to continuing clinical deterioration remains unexplored, and long-term epidemiologic and clinical surveillance of patients with chronic bronchitis will be required to answer this question.

References

1. Leeder, S. R. Role of infection in the cause and course of chronic bronchitis and emphysema. J. Infect. Dis. 131:731–742, 1975.
2. Tager, I., Speizer, F. E. Role of infection in chronic bronchitis. N. Engl. J. Med. 292:563–571, 1975.
3. Mufson, M. A., Saxtan, D., Shultz, P. S., Buscho, R. O., Finch, E. Virus and mycoplasma infections in exacerbations of chronic bronchitis. Clin. Res. 22:646A, 1974.
4. Definition and classification of chronic bronchitis for clinical and epidemiological purposes. A report to the Medical Research Council. Lancet 2:775–779, 1965.
5. Mufson, M. A., Chang, V., Gill, V., Wood, S. C., Romansky, M. J., Chanock, R. M. The role of viruses, mycoplasmas and bacteria in acute pneumonia in civilian adults. Am. J. Epidemiol. 86:526–544, 1967.
6. Clyde, W. A., Jr. Mycoplasma species identification based upon growth inhibition by specific antisera. J. Immunol. 92:958–965, 1964.
7. Croxton, F. E. Elementary statistics with applications in medicine. Prentice-Hall, New York, 1953, p. 263–265.
8. Wenzel, R. P., Hendley, J. O., Davies, J. A., Gwaltney, J. M., Jr. Coronavirus infections in military recruits: three-year study with coronovirus strains OC43 and 229E. Am. Rev. Respir. Dis. 109:621–624, 1974.
9. Monto, A. S., Lim, S. K. The Tecumseh study of respiratory illness. VI. Frequency of and relationship between outbreaks of coronavirus infection. J. Infect. Dis. 129:271–276, 1974.
10. McIntosh, K., Chao, R. K., Krause, H. E., Wasil, R., Mocega, H. E., Mufson, M. A. Coronavirus infection in acute lower respiratory tract disease of infants. J. Infect. Dis. 130:502–507, 1974.
11. Gump, D. W., Phillips, C. A., Forsythe, B. R., McIntosh, K., Lamborn, K. R., Stouch, W. H. Role of infection in chronic bronchitis. Am. Rev. Respir. Dis. 113: 465–474, 1976.
12. Eadie, M. B., Scott, E. J., Grist, N. R. Virological studies in chronic bronchitis. Br. Med. J. 2:671–673, 1966.
13. McNamara, M. J., Phillips, I. A., Williams, O. B. Viral and *Mycoplasma pneumoniae* infections in exacerbations of chronic lung disease. Am. Rev. Respir. Dis. 100:19–24, 1969.
14. Stenhouse, A. C. Rhinovirus infection in acute exacerbation of chronic bronchitis: a controlled prospective study. Br. Med. J. 3:461–463, 1967.
15. Stenhouse, A. C. Viral antibody levels and clinical status in acute exacerbations of chronic bronchitis: a controlled prospective study. Br. Med. J. 3:287–290. 1968.
16. Carilli, A. D., Gohd, R. S., Gordon, W. A virologic study of chronic bronchitis. N. Engl. J. Med. 270: 123–127, 1964.
17. Sommerville, R. G. Respiratory syncytial virus in acute exacerbations of chronic bronchitis. Lancet 2:1247–1248, 1963.
18. Westerberg, S. C., Smith, C. B., Renzetti, A. D. Mycoplasma infections in patients with chronic obstructive pulmonary disease. J. Infect. Dis. 127:491–497, 1973.
19. Ross, C. A. C., McMichael, S., Eadie, M. B., Lees, A. W., Murray, E. A., Pinkerton, I. Infective agents and chronic bronchitis. Thorax 21:461–464, 1966.
20. Cherry, J. D., Taylor-Robinson, D., Willers, H., Stenhouse, A. C. A search for mycoplasma infections in patients with chronic bronchitis. Thorax 26:62–67, 1971.
21. Stark, J. E., Heath, R. B., Curwen, M. P. Infection with influenza and parainfluenza viruses in chronic bronchitis. Thorax 20:124–127. 1965.
22. Moffat, M. A. J., Sutherland, J. A. W. Persistence of viral antibodies in patients with chronic bronchitis. Br. Med. J. 1:601–603, 1967.
23. Fisher, M., Akhtar, A. J., Calder, M. A., Moffat, M. A. J., Stewart, S. M., Zealley, H., Crofton, J. W. Pilot study of factors associated with exacerbations in chronic bronchitis. Br. Med. J. 4:187–192, 1969.
24. Lamy, M. F., Pouthier-Simon, F., Debacker-Willame, E. Respiratory viral infections in hospital patients with chronic bronchitis: observations during periods of exacerbation and quiescence. Chest 63:336–341, 1973.

