

Differences in the Response Times of Pages Originating From the ICU*

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Study objectives: To determine whether the type of paging system causes significant differences in the response time by physicians to their pages in an ICU setting.

Design and setting: Prospective cohort study performed in the ICU of two university-affiliated hospitals. All pages were classified by several different variables, including the type of paging system: direct paging if a nurse or hospital operator could directly place the page, or indirect paging if a nurse or hospital operator was required to contact the physician's office or a private answering service who would then independently contact the physician. The main outcome measure was physicians' response time, in minutes, to pages originating from the ICU.

Results: During a 100-day period, 402 pages were sent and answered by 166 different physicians (87 attending physicians and 79 housestaff/physician assistants). The median response time for all pages was 3 min with a 25 to 75% quartile of 1 to 8 min. Twenty-five percent of the pages placed through an indirect system were associated with a response time of ≥ 29 min. In a multivariate model with the response time dichotomized at ≥ 15 min ("slow") or < 15 min ("adequate"), pages placed through an indirect system were answered significantly more slowly than pages placed through a direct system ($p < 0.001$; odds ratio, 4.36; 95% confidence interval, 2.05 to 9.29). Pages answered in an adequate amount of time were also associated with a significantly higher degree of overall nursing satisfaction with the care delivered by the physician in response to the specific page when compared with pages answered in a "slow" manner ($p < 0.001$).

Conclusions: Physicians who use an indirect paging system are significantly slower in their response to ICU pages when compared with physicians who utilize a direct paging system. These results may lead to improvements in paging systems used by physicians who care for patients in an ICU setting. (CHEST 1999; 116:1019-1024)

Key words: hospital communication systems; ICU; ICU organization; hospital personnel; hospital medical staff

Abbreviations: CI = confidence interval; GEE = generalized estimated equations; OR = odds ratio; PA = physician assistant

Over the last decade, radiofrequency paging systems or beepers have added enormous convenience to physicians and have facilitated communication throughout the hospital. Hospital staff members and house officers now have more freedom to move about the hospital and, with the increasing use of cellular telephones, some physicians even have the luxury of answering pages while moving from hospital to hospital.¹

Recently, concerns have been raised about the

stressful effects on housestaff as the result of carrying a beeper. In two publications, beeper calls were reported to interrupt patient care, educational activities, and sleep.^{1,2} These observations led to the recommendation to reduce the number of unnecessary pages and to postpone nonurgent ones. Although pages appear to contribute to stress in the life of physicians, and especially housestaff, it is equally important that necessary pages, when sent, are answered in a timely manner. Delays in the response time to pages may cause aggravation to the person who placed the page, disrupt the ability of the nurse to perform his/her daily activities, and potentially influence patient comfort and care. In one study of the paging practices of a 38-bed pediatric unit, 19% of the pages sent to physicians were never answered.³

Many circumstances may influence the response time to a page, including individual characteristics of the physician, differences in the paging system, or

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simply the time of day. Identification of which factors alter the response time to pages could lead to improvements in the communication system between doctors and nurses. Effective paging systems are most necessary for physicians who care for ICU patients, as the status of these critically ill individuals can change rapidly.⁴ However, in this era of constantly advancing communications technology, some physicians who care for critically ill patients still utilize older and indirect forms of paging which require the nurse or hospital operator to contact an answering service or the physician's office, which subsequently page the physician. Therefore, we conducted a 100-day study in which ICU nurses from two hospitals recorded data concerning each individual page placed during their 8- to 12-h shift. We hypothesized that physicians who use an indirect paging system may be significantly and inappropriately delayed in their response time to all pages for critically ill patients.

MATERIALS AND METHODS

Settings

The study was conducted between August and December 1996 at two university-affiliated hospitals: Crawford Long Hospital of Emory University (Atlanta, GA) and Danbury Hospital (Danbury, CT), which maintains a Yale University teaching affiliate status.

Crawford Long Hospital is a 470-bed facility with 194 designated medical beds. The seventh floor ICU is a 12-bed medical unit and one of four ICUs in the hospital. There is an occasional overflow of patients from the surgical and cardiac ICUs into the seventh floor ICU. It is an open unit to which internists, family practitioners, surgeons, and medical subspecialists can admit patients. Some patients are admitted by Emory University faculty, and followed by residents and fellows in conjunction with the attending physician. The remainder of the patients are admitted by private attending physicians, some of whom utilize physician assistants (PAs).

