



CHICAGO JOURNALS



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Source: *Infection Control*, Vol. 5, No. 11 (Nov., 1984), pp. 513-518

Published by: [The University of Chicago Press](#) on behalf of [The Society for Healthcare Epidemiology of America](#)

Stable URL: <http://www.jstor.org/stable/30145435>

Accessed: 03/09/2013 11:21

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Prevalence of Cytomegalovirus Antibody in Nursing Personnel

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ABSTRACT

To evaluate the risk to nurses of childbearing age of acquiring cytomegalovirus (CMV) infection during the care of patients at high risk of the infection, 374 female hospital employees (288 nursing personnel) were interviewed and screened for antibody to CMV. Fifty-six percent of the population surveyed had antibody to CMV as measured by an immunofluorescent assay. Among nursing personnel, analysis of antibody prevalence by job title, work area, and duration of work showed no association between seropositivity and either current or past exposure to "high-risk" patients, such as infants and immunosuppressed individuals. Age, race (non-white), and the number of pregnancies reported by participants were significantly associated with the presence of antibody. Among 73 employees of a children's hospital, the prevalence of CMV antibody was 41%. This survey suggests that hospital nursing is not a major risk factor for acquiring CMV infection. However, this finding needs further evaluation in a prospective study of seroconversion rates among seronegative nurses. [Infect Control 1984; 5(11):513-518.]

INTRODUCTION

Cytomegalovirus (CMV), a member of the herpes virus family is ubiquitous in the general population. Serological surveys have demonstrated a prevalence of seropositivity among various populations ranging from 40% to 100%.¹ Although CMV is considered to be of low

communicability, it has been isolated from saliva, tears, breast milk, semen, urine, cervical cultures, and feces. Infants, immunosuppressed patients and patients receiving multiple blood transfusions are at high risk of acquiring the infection or reactivating a latent infection.²⁻⁵ They are also at risk of severe disease or residual damage from CMV infections. The most serious consequences of infection occur among congenitally infected children who may suffer neurological disturbances ranging from mild hearing deficits to microcephaly (cytomegalic inclusion disease) as a result of infection.

There is an increasing concern among nursing personnel of childbearing age that they may be at increased risk of acquiring CMV infections while caring for high-risk patients in hospital settings. This cross-sectional study was undertaken to evaluate the prevalence of serum antibodies to CMV among nursing personnel working in various areas of a hospital and to identify a population of seronegative individuals who could be followed prospectively to assess seroconversion rates.

MATERIAL AND METHODS

Population Studied

Areas of the hospital were selected for study to include those which specialize in the care of patients who are at high risk of developing CMV infections, including the nursery, the burn unit, the hematology-oncology unit, renal transplant and dialysis units, and intensive care units. In addition, psychiatric and out-patient clinic nurses (non-pediatric) were selected as presumably low-risk comparison groups. Notification of the screening was posted in each work area and participation was voluntary. Volunteers were solicited from nurses who were working at the time of the screening. Two hundred thirty-eight (63%) of the 374 individuals working in the areas selected for the study participated in the screening. Participation rates varied among work areas and ranged from 100% in

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the dialysis and transplant units to 39% in the out-patient clinics. Participants and non-participants were compared by age, and in all areas the participants were younger than non-participants. Non-nurses (eg, unit secretaries, respiratory therapists) and nurses from other areas of the hospital who requested to take part in the screening were included, for a total of 374 participants, but the latter were not used in all statistical analyses. An additional group of 73 (35% participation) nursery and pediatric nurses from a children's hospital was screened. Because of the difference in participation rates between the two hospitals, these participants were not included in the analysis of the university hospital participants and the prevalence of their serum antibodies are presented separately in this article.

Questionnaire Survey

All participants were interviewed using a questionnaire designed to collect demographic information, a detailed work history of all nursing and/or hospital jobs, and a brief history of the outcome of all pregnancies.

Serological Survey

Blood was obtained by venipuncture from all study participants. Serum was tested for CMV antibodies by two assays: first, by an indirect immunofluorescent assay (IFA) with a 1:16 dilution of serum (Virgo Reagents, Electronucleonics Lab); and secondly, by an enzyme immunoassay (EIA) using a solid-phase, microplate technique (M.A. Bioproducts Labs). The serum dilution used in this latter test was 1:25. These two assays were repeated on any sample for which there was a discrepancy between the two tests, and the result of the IFA on the second set of assays was reported to the participant and used in data analysis. Test results were reported as either negative or positive. There was agreement between the IFA and EIA results in 93% of the samples. There were 28 sera which were positive by IFA but negative by EIA. There were no sera which were positive by EIA and negative by IFA. Statistical analyses using both the IFA and EIA test results showed no significant differences in the findings. Therefore, the results of only the IFA test are presented in this report.

