HOSPITAL AIR QUALITY STUDY

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Abstract

A major research endeavor has been initiated to establish the extent to which prevailing ventilation codes for American hospitals should be revised to achieve the dual purpose of improving the patient care environment and increasing the energy efficiency of health care institutions. Accomplishments during the first year of this study and the activities planned for continuing investigations are the subject of this presentation.

Overview

The American Hospital Association (AHA) has undertaken a major research endeavor, primarily sponsored by the New York State Energy Research and Development Authority (NYSERDA), to consider the opportunities for and constraints on the relaxation of current American ventilation standards. The specific goal for this program is to establish the extent to which prevailing ventilation codes can be revised to achieve the dual purpose of improving the patient care environment and increasing the energy efficiency of health care institutions.

To achieve this program goal, a four phase plan has been developed. These phases consist of the following:

PHASE ONE - Design of Experiment
PHASE TWO - Initial Field Testing in Single Hospital
PHASE THREE - Obtain National Data Base
PHASE FOUR - Manipulation of Field Conditions

Based on the results of this four phase effort, ventilation strategies consistent with the need to control specified contaminants will be recommended after critical constraints on indoor air quality have been identified.

Scope of Work

While more than twelve thousand potential contaminants are likely to be found in hospitals, the goal of this undertaking is based on the assumption that measurement and control of a select group of threshold contaminants can accomplish the level of control needed for other less critical contaminants. Once this premise was accepted, the 1979 University of Minnesota (UM) Study of Energy Conservation Proposals for Hospital Ventilation and Thermal Systems (2) was adopted as the primary conceptual foundation for this AHA/NYSERDA initiative.

Integrity of Program

The desire to obtain outside input to insure the quality of this endeavor led to the formation of advisory groups to oversee the technical and health policy content of projected activities.

A Steering Committee has been given the responsibility of technically reviewing the scope, direction and anticipated tasks of this project. Key staff from governmental agencies including the Department of Health and Human Services (HHS), the Environmental Protection Agency (EPA), and the Department of Energy serve on this body. Other members consist of technical experts from professional organizations such as the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

While the Steering Committee has been organized to provide in-depth technical expertise, a Public Sector Advisory Committee has been formed to address health care policy issues. Its responsibilities are to ensure prior consultation and coordination with regard to required state approvals for experimentation and to secure state specific technical, medical and institutional expertise and counsel on project activities.

Phase I

Initial activities included an update of ventilation codes and standards identified in the UM Study; in this update, principal emphasis was placed on modifications contained in ASHRAE Standard 62-1981: Ventilation for Acceptable Indoor Air Quality (1) and the 1982 HHS Draft Minimum Requirements for Construction and Equipment of Hospital and Medical Facilities. (3).

A literature search conducted as part of the UM Study also was deemed to be dated; therefore an updated review of approximately four hundred titles pertaining to the purposes of ventilation and the impact of ventilation controls was prepared as part of the PHASE ONE baseline development effort.

A survey of half the hospitals in the United States also identified available field data in nearly fifty institutions.

Reflective of the results of these baseline efforts, a matrix was prepared for different functional areas identifying contaminants these hospital areas are liable to contain. This matrix assessment attempted to segregate pollutants as being either major or minor contaminants. It also endeavored to establish whether these assessments were based on available rational or empirical information, or the absence thereof. In a companion document, physiological responses of susceptible populations in each functional area also were summarized.

Design procedures also have been specified for controlled acquisition of field test data. The contemplated experimental methodology and design are outlined in the following work statements for future project phases.

Phase II

During the next phase of this project, extensive field tests will be conducted in one moderately sized hospital of approximately 200 beds. Authorization has been obtained from the hospital at which these tests will be conducted.

A primary objective of these tests will be to determine if it is possible to develop an understanding of the interaction of air circulation patterns among different functional areas. The tests are also intended to verify whether the PHASE ONE design plan is capable of obtaining useful data in spite of coupling effects and cross contamination patterns.

Data acquisition will occur through the use of EPA air quality instrumentation to conduct broad spectrum tests. Tests under consideration are intended to detect and confirm gaseous, viable, non-viable and radionuclide contaminants which may be critical threshold constraints in various functional areas.

As obvious sources of specific contaminants are determined they will be noted and methods for eliminating and/or controlling them recommended. However, the identification of the sources of all contaminants as an objective of this project has been deemed to be beyond the desired scope of this initiative.

Upon conclusion of the PHASE TWO initial data acquisition effort, major and minor contaminants postulated in PHASE ONE for different functional areas will be reexamined. The intent of this analysis will be to finalize priority contaminants and to pinpoint locations wihin hospitals where extensive PHASE THREE data acquisition efforts should be made. It is anticipated that the critical threshold contaminants selected at the conclusion of PHASE TWO for actual PHASE THREE monitoring will be drawn from the potential gaseous, viable and nonviable particle and radiation contaminants identified in Table 1. (It is probable that the presence of viable particles that are infectious and the byproducts of smoking will receive particularly careful consideration at that time.)

Table 1. Hospital Functional Area Contaminants.

