

## Research Paper ■

# Computerized Physician Order Entry and Electronic Medical Record Systems in Korean Teaching and General Hospitals: Results of a 2004 Survey

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**Abstract Objective:** To determine the availability of computerized physician order entry (CPOE) and electronic medical record (EMR) systems in teaching and general hospitals in the Republic of Korea.

**Design:** A combined mail and telephone survey of 283 hospitals.

**Measurements:** The surveys assessed the availability of CPOE and EMRs in the hospitals, as well as *inducement*, *participation*, and *saturation* regarding CPOE use by physicians.

**Results:** A total of 122 (43.1%) hospitals responded to the survey. The complete form of CPOE was available in 98 (80.3%) hospitals. The use of CPOE was mandatory in 92 (86.0%) of the 107 hospitals that responded to the questions regarding the requirement of CPOE use. In 85 (79.4%) of the hospitals in which CPOE was in use, more than 90% of physicians used the system. In addition, physicians entered more than 90% of their total orders through CPOE in 87 (81.3%) hospitals. In contrast, a complete EMR system was available in only 11 (9.0%) of the hospitals.

**Conclusion:** Of the teaching and general hospitals in the Republic of Korea that responded to the survey, the majority (80.3%) have CPOE systems, and a complete EMR system is available in only 9%.

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Many hospitals around the world have implemented computerized physician order entry (CPOE) systems. Numerous publications cite the benefits of using CPOE.<sup>1–4</sup> However, many drawbacks and difficulties associated with CPOE use have been described as well.<sup>5–7</sup>

The use of CPOE systems in Korean hospitals and clinics has been widely accepted since their first introduction to the Republic of Korea in 1982.<sup>8,9</sup> A brief report about Korean hospital information systems was published in Korea in 2003. That study differed in design from the present survey, used different terminology that did not include CPOE, and did not assess the availability of complete electronic medical records (EMRs).<sup>10</sup> To our knowledge, this is the first report pre-

sent to the outside world concerning Korean data on CPOE and EMR use.

Ash et al.<sup>11</sup> discovered that 16.5% of American hospitals had CPOE available to some degree (9.6% completely, 6.5% partially) in 2002. According to Health Care News, the rates of EMR use by general practitioners in the Western world in 2002 were 90% in Sweden, 88% in the Netherlands, 62% in Denmark, 58% in the United Kingdom, 56% in Finland, 55% in Austria, and 17% in the United States.<sup>12</sup> A similar study conducted in Korea in 2003 to survey the computerization status of private clinics revealed that 259 (58.2%) of 445 clinics used an EMR system for their outpatients.<sup>13</sup>

Due to differences in practice patterns and national health care systems, difficulties arise in comparing these survey results among nations. Different populations, survey methods, types of questionnaires, and varying definitions of CPOE and EMR influence survey results. In order to allow direct comparisons, we adopted a survey form used in previous studies in the United States.

Although a detailed and well-designed survey may be advantageous in collecting more information,<sup>14</sup> a survey form that is too complicated will decrease the response rate, resulting in a nonrepresentative result. Ash et al.<sup>11,15</sup> have developed a simple survey form, a postcard with a brief set of questions, to assess CPOE status. We decided to use the same postcard and brief questionnaire in our survey, with the permission of one of the authors (Joan Ash). We added one additional question about EMR availability to the original survey.

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In this study, we sought the following information in order to determine CPOE and EMR use in Korea and to make a comparison with use in Western nations: (1) the availability of CPOE and EMR systems in Korean teaching and general hospitals, (2) the level of the required use of CPOE, (3) the percentages of doctors in the hospitals who use CPOE, and (4) the percentages of the doctors' orders that are entered through CPOE.

## Methods

### Survey Development

The survey devised by Ash et al.<sup>11,15</sup> fits easily onto a postcard and can be filled out quickly. The postcard survey used in this study consisted of five simple questions (Fig. 1). The first four questions were related to CPOE and were directly adopted from the original survey of Ash et al. The last question, which we added, addressed EMR availability. This question was included to determine how many Korean teaching and general hospitals are currently using any form of EMR system.