American Journal of Infection Control

Volume 18 Number 6 December 1990

ARTICLES

Occurrence of infectious symptoms in children in day care homes

Arlene Manns Butz, CPNP, ScD
Elaine Larson, RN, PhD, FAAN
Patricia Fosarelli, MD
Robert Yolken, MD
Baltimore, Maryland

Transmission of enteric pathogens is facilitated in child day care centers, including family day care homes, by frequent and intimate exposure among susceptible hosts, with diaper changing as the highest-risk procedure for such transmission. The objective of this study was to evaluate the effectiveness of an intervention program in decreasing the incidence of infectious disease symptoms in children attending family day care homes during a 12-month period. Each of 24 family day care homes was randomly assigned to an intervention or control group. The intervention included four components: (1) a handwashing educational program and (2) use of vinyl gloves, (3) use of disposable diaper changing pads, and (4) use of an alcohol-based hand rinse by the day care provider. Symptoms of enteric disease (diarrhea and vomiting) were significantly reduced in intervention family day care homes ($p \leq 0.05$), whereas respiratory symptoms were not significantly different between intervention and control family day care homes ($p = 0.35$). Diarrhea was reported in 1 of every 100 child care days, representing one diarrhea episode per month in a typical family day care home. (AM J INFECT CONTROL 1990;18:347-53).

More than half of U.S. women with children under the age of 6 years are currently in the labor force. Child care is provided for more preschool-age children in family day care homes (37%) (FDCHs) than in in-home care (31%) or day care centers (23%).[1] Thus most children spend a minimum of 10 hours per week in day care.[2]

Transmission of certain infectious diseases have been associated with day care centers, including *Haemophilus influenzae* type b,[3] hepatitis A,[4] and infectious diarrhea caused by *Giardia lamblia*, *Shigella*, and rotavirus.[5-8] Outbreaks of infectious diseases, especially those associated with diarrhea, in day care centers pose direct threats to infants and toddlers, who are subsequently likely to infect others.[9, 10] Diarrheal attack rates in children attending day care centers range from 50% to 71% during diarrheal

From the School of Nursing, and the Department of Pediatrics, Johns Hopkins University.

Supported by Johnson & Johnson/SURGIKOS.

Reprint requests: Arlene M. Butz, CPNP, ScD, Johns Hopkins University, Houck 381, 600 N. Wolfe St., Baltimore, MD 21205.

7/46/21893

were instructed to use an alcohol-based (60% isopropyl alcohol) hand rinse (Cal STAT, Calgon Corp., St. Louis, Mo.). All supplies were provided to each intervention day care provider. This combined intervention was chosen to maximize any beneficial effects. The control homes received no educational intervention but received biweekly nurse visits for symptom data collection.

Assessment of symptoms. Daily symptom records for each child were kept by all day care providers for a 12-month study period. Each day the provider recorded the following symptoms for each child: diarrhea, vomiting, runny nose, and absence from day care home. All absent days, including those for vacation, maternal illness, and days off, were recorded. Reason for absenteeism was not recorded. If no data were recorded on any given day, that day's data were coded as missing.

Definitions of symptoms were provided to providers. Diarrhea was defined as the occurrence of loose, unformed bowel movements at twice the normal frequency. Normal frequency of bowel movements was further defined for the day care providers: infants, one to two stools per day; and older children, one stool per day. The presence or absence of symptoms was recorded only for days of attendance; no recording of symptoms was attempted in the child's home. Every 2 weeks a registered nurse visited each FDCH to collect the completed symptom records. All providers, control and intervention, were remunerated with $2.00 during the biweekly visits as well as an additional amount three times during the study period for completing the symptom records.

Statistical analysis. The proportion of child symptom days (diarrhea, vomiting, and runny nose) was calculated for all children for each month and plotted across the 12-month study period to ascertain seasonal trends in symptom reporting. The trends reported do not necessarily reflect the same children during the study period. Each month represented an independent proportion of child symptom days. Multiple symptoms are reported as group rates, not by the individual child. Additionally, a series of chi-square tests of association were performed to compare the intervention and control homes for the number of symptom days reported during the 12-month period (significance level $p = 0.05$).