Statistical Analysis

A chi-square test was used to compare frequency rates between three or more variables. A logistic regression model, obtained from the Statistical Analyses System (SAS) program package,⁶ was used to describe simultaneously the presence of antibodies, hospital exposure (duration of employment), and other factors which might confound or modify the presence of antibodies.

RESULTS

Three hundred seventy-four female hospital personnel participated in the screening. The mean age of the participants was 32 (range 19 to 59). Fifty-six percent of the total population surveyed had antibodies to CMV as measured by the IFA test. The mean age of those with CMV antibody was 34 years (range 19 to 59), while the mean age of those without antibody was 29 years (range 20 to 55). Age

was strongly associated with seropositivity, increasing from 41% in those 24 years or younger to 78% in those 35 years or older (Table 1).

Race was also strongly associated with the presence of antibody. Sixty-one (87%) of black participants as compared with 144 (48%) of white participants had antibody to CMV. All four participants of Asian or Pacific Islander descent had antibody to CMV. In addition to race and age, the number of reported pregnancies and marital status were both significantly associated with seropositivity, however, the association with marital status disappeared after controlling for age.

Evaluation of the association between demographic variables and antibody status by means of a logistic regression model indicated only race ($p = .0004$) and the number of reported pregnancies ($p = .0379$) remained statistically significant variables, although age was of borderline significance ($p = .0698$) (Table 2).

Neither the reported "percentage of time spent doing direct patient care" nor the reported "number of needles with contaminated needles" was associated with antibody status ($p = .940$ and $p = .765$ respectively); while the "number of times administered blood" was inversely related to seropositivity ($p = .0055$). These variables were not included in the logistic regression model.

Of the 374 hospital workers described above, 288 were nursing personnel (staff nurses, head and assistant head nurses, licensed practical nurses, and nurse's assistants). Fifty-three percent of the nursing group had antibodies to CMV. When evaluated by current work area (Table 3), nurses working in clinics had the highest rate of seropositivity (79%), whereas the lowest rate (43%) was found among burn unit nurses. Nursing personnel working in the newborn intensive care unit, dialysis, and transplant units did not have a higher rate of seropositivity than nurses working in areas of the hospital which do not care for high-risk patients (eg, out-patient clinics, psychiatry). Mean and median ages along with the percentage of non-whites in each of these groups are provided and may explain some of the difference in the prevalence rates between groups.

A comparison of the prevalence of antibodies among workers by job title showed little difference between clerical workers and assistant head nurses, two groups with similar mean ages. Race appears to explain the high prevalence of antibody among nurse's aides and licensed practical nurses (LPNs). Respiratory therapists, although only nine participated in the survey, had a seropositivity rate of 78% (Table 4).

Since antibodies have been shown to persist for years, a nurse's entire past work history was evaluated in addition to her current work area (especially in light of the high rate of job turnover both within and between hospitals). Since complete work histories were available on all participants, the amount of time each worker had spent in one of the hypothesized "high-risk" areas (ie, nursery, oncology, transplant, dialysis, and intensive care units) could be evaluated (Table 5). Duration of work was divided into five arbitrarily selected categories (range: 0 to 0.5 yrs to 10+ yrs) and nurses with a history of less than 6 months work in any of the high-risk areas and all non-

**TABLE 1
PREVALENCE OF CYTOMEGALOVIRUS
ANTIBODY IN HOSPITAL PERSONNEL
BY AGE**

Age	Positive	Negative
≤24	29/71 (41%)	42/71 (59%)
25-29	57/125 (46%)	68/125 (54%)
30-34	49/80 (61%)	31/80 (39%)
≥35	76/98 (78%)	22/98 (22%)
All Ages	211/374 (56%)	163/374 (44%)

Chi-square = 31.512, df = 3, p = 0.0001

**TABLE 2
LOGISTIC REGRESSION MODEL OF
CYTOMEGALOVIRUS ANTIBODY
SEROPOSITIVITY, EXPOSURE, AND
DEMOGRAPHIC VARIABLES**

Variable	P Value
Race	.0004
Number of Pregnancies	.0379
Age	.0698
Education	.4592
Exposure Years	.8439