The first question addressed *CPOE availability* in the hospital. The second inquired about the level of its required use (*inducement*). The third question asked the respondent to estimate the percentage of hospital physicians who use the system (*participation*), and the fourth question asked for the percentage of doctors' orders that are entered by physicians into the CPOE

1. **Availability: Computerized order entry by physicians is**

- Not available at all (no system in place for use by physicians)
- Partially available (offered in some form or in some locations)
- Completely available (all orders can be entered in all locations)
- Was formerly available (system previously in place abandoned)  
Please explain:

2. **Inducement: Computerized order entry by physicians is**

- Optional (available, and there is no active program to increase use)
- Encouraged (program in place to encourage use; other options are discouraged)
- Required (no other option exists except in emergencies)

3. **Participation: Please estimate the percentage of the total physicians' orders entered by physicians through CPOE (place an X on the line).**

|-----|-----|-----|-----|  
0%    25%    50%    75%    100%

4. **Saturation: In your hospital, what would be an estimated percentage of the total physicians' orders that are entered by physicians using CPOE? (Please place an X on the appropriate percentage on the line).**

|-----|-----|-----|-----|  
0%    25%    50%    75%    100%

5. **EMR system** (a computer application with which health care personnel enter all of the medical records related to the patient care.

- It is a comprehensive system which includes all the health care records, such as admission and progress notes, operation notes, anesthesia notes, discharge summaries, and nurses' records.) is
- Not available at all (no system in place for use by physicians)
  - Partially available (offered in some form or in some locations)
  - Completely available (all orders can be entered in all locations)
  - Was formerly available (system previously in place abandoned)  
Please explain:

Source of information: Your job title

**Figure 1.** The postcard survey form (Modified from Ash et al.<sup>11</sup> [Editor's Note: Question #3 in Ash et al.<sup>11</sup> is worded differently than above]).

system (*saturation*). The final question addressed the *availability* of an EMR system in the hospital. The answers to the questions on CPOE availability, CPOE inducement, and EMR availability were represented on Likert scales. The answers to the two questions regarding participation and saturation of CPOE were marked on a visual analog scale (0 to 100%, divided in quarters) as shown in Figure 1.

### Subjects

We obtained a list of 283 teaching and general hospitals, excluding military general hospitals, from the Web sites of the Health Insurance Review Agency of Korea ([www.hira.or.kr](http://www.hira.or.kr)) and the Korean Medical Association Membership Directory of 2003. We organized the list to contain the hospital names, zip codes, addresses, telephone numbers, and number of beds. The information was entered into a database for the generation of cover letters, mailing labels, and future statistical analyses.

The teaching hospitals were large tertiary care university hospitals with their own medical schools, including residency and fellowship programs. The Korean Hospital Association defined general hospitals as hospitals with 80 or more beds and at least eight major clinical departments, which included internal medicine, general surgery, pediatrics, obstetrics and gynecology, radiology, emergency medicine, and pathology.

### Mailing and Follow-up

A survey was mailed to the director of hospital information systems at each teaching and general hospital. The director is responsible for the operation and maintenance of the systems. The mailing included a one-page cover letter explaining the study purpose, definitions of CPOE and EMR, and a self-addressed, stamped postcard asking the five questions discussed above.

The following quoted statements are the definitions of CPOE and EMR offered in the cover letter that accompanied the postcard questionnaire.

CPOE is an integrated computerized system into which physicians directly enter orders related to patient care, medications, therapies, diagnostic tests, and other ancillary services. It may or may not have decision-supporting tools.

The question regarding the completeness of the CPOE was also adopted from Ash's original article, which considered a complete CPOE system to be one into which more than 90% of orders were entered. A CPOE system into which less than 90% of orders were entered was considered incomplete.<sup>11,15</sup>

EMR is a computer application with which health care personnel enter all of the medical records related to the patient care. It is a comprehensive system that includes all the patient's health care records, such as admission and progress notes, operation notes, anesthesia notes, discharge summaries, and nurses' records.

Although the definitions of both CPOE and EMR were given in the cover letter, only a brief definition of EMR was given on the postcard owing to space limitations (Fig. 1). After waiting two months for the mail response, we began making telephone calls to the directors of hospital information systems who had not yet responded to the postcard survey. All the telephone calls were made by the same person (the first

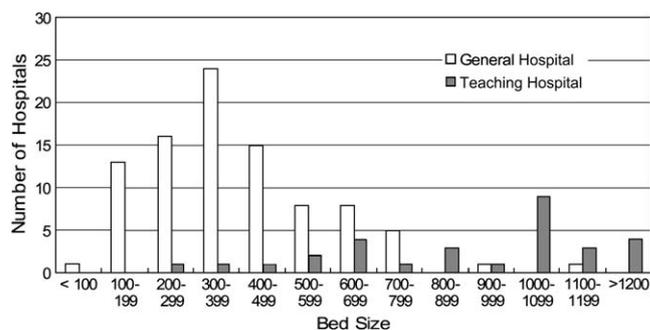
author) to ensure the consistency of results. A maximum of three phone call attempts were made. The same definitions of CPOE and EMR described in the introduction and methods sections were used to collect data during the telephone surveys. During the telephone survey, inquiries were made concerning the receipt of the questionnaire, and then the interviewer explained the purpose of our study and asked the questions listed on the questionnaire.