Danbury is a 345-bed hospital with 38 medical housestaff. The ICU is a 10-bed combined medical/surgical unit. It is an open unit to which internists, family practitioners, and surgeons can admit their own patients and follow them. Some of these patients are designated "teaching" (the housestaff are involved in the care of the patient) and some are "off teaching" (the housestaff do not participate in medical care). The decision as to whether a patient is followed by the housestaff is up to the discretion of the primary attending physician.

Data Collection

For each shift, only one nurse, chosen at random, was asked to complete a log book for his/her assigned patients. Each nurse was assigned to only one to three patients during his/her 8- to 12-h shift. These nurses were aware that the study concerned the response times to pages, but were not informed as to which of the possible variables were of primary interest. Each time the nurse needed to contact a physician, an entry was made in the log book. The nurse recorded (1) the name of the physician; (2) the date

and time that the page was placed; (3) the date and time the page was answered; (4) the type of paging system that was used; and (5) the reason for the page. For each page, the nurse was asked to evaluate his/her overall satisfaction with the care delivered by the physician in response to the page. The nurse's satisfaction with the overall response of the physician was ranked on a scale from 1 to 5, where 1 = not satisfied and 5 = extremely satisfied. Physicians were repeatedly paged until the page was finally answered. If the physician required multiple pages, the amount of time required to answer the page was calculated as the time elapsed from when the initial page was placed to when the physician answered the final page. If the physician happened to already be in the unit when his/her assistance was required, an entry was recorded in the log book by the nurse, and the page was not sent. In order to avoid the possibility of causing a Hawthorne effect on the results, none of the physicians in either hospital, except the authors, were aware of the study.⁵ In addition, the two authors, who are physicians, were not included in the study.

Based on the time that the page was placed, all pages were categorized by (1) the day of the week (weekdays [from 6:00 AM Monday until 8:00 PM Friday] vs weekends [8:01 PM Friday until 5:59 AM Monday, and all holidays]); and (2) day (6:00 AM to 8:00 PM) vs night (8:01 PM to 5:59 AM). Physicians were also categorized according to (1) rank (attending physician or housestaff), and (2) subspecialty (2a = generalist, including internal medicine or family practice; 2b = medical subspecialist, including all internal medicine subspecialties; 2c = surgeon, including all surgical subspecialists).

Paging System

All pages were classified into two systems. The page was classified as (1) a direct paging system if either the nurse or hospital operator could directly page the physician with a short-range voice pager (Danbury Hospital) or personal digital pager (Crawford Long Hospital), or (2) an indirect paging system if the nurse or hospital operator had to call the doctor's office or a private answering service, which would then independently contact the physician.

Statistical Analysis

Because the response times were not normally distributed, the results are initially reported as a median value and 25 to 75% quartiles. A Wilcoxon nonparametric analysis was used for all univariate analyses. In the analysis of response times for attending physicians according to their specialty, a Bonferroni adjustment was utilized to account for multiple comparisons.⁶ Because five comparisons were tested for in each analysis, an alpha value of 0.01 was used. In addition, the data were divided into categorical variables and analyzed using a χ^2 analysis. Furthermore, a multivariate generalized estimated equations (GEE) analysis was used to adjust for the lack of independence of each page.⁷ The effects of several independent variables (attending physician vs housestaff, weekend vs weekday, day vs night, direct vs indirect paging system, and hospital) were studied in a stepwise manner. When the type of attending physician was included in a model, the variable was categorized into three individual groups: surgeons, generalists, and medical subspecialists. Variables were dropped from the model if they were not significant, but hospital (Crawford Long vs Danbury) and time of day (day vs night) were retained in all analyses whether or not their effect was statistically significant. Other variables were retained in the model if their p value was < 0.10 . Two-way interactions between all of the variables were retained in the model if the p value for these terms was also < 0.10 ; however, no

interaction terms of significance were discovered. Odds ratios (ORs) and 95% confidence intervals (CIs) were determined for each independent variable in all multivariable logistic regression analyses. Unless previously specified, an alpha value of 0.05 was used for all analyses.