RESULTS

Population. During the period from Jan. 4, 1988, to Dec. 31, 1988, 114 children were enrolled from 24 FDCHs. From all FDCHs, only two children were not enrolled. Baseline data are reported on 108 children (95%) whose parents could be contacted by telephone. During the 12-month period, 47 children (27 control, 20 intervention) departed from and 19 (8 control, 11 intervention) new children entered the FDCHs, accounting for 86 children enrolled at the termination of the study. Two FDCHs (one control, one intervention) discontinued care during the 12-month study period, accounting for 11 of the departing children. The majority (68%) of children departing from day care left during the second half of the study period.

Sociodemographic characteristics of the children by type of home are shown in Table 1. There were no statistically significant differences between the two groups of children by age, sex, race, maternal age, preexisting health condition, or number of siblings in their home. A preexisting health condition, which was reported by 19% of all children, included asthma, recurrent ear infections, cerebral palsy, ventricular septal defect, chronic constipation, cancer, and seizures. There were no statistically significant sociodemographic differences in the control or intervention providers (Table 2). The providers tended to be older (mean age 48.5 years), and more than half (58%) had not completed high school.

Symptom reports. During the study period, a total of 20,587 child days were included (control, 10,428 days; intervention, 10,159 days), with an average daily census of 100 children (control, 47.5 children/day; intervention, 52.5 children/day) aged 1 month to 7 years. Absent days totaled 1727 (8.4%), and missing days totaled 461 (2.2%) during the 12-month study period. Absent and missing days were excluded

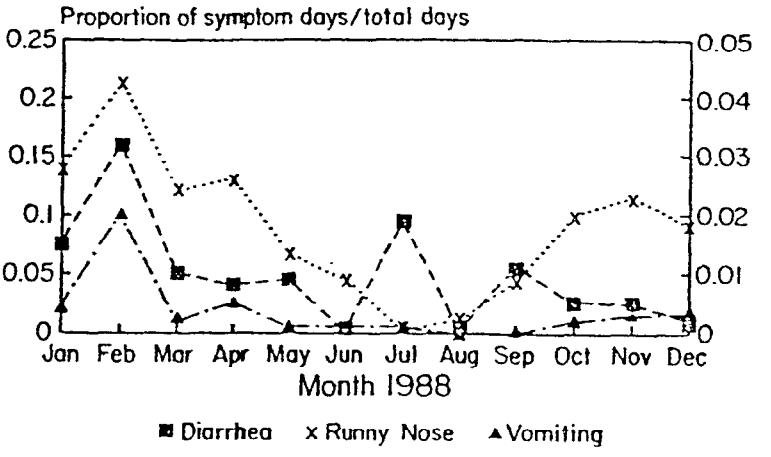


Fig. 1. Symptom rates for both intervention and control homes by month for diarrhea, runny nose, and vomiting. Runny nose rates are plotted on scale at *left*, and diarrhea and vomiting rates are plotted on scale at *right*.

Table 2. Sociodemographic characteristics among control and intervention day care providers (n = 24)

Characteristic	No. of subjects (%)		p value
	Control	Intervention	
Age (mean; yr)	43.1	48 8	0 840
Race			
Black	12 (100)	12 (100)	1 00
Educational level			
Some high school	8 (67)	6 (50)	0 526
High school graduate	3 (25)	3 (25)	
Some college or technical	1 (8)	3 (25)	
Participation in child care course			
Yes	5 (42)	8 (67)	0 207
No	7 (58)	4 (33)	

occurred only during the biweekly visits. Control homes received no supplies, and use of vinyl gloves was not observed in the control homes during the study period.

DISCUSSION

Prevention and control of infectious diseases in day care facilities depends on maintenance of optimal hygienic standards. Handwashing by providers is considered the single most important preventive measure[15] in day care facilities. The results of our study demonstrate that symptoms of enteric disease (diarrhea and vomiting) are lowered in FDCHs when specific hygienic measures such as handwashing, use of vinyl gloves, disposable diaper pads, and alcohol-based hand rinse are used. The relative contribution of each component of the intervention cannot be distinguished in our data because the intervention was devised to produce the maximum effect in low-income, inner-city FDCHs. To test each component of the intervention, a larger sample size would be required. Further studies need to be undertaken to determine which factor is responsible for lowering the symptom rates reported in the intervention FDCHs.