Gaseous	Viable Particles	Radiation
Acetone	Algae	Alpha Rays
Acrolein	Bacteria	Beta Rays
Ammonia Compounds	Fungi and Spores	Gamma Rays
Benzene	Mites	X-Rays
Carbon Dioxide	Molds	Other
Carbon Monoxide	Pollen	
Chlorine	Viruses	
Ethylene Oxide	Other	
Formaldehyde		
Halogenated Hydrocarbons	**Non-Viable Particles**	
Other Hydrocarbons		
Hydrogen Cyanide	Aitken Nuclei	
Mercaptans	Asbestos	
Mercury	Benzo(a)pyrene	
Methane	Cadmium	
Nitrogen Compounds	Carbon	
Nitrogen Oxides	Cellulose	
Nitrous Oxides	Glass Fiber	
Oxygen	Large Ions	
Ozone	Large Particles	
Phenols	Lead	
Phosphates	Nicotine	
Polyhalogenated Hydrocarbons	Phenols	
	Phosphates	
Potassium Hydroxide	Pyrene	
Sodium Hydroxide	Small Ions	
Styrene	Small Particles	
Sulfur Compounds	Soap Powders	
Toluene	Tar	
Water Vapor	Others	
Xylene		
Others		

Phase III

While PHASE TWO calls for full spectrum tests in one hospital, PHASE THREE will concentrate on characteristic contaminants in selected areas of multiple hospitals.

The objective of the national data acquisition effort will be to obtain field test data under controlled conditions from fourty hospitals. Actual test sites will be chosen from candidates exhibiting a variety of distribution characteristics discussed in the following paragraphs.

Facility size was identified as a critical parameter because differences are common in activities conducted within institutions; for example, research activities are more likely to be conducted in laboratories of large hospitals than small ones. Choosing this as a critical factor also reflects concern that the physical size of individual funcional areas influences the degree to which they are provided with dedicated air handlers.

It is anticipated that the data acquisition efforts will concentrate on the Metropolitan New York Area and either Los Angeles or Houston. The heating degree day differential between New York and either of the two other locations is large. Hopefully, this will allow a determination to be made if hospital air quality is influenced by outdoor thermal conditions.

The quality of air inside hospitals is largely maintained by the use of outdoor air to dilute internally generated contaminants. Therefore the environment outside hospitals will have a direct bearing on the quality of the data acquired. Generally speaking, it is likely that inner city air in the urban centers being considered as tentative field test locations is highly polluted. However, it is also probable that suburban areas included around these cities will have a sufficient number of clean air sites to allow the acquisition of comparative data.

Upon completion of the national data acquisition effort, recommendations for modifying air handler operations will be made. In view of the unproven impact this may have on patient care, it is essential the effort include a particularly thorough methodology for on-line monitoring and evaluation of the impact of all proposed adjustments.

Phase IV

The initial activities in this phase of the project will consist of the modification of designated air handlers in accordance with the recommendations developed in PHASE THREE. It is anticipated these changes primarily will consist of operational adjustments, although selective capital investments also will be made to demonstrate the ability of energy conservation devices to maintain or enhance indoor air quality.

After these modifications have been made, air handlers will be operated in accordance with the protocols developed in PHASE THREE. The air quality and energy consumption data obtained then will be compared to the control data previously obtained. Based on the results of this comparison, recommendations will be prepared for consideration by hospitals and individuals concerned with the development of future codes and standards which bear on ventilation rates and air quality requirements for hospitals.

Timetable

The length of time required to achieve the objectives of this research initiative led to the establishment of the previously identified phasing plan so that progress and activities could be scheduled and funded in discrete increments of moderate duration. The results of PHASE ONE (due for completion by the summer of 1984) already have been adequate to obtain authorizations and support to proceed with PHASE TWO activities. The identification of both the air handling unit survey and the data processing requirements for potential PHASE THREE and FOUR field test sites also has begun. However, current schedules indicate that PHASE FOUR activities and the completion of the overall program will not occur until 1988 or 1989.

Conclusions

It is anticipated that this four phase hospital air quality research initiative will impact American hospital ventilation practices by leading to:

- Widespread abandonment of constant air change rates;
- Selective increases in air change rates to control critical contaminants;
- Substitution of materials to eliminate sources of contaminants; and
- Increased substitution of filtered return air for outdoor air.

References

(1) American Society of Heating, Refrigerating and Air Conditioning Engineers, and American National Standards Institute. ANSI/ASHRAE Standard 62-1981: Ventilation for Acceptable Indoor Air Quality. New York: American Society for Heating, Refrigerating and Air Conditioning Engineers, 1981.

(2) Banks, R.S., Michaelsen, G.S., and Rainer, D. Energy Conservation Proposals for Hospital Ventilation and Therman Systems. Minneapolis: University of Minnesota School of Public Health, July 1979.

(3) U.S. Department of Health and Human Services; Health Resources Administration; Bureau of Health Facilities Financing, Compliance, and Conversion. Draft Minimum Requirements for Construction and Equipment of Hospital and Medical Facilities. Washington, D.C.: U.S. Government Printing Office, 1982.

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