RESULTS

A total of 18 nurses, nine at each hospital, completed log books for the study. A total of 425 page attempts were recorded on 100 random days throughout a 5-month period (August to December 1997). As only one nurse was recording pages at each hospital per day, this equals more than two pages to a physician/nurse/d. Overall, 166 medical personnel were paged during this study: 87 attending physicians, 10 fellows, 8 PAs, and 61 residents. Because some of the individual ranks of medical personnel were not sufficiently common to be analyzed separately, all of the individuals were grouped into two ranks: attending physicians (n = 87) and housestaff (n = 79), which included fellows, residents, and PAs. The attending physicians (n = 87) were further subdivided into surgeons (n = 23), generalists (internal medicine and family practice; n = 24), and medical subspecialists (n = 40).

All fellows and residents used the direct paging system exclusively. Twenty-five attending physicians were paged using only a direct paging system, 54 attending physicians were paged using only an indirect paging service, and 8 attending physicians utilized both systems during the study. The use of indirect and direct paging systems was randomly distributed among the types of attending physicians: surgeons (7 = direct, 13 = indirect, 3 = both); generalists (8 = direct, 14 = indirect, 2 = both); and medical subspecialists (10 = direct, 27 = indirect, 3 = both). Of the eight PAs included in the study, six were paged using only direct paging, one used an indirect paging system, and one utilized both systems during the study. No more than 10 independent answering services (seven in Atlanta, GA, and three in Connecticut) and 44 physician's offices were represented in this study as part of the indirect paging system.

Of the 425 page attempts, the physician was physically in the unit during 22 of them, and one page was never answered. Therefore, a total of 402 pages that were sent and completed are included in the final analyses. The reasons for all the pages are displayed in Table 1. The majority of the pages (51%, 205/402) were secondary to a change in the status of the patient.

Univariate Analysis

The median (25 to 75% quartile) response time for all of the pages (n = 402) was 3 min (1 to 8 min). All

Table 1—Distribution of Reasons for Pages

| Reason for Page | No. of Pages n = 402 | Percentage |
|--|-------------------------|------------|
| Change in patient status | 205 | 51 |
| Critical laboratory results | 72 | 18 |
| Obtain new orders | 47 | 12 |
| Clarify existing orders | 41 | 10 |
| Family or patient wanted to meet with physician | 8 | 2 |
| Other | 29 | 7 |

variables were initially tested in individual univariate analyses. As displayed in Table 2, pages placed through an indirect paging system were responded to more slowly than those placed through a direct paging system (p < 0.001). In addition, pages placed during the day were answered more slowly than pages at night (p < 0.001), and attending physicians answered their pages more slowly than residents (p < 0.001). Pages were stratified as "slow" when the physician required ≥ 15 min to answer the page or "adequate" when the physician answered the page in < 15 min. This differentiation, although arbitrary, was based on a poststudy sampling of the 18 study nurses to the question, "What is the maximum amount of time it should take a physician to answer a page for a ICU patient?" As shown in Table 3, the results of a χ^2 analysis with the response time dichotomized as "slow" or "adequate" were also significant for paging system (p < 0.001), time of day (p < 0.001), and rank of physician (p < 0.001).

Multivariate Analysis

In a GEE analysis, adjusting for the lack of independence between the pages, the effects of the

Table 2—Differences in Response Time Stratified by Four Independent Variables

| Independent Variables | No. | Response Time | | p Value |
|-----------------------|-----|---------------|-------------------------|---------|
| | | Median, min | 25–75% Quartile, min | |
| Paging system | | | | |
| Direct paging | 278 | 2 | 1–5 | < 0.001 |
| Indirect paging | 124 | 9 | 3–29 | |
| Rank of physician | | | | |
| Attending | 178 | 5 | 2–15 | < 0.001 |
| Housestaff | 224 | 2 | 1–5 | |
| Time of day | | | | |
| Day | 214 | 5 | 2–14 | < 0.001 |
| Night | 188 | 2 | 1–5 | |
| Day of week | | | | |
| Weekday | 286 | 3 | 1–7 | 0.41 |
| Weekend/holiday | 116 | 4 | 1–10 | |