Fecal coliform bacteria and rotavirus have been detected in day care centers on environmental surfaces, including diaper changing areas, carpet, and teachers' hands.[18-20] The simian rotavirus SA-11, suspended in distilled wa-

mary of findings—national day care home study. Department of Health and Human Services Publication No. OHDS 80-30282. Cambridge: ABT Associates, 1981.
3. Redmon SR, Pichichero ME. *Haemophilus influenzae* type b disease. JAMA 1984;252:2581-4.
4. Hadler SC, Erben JJ, Francis DP, et al. Risk factors for hepatitis A in day care centers. J Infect Dis 1982; 145:225-61.
5. Pickering LK, Evans DG, DuPont HL, Vollet JJ, Evans DJ. Diarrhea caused by *Shigella*, rotavirus, and *Giardia* in day care centers: prospective study. J Pediatr 1981;99:51-6.
6. Bartlett AV, Moore M, Gary GW, Starko KM, Erben JJ, Meredith BA. Diarrheal illness among infants and toddlers in day care centers. II. Comparison with day care homes and households. J Pediatr 1985;107:503-9.
7. Tauxe RV, Johnson KE, Boarse JC, Helgerson SD, Blake PA. Control of day care shigellosis: a trial of convalescent day care in isolation. Am J Public Health 1986; 76:627-30.
8. Ekanem EE, DuPont HL, Pickering LK, Selwyn BJ, Hawkins CM. Transmission dynamics of enteric bacteria in day-care centers. Am J Epidemiol 1983;118:562-72.
9. Goodman RA, Osterholm MT, Granoff DM. Infectious diseases and child day care. Pediatrics 1984;74:134-9.
10. Bartlett AV, Broome CV, Hadler SC. Public health considerations of infectious diseases in child day care centers. J Pediatr 1984;105:683-701.
11. Rodriguez WJ, Kim HW, Brandt CD, et al. Longitudinal study of rotavirus infection and gastroenteritis in families served by a pediatric medical practice: clinical and epidemiologic observations. Pediatr Infect Dis J 1987; 6:170-6.
12. Pickering LK, Bartlett AV, Reves RR, Morrow A. Asymptomatic excretion of rotavirus before and after rotavirus diarrhea in children in day care centers. J Pediatr 1988;112:361-5.
13. Johansen AS, Leibowitz A, Waite LJ. Child care and children's illness. Am J Public Health 1988;78:1175-7.
14. Pickering LK. The day care center diarrhea dilemma. Am J Public Health 1986;76:623-4.
15. Black RE, Dykes AC, Anderson KE, et al. Handwashing to prevent diarrhea in day-care centers. Am J Epidemiol 1981;113:445-51.
16. Sattar SA, Lloyd-Evans N, Springthorpe VS. Institutional outbreaks of rotavirus diarrhoea: potential role of fomites and environmental surfaces as vehicles for virus transmission. J Hyg (Camb) 1986;96:277-89.
17. Child Day Care Infectious Disease Study Group. Public health considerations of infectious diseases in child day care centers. J Pediatr 1984;105:683-701.
18. Weniger BG, Ruttenber AJ, Goodman RA, Juranek DD, Wahlquist SP, Smith JD. Fecal coliforms on environmental surfaces in two day care centers. Appl Environ Microbiol 1983;45:733-5.
19. Keswick BH, Pickering LK, DuPont HL, Woodward WE. Survival and detection of rotaviruses on environmental surfaces in day care centers. Appl Environ Microbiol 1983;46:813-6.
20. Ansari SA, Sattar SA, Springthorpe VS, Wells GA, Tostowaryk W. Rotavirus survival on human hands and transfer of infectious virus to animate and nonporous inanimate surfaces. J Clin Microbiol 1988;26:1513-8.
21. Moe K, Shirley JA. The effects of relative humidity and temperature on the survival of human rotavirus in faeces. Arch Virol 1982;72:179-86.
22. Pickering LK, Woodward WE. Diarrhea in day care centers. Pediatr Infect Dis J 1982;1:47-52.