**TABLE 3
PREVALENCE OF CYTOMEGALOVIRUS ANTIBODY
IN 288 NURSING PERSONNEL BY JOB AREA**

Area	% Positive	N	Mean	Age Median	S.D.	% Non-White
Clinics	79%	19	38	35	9.0	33%
Intravenous Therapy	75%	4	32	31	6.3	0
Nursery	67%	21	37	37	12.9	43%
Oncology/Hematology	65%	17	33	30	10.3	18%
MICU*	58%	36	29	28	6.6	11%
Psychiatry	55%	33	35	34	9.0	27%
NBICU†	50%	12	32	28	8.7	16%
Dialysis	50%	12	30	30	4.5	0
Transplant	45%	22	36	31	11.7	27%
Obstetrics-Gynecology	44%	36	30	29	6.5	22%
SICU‡	43%	35	30	28	5.9	6%
Burns (Pediatric)	43%	35	28	26	7.6	11%
Other	50%	6	39	46	13.8	17%

*MICU—medical intensive care unit

†NBICU—newborn intensive care unit

‡SICU—surgical intensive care unit

nurses (excluding respiratory therapists) were included in the 0 to 0.5 year category. Seropositivity was not associated with duration of work in high-risk areas when stratified by age. When this measure of exposure (exposure years) was added to the logistic regression model there was no significant association between years of work and seropositivity ($p = .8439$).

Results of screening at the children's hospital are presented separately since the participation rate (37%) was considerably lower than that at the university hospital (63%). The overall seropositivity rate was 41%, ranging from 27% in nursery personnel to 47% in ward nurses (Table 6). The population screened at the children's hos-

pital was younger (mean age 28 v. 32 years) and had fewer non-whites (4% v. 21%) than that at the university hospital.

DISCUSSION

The prevalence of CMV antibody has been shown to increase with age and to vary with the geographical area, socioeconomic status, and racial composition of the population studied.⁷⁻⁹ Serological surveys in London and Stockholm reported a prevalence of CMV antibody (measured by complement fixation) in adults aged 35 and older of 53% to 57%.^{10,11} Studies from Washington State and Washington, D.C. found a prevalence of antibody of

**TABLE 4
PREVALENCE OF CYTOMEGALOVIRUS ANTIBODY
IN 374 HOSPITAL PERSONNEL BY JOB TITLE**

Job Title	% Positive	N	Mean	Age Median	S.D.	% Non-White
Nurse's Aide	85%	26	43	44	11.9	77%
Respiratory Therapist	78%	9	26	24	6.8	22%
LPN	76%	33	40	38	11.3	58%
Nursing Administrator	73%	22	34	32	7.3	18%
Clerical	62%	34	32	31	8.1	30%
Assistant Head Nurse	60%	20	31	31	5.4	10%
Staff RN	48%	202	30	28	7.0	9%
Head Nurse	45%	11	36	34	8.3	9%
Dietitian	33%	9	29	29	2.7	0
Other	86%	8	26	25	4.2	0

**TABLE 5
PREVALENCE OF CYTOMEGALOVIRUS ANTIBODY
IN HOSPITAL PERSONNEL BY DURATION OF WORK
IN HIGH-RISK AREAS**

Age	Duration (yrs) of Work in High-Risk Areas					Total
	0-5	.5-3	3-5	5-10	10+	
<24	15/41 (37%)	9/22 (41%)	0/1	0	0	24/64 (38%)
25-29	22/42 (52%)	16/36 (44%)	9/25 (36%)	8/19 (42%)	0	55/122 (45%)
30-34	26/44 (59%)	9/16 (56%)	3/5 (60%)	5/9 (56%)	5/5 (100%)	48/79 (61%)
35+	34/40 (85%)	8/13 (62%)	3/5 (60%)	7/10 (70%)	22/28 (79%)	74/96 (77%)
Total	97/167 (58%)	42/87 (48%)	15/36 (42%)	20/38 (53%)	27/33 (82%)	201/361 (56%)

**TABLE 6
PREVALENCE OF CYTOMEGALOVIRUS ANTIBODY
IN 57 PEDIATRIC NURSING PERSONNEL BY JOB AREA**

Area	% Positive	N	Mean	Age Median	S.D.	% Non-White
Pediatric	47%	15	25	26	2.0	13%
Clinics	44%	9	31	27	4.1	11%
NBICU*	33%	28	28	26	7.0	4%
Nursery	27%	11	26	24	3.6	0
Other	50%	4	34	27	16.1	0

*NBICU—Newborn Intensive Care Unit

70% to 81% in this age group.^{12,13} In contrast, in many parts of Asia and Africa and in pre-industrial cultures, serologic evidence of CMV infection is virtually universal by 2 years of age.¹⁴ The relative contributions of environmental and genetic factors in these variable rates of CMV acquisition are not known. Minor differences in the prevalence of antibody might be explained by the sensitivity of the antibody assay. For this reason, two antibody assays, IFA and EIA, were used in the present study, but both gave similar results.