Table 3—Differences in Response Time According to Dichotomous Variables

| Dichotomous Variables | No. of Slow Pages | Percentage | No. of Adequate Pages | Percentage | p Value |
|-----------------------|-------------------|------------|-----------------------|------------|---------|
| Paging system | | | | | |
| Direct paging | 21/257 | 8 | 257/278 | 92 | < 0.001 |
| Indirect paging | 49/124 | 40 | 75/124 | 60 | |
| Rank of physician | | | | | |
| Attending | 56/178 | 31 | 122/178 | 69 | < 0.001 |
| Housestaff | 14/224 | 6 | 210/224 | 94 | |
| Time of day | | | | | |
| Day | 51/214 | 24 | 163/214 | 76 | < 0.001 |
| Night | 19/188 | 10 | 169/188 | 90 | |
| Day of week | | | | | |
| Weekday | 48/286 | 17 | 238/286 | 83 | 0.60 |
| Weekend/holiday | 22/116 | 19 | 94/116 | 81 | |

paging system ($p < 0.001$; OR, 4.36; 95% CI, 2.05 to 9.29), time of day ($p = 0.03$; OR, 2.16; 95% CI, 1.06 to 4.39) and the rank of physician ($p = 0.03$; OR, 2.17; 95% CI, 1.01 to 4.52) all remained significant.

Subgroup Analysis of Attending Physicians

Forty-four percent of the pages (178/402) were to attending physicians. In individual univariate analyses, surgeons answered their pages more quickly (median [25 to 75% quartile], 3 min [1 to 7 min]) than either medical subspecialists (median [25 to 75% quartile], 5 min [3 to 24 min]; $p < 0.001$) or generalists (median [25 to 75% quartile], 10 min [5 to 18 min]); $p < 0.001$). However, medical subspecialists did not answer their pages any quicker than the generalists ($p = 0.55$). Of the 178 pages to attending physicians, 117 were placed through an indirect paging system and 61 were placed through a direct paging system. Pages placed through a direct system were answered more quickly (median [25 to 75% quartile], 4 min [2 to 9.5 min]) than indirect pages (median [25 to 75% quartile], 7 min [3 to 30 min]); $p < 0.001$). In addition, the response time for attending physicians did not differ depending on the time of day ($p = 0.12$) or the day of the week ($p = 0.42$).

When the response time was dichotomized, 32% (56/178) of the page responses were slow (≥ 15 min) and 68% (122/178) were adequate (< 15 min). When the attending physician pages were stratified by the type of paging system, 39% (46/117) of the indirect pages were slow, compared with only 16% (10/61) of the direct pages ($p = 0.002$). Again, there was no difference in regard to the response of the attending physicians based on the time that the page was placed (day vs night, $p = 0.13$), or the day of the week (weekday vs weekend, $p = 0.35$).

Only the effects of the type of paging system (direct vs indirect) on the paging response time

remained significant in a GEE analysis adjusting for type of attending physician, hospital, time of day, and day of week ($p < 0.001$; OR, 4.25; 95% CI, 1.91 to 9.51).

Overall Satisfaction and Compliance

Pages that were answered in < 15 min were associated with a statistically higher score on the nurse satisfaction scale when compared with pages that required ≥ 15 min to answer ($p < 0.001$; Table 4).

After the study was completed, we randomly sampled a total of 40 physicians (20 at each hospital) to determine if the secrecy of the study had been maintained by the nursing staff. None of the 40 physicians were aware that the study had occurred.

DISCUSSION

Although the utilization of beepers has improved the quality of life for medical personnel in the hospital, paging systems should not delay the physician's response to emergencies. This study demonstrated that medical personnel do differ in their response times to pages. Pages placed during the night were answered more quickly than daytime

Table 4—Degree of Nurse Satisfaction With Slow and Adequate Paging Response Times

| Nurse Satisfaction | No. of Slow Pages | Percentage of Slow Pages | No. of Adequate Pages | Percentage of Adequate Pages |
|--------------------|-------------------|--------------------------|-----------------------|------------------------------|
| None | 15/70 | 21 | 3/332 | 1 |
| Mild | 4/70 | 6 | 14/332 | 4 |
| Moderate | 11/70 | 16 | 35/332 | 10 |
| Very | 24/70 | 34 | 92/332 | 28 |
| Extreme | 16/70 | 23 | 188/332 | 57 |

pages, and residents responded to pages more quickly than attending physicians. However, the most significant factor identified in this study was the effect of the type of paging system. When the nurse or hospital operator could not directly page the physician and therefore had to rely on the physician's office or an independent paging system, the response time to the page was longer. Twenty-five percent of the pages placed through an indirect system were associated with a response time of ≥ 29 min.