ierte Patient en analysiert. Ein Epidemio-
I bei 344 Patienten festgestellt, was einer
inkenhäusen, mit Rücksicht auf die be-
n 3,6 und 10,5 %. Die höchste NI-Präva-
Urologie 13,6 %, Chirurgie 12,2 %). Uner-
eilungen (hauptsächlich Durchfallkrank-
fektionen des oberen Respirationstraktes
Wunden und Infektionen des Harnwege-
Wunden und Infektionen der Harnwege
Infektionen des Gastrointestinaltraktes
terien wurden häufiger isoliert als gram-

a, J., Puškoková, G.: Prevalencia de

puntal de las IN en diez hospitales para
evalencia de ellas y despertar el interés

s hospitaliza los. Un epidemiologo junto
) la IN en 344 enfermos, alcanzando la
e, en cuanto a los hospitales diferentes.
tes de cirugía (urología 19.6 p. c., cirugía
lencia en la sección de pediatría (ante
njuntivitis). Después de las infecciones
uencia infecciones de las lesiones quirúr-
alencia de la IN de lesiones quirúrgicas,
cutáneas mientras que la prevalencia de
disminuendo con la edad. Se aislaron
ampositivas (2 : 1).

J. Hosp. Inf. 1981, 2, Supplement, 1—11.
rs, P. D., et al.: J. Hosp. Inf., 1981, 2,
oment, 13—17. 6. Center for Diseases
d: National Nosocomial Infections Study
t. Annual Summary 1979, March 1982.
stnerová, V., Kestner, J., Schulz, F.,
ová, A., Štrakovský, R.: ČsEMI, 24,
4: 193—210.

JOURNAL OF HYGIENE, EPIDEMIOLOGY, MICROBIOLOGY
AND IMMUNOLOGY, 31, 1987, No. 4, 375—380

SCREENING THE VIRICIDAL EFFICIENCY OF ANTISEPSIS, DISINFECTION AND CHEMICAL STERILIZATION — A DRAFT METHODOLOGY FOR PRACTICE

O. BYDŽOVSKÁ

Institute of Hygiene and Epidemiology, Prague, Czechoslovakia

SUMMARY

The paper documents the high resistence of *E. coli* phage ØX 174, one of the small non-enveloped viruses of icosahedral symmetry, vis-a-vis certain physico-chemical factors. It is this property that makes the phage a suitable model for evaluating in practical terms the efficiency of antisepsis, disinfection and chemical sterilization. The phage is detected in smears, prints and on carriers using the plaque method. The system *E. coli* — phage ØX 174 may serve as a bioindicator of the viricidal efficiency of chemical sterilization eventually of the measure of adsorbance of sterilizing agents on the treated material.

J. Hyg. Epidemiol. Microbiol. Immunol., 31, 1987, 4: 375—380

In combating the spread of viral infections it is essential that such antiseptics, disinfectants and chemical sterilization procedures be used that have been tested for their viricidal efficiency. To provide for the inactivation of all types of viruses, respective preparations and methods should be experimentally verified on members of the most resistant viral families.

The use of *Escherichia coli* phage ØX 174, which is morphologically similar to picorna- and parvoviruses, as a model for evaluating disinfection efficiency was reported in several papers [1—4]. Since 1982, the corresponding method has been included in a Comecon draft of unified procedures of disinfection evaluation. Bacteriophage ØX 174 together with two other *E. coli* phages were used by French investigators as models for assessing viral inactivation, the paper dating back to 1984 [5].

The present paper describes the resistance of the above virus vis-a-vis some physico-chemical effects as well as its possible applications in

1. evaluating practically accomplished antisepsis;
2. evaluating disinfection of hands, surfaces and objects by means of washing, mopping with towels, wiping and vapours;
3. evaluating the viricidal efficiency of room-disinfection and of chemical sterilization.

THE PLAQUE METHOD AND ITS APPLICATIONS

Microorganisms. Bacteriophage Ø X 174, ATCC Collection No 13706-B1, and *Escherichia coli* C, ATCC Collection No 13706-1. Plaque tests were carried out using methyl methacrylate

Address for correspondence:
O. Bydžovská, Institute of Hygiene and Epidemiology, Šrobárova 48, 100 42 Praha 10, Czechoslovakia

equilibration of vapours tension at ambient temperature. After exposure, the carriers are transferred into plate wells and covered with agar medium to assay for the plaques. Control carriers are kept at room temperature for the length of exposure.

In this experimental set-up, the efficiency of 3 % solution Porasteril (32—38 % peracetic acid) on glass and stainless steel carriers was already absolute after 10 min. exposure, with control carriers displaying patterns of consistent *E. coli* lysis.