The data from our study show race was strongly associated with seropositivity. The association does not appear to be explained by level of education, since most participants were nurses or other personnel with similar levels of education. Our questionnaire did not collect other information on socioeconomic status, and it is possible that environmental factors rather than genetic factors are responsible for the racial differences. We did find an association between the number of reported previous pregnancies and the prevalence of antibodies. Whether the association with number of pregnancies was related to the pregnancy itself or the fact that these women are likely to care for (or have cared for) children around their home could not be evaluated from the available data. Other studies have found an association with pregnancy, although they did not control for age in the analysis of this association.¹⁵

In this study working as a nurse in a high-risk area did not appear to be associated with the presence of CMV antibody. Because of the small number of participants in the non-nurse groups, these groups were not evaluated by the area of the hospital in which they worked. A comparison of seropositivity rates among all participants by job title showed that nurse's aides and LPNs had the highest prevalence rates among the job titles evaluated. The fact that these two groups both had higher mean ages and a higher percentage of non-whites than all other groups may explain this finding. Respiratory therapists had the second highest prevalence rate (78%) although this group consisted of only nine employees. It is plausible that this group of workers may be at increased risk since they have frequent, direct contact with patients who are likely to excrete CMV in respiratory secretions. Respiratory therapists should receive more attention in studies of CMV transmission in the future.

Participation in our study was voluntary, thereby introducing the potential for selection bias. The overall participation rate was only 63%, ranging from 37% to 100% in various work areas. Participants when compared to non-participants in their same work area were on the average younger (mean age one to eight years younger). Areas with the highest participation rates were those in which nurses cared for dialysis and intensive care patients and perhaps perceived a greater risk of CMV infection. This may also explain why we had lower participation from older employees. Although nurses may have agreed to participate because they perceived a greater risk of infection related to their work, they are not routinely screened for CMV antibody and therefore, it is unlikely that participants had prior knowledge of their antibody status. The low participation rate among clinic nurses

(37%) may have had an effect on our findings and selection bias could in part explain why they had a higher antibody prevalence rate than nurses working in the assumed high-risk areas, but, this explanation is less likely than the effect of the older age of this group. In contrast, the CMV antibody prevalence rate among Children's Hospital participants was low (41%) as was the participation rate (37%). These data suggest that selection bias is not a factor in our findings.

To date, at least four studies have been published which have evaluated the risk of transmission of CMV infection to pediatric nurses. A study by Yeager of 172 hospital employees found a seroconversion rate of 4.1% to 7.7% per year among pediatric nurses in contrast to no documented seroconversions among 27 seronegative non-nurses. However, this difference was not statistically significant.¹⁶ A study by Ahlfors in Sweden found no difference in seroconversion rates between a group of 292 pediatric nurses and a control group of 163 females without professional contact with children.¹⁷ Haneberg reported a prevalence of seropositivity of 77% in a group of 112 high-risk pediatric nurses compared with 39% in a group of 49 low-risk pediatric nurses. The difference in prevalence rates between these two groups was even greater in the 20 to 29 year age group.¹⁷ Dworsky found a seroconversion rate of 3.3% per year among 61 pediatric nurses compared with a rate of 2.3% per year among 1,549 community controls tested at the beginning and end of their pregnancy and a rate of 5.5% among 372 community controls tested between pregnancies.¹⁸ The differences in seroconversion rates between nurses and other comparison groups were not statistically significant.

The present study determined the prevalence of CMV antibody among nursing personnel in both pediatric and non-pediatric areas of the hospital. Two other studies have evaluated CMV transmission among hospital personnel in other high-risk areas. Duvall et al recovered CMV from 11 of 32 adult patients with neoplastic disease. They found no virus shedding among the 17 controls consisting of ward personnel and members of families of infected patients.² This study, however, involved a very small sample of hospital workers and covered a period of only two months. Tolkoﬀ-Rubin studied 26 staff members of a dialysis unit at monthly intervals for a year and found no evidence of active CMV infection among any of the staff, all of whom had close, direct personal contact with patients.¹⁹

Since there are many factors—both work-related and non-work related—which may be associated with the transmission of CMV and since CMV antibodies are known to persist for years, prospective studies of the risk of CMV infection are needed. A follow-up study of seronegative participants is underway which addresses additional risk factors (eg, work and non-work contact with children and other high-risk groups, and sexual activity).

In the present study, 56% of 374 hospital workers were found to have CMV antibody. A separate group of 73 pediatric workers had a prevalence of 41%. Seropositivity was strongly associated with race and the number of reported pregnancies and less significantly with age, but

no association was found between seropositivity and either past or present work in patient care areas, where previous studies have shown patients shed CMV virus.

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