As the utilization of beepers in the hospital setting has increased over the last decade, the number of ICU beds has also risen dramatically in the United States. By 1983, more than 90% of all US acute care hospitals had a least one ICU.⁸ From 1976 to 1982, the number of ICU beds grew at a rate of 29%, compared with a growth of only 5% for general care beds during the same period.⁸ In addition, the organization of care in the ICUs in the United States has also been examined. Based on a survey of 2,876 separate ICUs in 1,706 hospitals in the United States, more than 50% of the units were classified as open units (defined as units where any physician could write an order).⁹ Only 6% of the ICUs reported having in-house, 24-h attending physician coverage. Therefore, a great deal of communication between ICU nurses and physicians caring for critically ill patients relies on paging systems.

Our study raises the concern that slower paging systems may make it difficult for attending physicians to respond to emergencies in the ICU in a timely manner. The Society of Critical Care Medicine has defined Level I critical care units as units that provide a wide range of continuous, sophisticated, tertiary levels of service, including not only state-of-the-art equipment but also the services of specially trained physicians.⁴ The Society also made recommendations concerning the organization, services provided, transport policies, and nursing and physician availability for these units.¹⁰ In regard to physician availability, it is considered essential that surgeons, anesthesiologists, cardiologists, and pulmonary internists be on call and able to reach the bedside of the patient within 30 min. Although these recommendations have never been validated in a clinical study, less efficient paging systems that delay the notification of physicians of an emergency may make it impossible for physicians to be at the bedside of the patient in the required 30 min.

The exact difficulty with an indirect paging system could not be identified in our study. However, there are several possibilities. It is possible that physicians who opt to utilize an indirect system of paging are intrinsically slower in their response to pages. Generalists may have a slower response time because of

an inherent belief that their pages are of a less urgent nature. However, in this study, 35% of the pages to a generalist were for a change in patient status. It is also possible that the simple addition of an extra telephone call slows the paging process. Finally, the response time of the receptionists at a physician's office or the attendants employed by independent answering services may be unacceptably delayed. We were not able to differentiate whether the indirect paging system is slower when the process is filtered through the physician's office vs an independently contracted answering service.

Although our results identify several variables that alter the response time to pages in a statistical significant manner, this study was not designed to determine whether these alterations create clinically significant differences in the delivery of care to ICU patients. The only effect we examined was the overall satisfaction of the nurse with regard to the quality of care delivered by the physician in response to that specific page. This study did demonstrate that pages answered in < 15 min were associated with a significantly higher level of nurse satisfaction than pages answered in ≥ 15 min.

Some other potential modifiers could influence the interpretation of our study. Although more than 400 pages, 166 different medical personnel, and up to 10 different answering services were examined in this study, our findings may not be characteristic of other hospitals across the country. Our study is clearly a small sampling of all the ICUs, physicians, and answering services in the United States. However, the patterns in the response time to pages in the two hospitals were similar, suggesting that it is possible that our study is generalizable to other ICUs. It might appear that only two pages to a physician per nurse per day is a unusually low number of pages, which implies that the nurses were unable to record all of the pages they issued. However, in the study by Katz and Schroeder,¹ interns received only six to seven pages per day on their nonadmitting days for *all* of their patients. Another explanation for the low number of pages may be an overall low severity of illness of our patients or increased autonomy of the nurses involved in the study. If any of the nurses became aware of the primary variables of interest in this study, their responses may have also biased the results of the study. As long as the nurses did not all bias the recording of the results in the same manner and direction, this form of misclassification would actually reduce the magnitude of the results' significance.¹¹ Finally, it would be interesting and important to examine whether delays in the response to

pages have a negative impact on the perception of the patient and family concerning care delivered in the ICU setting. These questions will need to be answered in a larger study that can examine these factors.

Newer forms of communication are available that may improve the paging response time of physicians. Some hospitals have implemented an alphanumeric paging system, which is capable of transmitting written messages.¹² These messages can include a short report of the reason for the page, its urgency, where the page originated, and a call-back telephone number. Some cardiologists in the Atlanta, GA, area have started to utilize, in place of a paging system, small cellular telephones that allow a nurse to call the physician directly. This technique eliminates the time delay related to a physician trying to answer a routine page. Whether these newer systems of communication will prove to be effective and cost-efficient is presently unknown.

In summary, beepers have become a standard form of communication in hospitals throughout the United States. This study identifies differences in the response times to ICU pages according to the type of paging system, the rank of physician, and the time of day. Hopefully, our results will lead to further investigations into this potentially serious deficiency with the goal of subsequent improvements in the lines of communication between nurses and physicians in the ICU setting.

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