Disinfectant vapours fail to penetrate tubing lumina at atmospheric pressure irrespective of tubing length and diameter. Sprössig [5] describes a simple disinfecting equipment utilizing vapours at a pressure reduced by 15 mm Hg.

2d. Evaluating Surface Disinfection

The method corresponds to disinfection performed during routine cleaning. The tested surfaces were made of materials commonly used in medical facilities, such as glass, stainless steel, plastics, PVC, tiles, enamel, wood with oil-paint coatings. Horizontally placed plates made of these materials were marked with 100 mm by 100 mm squares. Prior to testing, the routinely washed surfaces were exposed 30 min to germicidal lamps.

Contamination was carried out by spreading 0.1 ml broth suspension of phage of about 10^7 pfu/ml over the square surface 10 mm from the edge of the area, the operation being performed using a sterile L-shaped glass rod. After drying, the entire square specimen was disinfected by a gauze wad measuring 100 mm by 100 mm and soaked in the tested solution. Control surfaces were wiped off with tap water or common detergent. Spray preparations were applied according to the manufacturers' instructions. After drying, the surface was wiped off with a gauze wad soaked in nutrient broth which was then rinsed in 10 ml broth. The number of plaques was determined semiquantitatively in 1 ml rinse medium using a scores scale of 0—5. The results obtained using some preparations are presented in Table 2.

Table 2. Efficiency of Chloramin B, Chlordetal, Alkaline By-Product of Chloramin B Production and Dikonit on Surfaces Disinfected by Wiping

Surface 2 %	Chloramin 2 %	Chlordetal 6 %	Alkali 0.5 %	Dikonit	Control
Glass	0	0	0	0	5
Stainless steel	0	0	0	0	5
Hardened cardboard	0	1	0	0	5
PVC	2	1	0	1	5

Evaluating pfu in rinse medium

0 — < 1 pfu/ml
1 — 1—10 pfu/ml
2 — 11—50 pfu/ml
3 — 51—100 pfu/ml
4 — > 100 pfu/ml
5 — consistent *E. coli* lysis

Description of the Tested Preparations:

Chlordetal is a newly developed preparation containing, in addition to Chloramin B, a stabilizor and detergent. Chloramin alkali is a Chloramin by-product containing residual amounts of Chloramin, NaClO and NaOH.

Active chlorine concentration:
Chloramin B — 270—290 g/l
Chlordetal — 100—110 g/l
Chloramin alkali — 40 g/l
Dikonit — 550 g/l.

3a. Evaluating Room-disinfection

Sterile carriers from cotton textiles contaminated with a dry drop of phage broth suspension at a titre of about 10^7 pfu/ml were wrapped up in sterilization paper, e.g. Lukasterik five apiece and stored, in a refrigirator till used. Storage time should not exceed 1 week. Wrapped up carriers were then placed at various sites inside the device together with the other items to be desinfected.

Control carriers were removed
at room temperat re till det
nutrient medium with *E. coli*
The above p cedure was
desinfector with a capacity of
Carrier decontam nation after
were massively contaminated

3b. Evaluating Chemical

The efficiency of chemica
materials, glass carriers suitabl
The efficiency of steriliza
thread divided by knots into 30
diameter, the thread having be
about 10^7 pfu/ml and subseque
side of tubing. Both carriers a
sterilization, along with other
tion of the cycle, the phage is
are removed from inside the t
the phage being detected as o
Using the above proced
(Austria) another imported eth
made formaldehyde-based dev
carrier surfaces and in tubing h
were not sufficiently effective
of that, formaldehyde binding
at the time of phage detection
of formaldehyde to textiles ha
hyde adsorbtion to sterilized
bioindicator of the efficiency
E. coli — phage ØX 174 which
would seem a suitable candid

Evaluating practically
tion by means of *E. coli*
tests can be carried out
without the need for speci
centrate viruses from larg
fectants have been remov
cultures and animal virus
dispensing. Non-sterile ha
massive inoculations with
microorganism for 20 hou
Comparing efficiency
and tested on 4 species
genera *Coxsackie, ECHO,*
earlier [10, 11]. The disi
from 0.05 % to 10 % dep
a similar effect on the test
compounds, or solum sapo
Bacteriophage ØX 174 ca
evaluation of the inactiva
of this type.

r exposure, the carriers are trans-
y for the plaques. Control carriers

ion Peratert (32—36 % peracetic
fter 10 min. exposure, with control

atmospheric pressure irrespective
e disinfecting equipment utilizing

ring routine cleaning. The tested
facilities, such as glass, stainless
s. Horizontally placed plates made
ares. Prior to testing, the routinely

roth suspension of phage of about
he area, the operation being perfor-
ire square specimen was disinfected
the tested solution. Control surfaces
reparations were applied according
e was wiped off with a gauze wad
. The number of plaques was deter-
scale of 0—5. The results obtained

Product of Chloramin B Production by Wiping

.5 %	Dil onit	Control
	0	5
	0	5
	0	5
	1	5

51—100 pfu/ml
> 100 pfu/ml
consistent E coli lysis

g, in addition to Chloramin B, a sta-
product containing residual amounts

ramin alkali — 40 g/l
nit — 550 g/l.

a dry drop of phage broth suspension
ion paper, e.g. Lukasterik five spiece
t exceed 1 week. Wrapped up carriers
with the other items to be disinfected.

Control carriers were removed from the refrigirator at the same time as the tested ones and kept at room temperature till detection. The phage was determined by covering the carriers with nutrient medium with *E. coli* to assay for plaque formation.

The above procedure was used to evaluate the viricidal efficiency of a formaldehyde-based disinfector with a capacity of 5 m³ manufactured by Goedecker, Federal Republic of Germany. Carrier decontamination after a 3-h disinfection cycle was absolute, whereas control carriers were massively contaminated 6 days after being prepared.

3b. Evaluating Chemical Sterilization

The efficiency of chemical sterilization can be evaluated using carriers from thermolabile materials, glass carriers suitable for counting plaques, textile carriers or other porous materials.

The efficiency of sterilization inside the tubes can be assayed as follows: a length of cotton thread divided by knots into 30 mm segments is passed through the lumina of the tubes of varying diameter, the thread having been contaminated by immersion into phage suspension containing about 10^7 pfu/ml and subsequently dried. A 30 mm segment of the thread is left loose on either side of tubing. Both carriers and tubing are wrapped upin sterilization paper and subjected to sterilization, along with other items, at various sites inside the disinfecting device. After completion of the cycle, the phage is assayed on the surface of carriers using plate wells; the threads are removed from inside the tubing, cut into 30 mm segments with knots which are numbered, the phage being detected as on carrier surfaces.

Using the above procedure, 2 formaldehyde-based devices manufactured by ODELGA (Austria) another imported ethyleneoxide-based one as well as two prototypes of Czechoslovak-made formaldehyde-based devices were tested. In the imported equipment, viricidal activity on carrier surfaces and in tubing lumina was absolute. As regards the prototypes, some of the cycles were not sufficiently effective depending on sterilization temperature, time and course. On top of that, formaldehyde binding to textile was detected during some cycles which was manifested at the time of phage detection by inhibition of *E. coli* growth around carriers. Long-term binding of formaldehyde to textiles has been known for some time [8]. A procedure to prevent formaldehyde adsorbtion to sterilized material will have to be developed for the prototypes. No viral bioindicator of the efficiency of chemical sterilization has been introduced yet [9]. The system *E. coli* — phage ØX 174 which, in addition, signals formaldehyde binding to sterilized materials, would seem a suitable candidate for that role.

DISCUSSION

Evaluating practically performed antisepsis, disinfection and chemical sterilization by means of *E. coli* phage ØX 174 offers a number of advantages. Appropriate tests can be carried out in microbiological laboratories with common equipment without the need for special nutrient media, cell cultures and instruments to concentrate viruses from large volumes available after toxic concentrations of disinfectants have been removed by dilution. Neutralizing reagents may damage cell cultures and animal viruses fail to consistently yield titres high enough for liberal dispensing. Non-sterile handling of smears and carriers is made possible owing to massive inoculations with *E. coli* which prevent contamination with a different microorganism for 20 hours till test results evaluation.

Comparing efficiency of 12 disinfectant preparations used in Czechoslovakia and tested on 4 species of animal viruses from the Picornaviridae family, from genera *Coxsackie*, *ECHO*, *Cardiovirus* and on bacteriophage ØX 174 was reported earlier [10, 11]. The disinfectants which were applied at concentrations ranging from 0.05 % to 10 % depending on chemical composition and efficiency, produced a similar effect on the tested picornaviruses and phage ØX 174. Quaternary ammonia compounds, cresolum saponatum and chlorinated benzylphenols proved ineffective. Bacteriophage ØX 174 can be assumed to be a suitable model for approximate evaluation of the inactivating effect of preparations and methods vis-a-vis viruses of this type.

RÉSUMÉ

Bydžovská, O.: **Le dépistage de l'efficacité virucide de l'antisepsie, de la désinfection et de la stérilisation chimique.**

Une haute résistance de E. coli-phage ØX 174, représentant de petits virus sans enveloppe d'une symétrie icosaédrale, à certaines influences physiques et chimiques est décrite. Le phage est donc utilisable en virus modèle pour les buts de l'évaluation de l'antisepsie, de la désinfection et de la stérilisation chimique faites en pratique. La présence du phage est recherchée par méthode de plaques à partir des frottis, des empreintes ou directement des matériaux porteurs. Le système E. coli C-bactériophage ØX 174 peut être utilisé comme bioindicateur de l'efficacité virucide de la stérilisation chimique, éventuellement de la fixation de l'agent stérilisant au matériel traité.

ZUSAMMENFASSUNG

Bydžovská, O.: **Reihenuntersuchung der virustötenden Wirksamkeit der Antiseptik, der Desinfektion und der chemischen Sterilisation. Ein methodischer Vorschlag für die Praxis.**

Beschrieben wird die hohe Resistenz des E. coli-ØX-174-Phagen, Vertreters der kleinen hüllenlosen Viren mit Ikosaeder-Symetrie, gegenüber einigen physikochemischen Einflüssen. Deshalb ist dieser Phage als ein Modellvirus zur Bewertung der Wirksamkeit der praktisch verwendeten Antiseptik, der Desinfektion und der chemischen Sterilisation sehr geeignet. Das Vorhandensein des Phagen wird vermittels der Plaquenmethode in Ausstrichen, Abdrücken oder unmittelbar auf den Trägern nachgewiesen. Das System E. coli C — Bakteriophage ØX 174 kann als Bioindikator der virustötenden Wirksamkeit der chemischen Sterilisation bzw. der Bindung des Sterilisierungsagens an das behandelte Material verwendet werden.

RESUMEN

Bydžovská, O.: **Pesquisaje de la eficiencia viricida de la antisepsia, de la desinfección y de la esterilización química. Una propuesta metódica para la práctica.**

Se describe la alta resistencia del bacteriofago de E. coli ØX 174, representante de pequeños virus no envueltos con la simetría de icosaedro, contra algunos efectos fisicoquímicos. Por eso es este fago conveniente como un virus de modelo para apreciar la eficacia de la antisepsia utilizada prácticamente así como de la desinfección y de la esterilización química. Se averigua la presencia del fágo mediante el metodo de placas en frotis, impresiones o directamonte sobre portadores. Es utilizable el sistema E. coli C — bacteriofágo ØX 174 como bioindicador de la eficiencia viricida de la esterilización química, eventualmente del enlace del agente estirlizante con el material tratado.

REFERENCES

1. **Bydžovská O., Kneiflová J.:** J. Hyg. Epidem. Microbiol. Immunol. 27, 1983, 1: 60—68. 2. **Bolek S. a kol.:** Dezinfekce, sterilizace a režim v prevenci nosokomiálních nákaz. *Zdravotnické aktuality* 84, 202: 303 až 306. 3. **Bydžovská O., Měrka V.:** J. Hyg. Epidem. Microbiol. Immunol. 25, 1981, 4: 414—423. 4. **Bydžovská O., Bendová E.:** AHEM 1983, 4: 71—78. 5. **Lepage Ch., Romond Ch.:** Path. Biol. 32, 1984, 5bis: 631—635. 6. **Sprössig M.:** Hyg. + Med. 4, 1979: 294—299. 7. **Bydžovská O.:** II. dni novej techniky „Centrálna sterilizácia", sborník referátů, Nové Zámky, 1984: 63—66. 8. **Adler V. G., Boss E. et al.:** J. Appl. Bacteriol. 34, 1971, 4: 757—763. 9. **Mecke P., Beckert J.:** Hyg. 1 Med. 6, 1981: 597—602. 10. **Bydžovská O.:** Čs. epidem. 17, 1968, 1: 47—53. 11. **Bydžovská O.:** AHEM, 1983, 2: 37—45.

Received November 25, 1985