### Analysis

Those who responded by mail were grouped separately and compared with those who answered over the telephone. The CPOE and/or EMR availabilities were compared between the teaching (tertiary) hospitals and general hospitals as well. Data from the answers to the five questions were analyzed with a statistical analysis program (SPSS 8.0 for Windows).

### Results

A total of 57 teaching hospitals and 226 general hospitals were included in this study. Overall, 71 of 283 hospitals (25%) returned responses to the survey by mail. We were able to get an additional 51 responses from the subsequent telephone surveys. The most common reasons for failure to obtain telephone responses were inability to reach responsible persons in a maximum of three attempts and the refusal of responsible persons to participate in the survey. The final response rate was 43.1%. The 122 hospitals that participated in the study included 30 teaching hospitals and 92 general hospitals. The sizes of the teaching hospitals ranged from 288 to 1,790 beds, and the capacities of the general hospitals ranged from 94 to 1,141 beds (Fig. 2).



**Figure 2.** The distribution of number of beds in teaching and general hospitals that had responded to the survey.

We sought to make a comparison between the mail and phone response groups using the  $\chi^2$  test for the potential differences. There were significant differences in the availability of CPOE and EMR between the two groups ( $p < 0.05$ ), but bed size did not influence the availability of either CPOE or EMR ( $p = 0.871$  and  $p = 0.102$ , respectively).

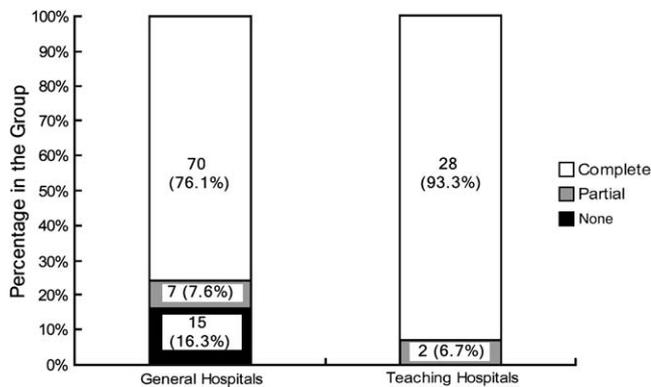
Descriptions of the answers to the four questions about CPOE and their relative proportions appear in Table 1. In response to the question about the availability of CPOE, 80.3% of the hospitals reported that they had CPOE available at all locations within the hospital for all types of orders. Only 7.4% of hospitals responded that they had either limited access to CPOE in some locations of the hospital or that CPOE was only applicable to limited types of orders. The remaining 12.3% of hospitals responded that they had no CPOE system

**Table 1 ■ Hospitals That Had Computerized Physician Order Entry (CPOE) in 2004**

Category	Analysis of CPOE Status				
	Mail Response Group	Phone Response Group	General Hospitals	Teaching Hospitals	Total
<b>Availability</b>					
Complete	60* (84.5%)†	38 (74.5%)	70 (76.1%)	28 (93.3%)	98 (80.3%)
Partial	7 (9.9%)	2 (3.9%)	7 (7.6%)	2 (6.7%)	9 (7.4%)
Not available at all	4 (5.6%)	11 (21.6%)	15 (16.3%)	0 (0.0%)	15 (12.3%)
Total	71 (100.0%)	51 (100.0%)	92 (100%)	30 (100%)	122 (100%)
<b>Inducement</b>					
Required	57 (85.1%)	35 (87.5%)	63 (81.8%)	29 (96.7%)	92 (86.0%)
Encouraged	6 (9.0%)	4 (10.0%)	9 (11.7%)	1 (3.3%)	10 (9.3%)
Optional	4 (6.0%)	1 (2.5%)	5 (6.5%)	0 (0%)	5 (4.7%)
Total	67 (100.0%)	40 (100.0%)	77 (100.0%)	30 (100.0%)	107 (100.0%)
<b>Participation</b>					
0–10% of physicians use it	2 (3.0%)	3 (7.5%)	5 (6.5%)	0 (0.0%)	5 (4.7%)
11–50% of physicians use it	4 (6.0%)	1 (2.5%)	5 (6.5%)	0 (0.0%)	5 (4.7%)
51–90% of physicians use it	10 (14.9%)	2 (5.0%)	8 (10.4%)	4 (13.3%)	12 (11.2%)
91–100% of physicians use it	51 (76.1%)	34 (85.0%)	59 (76.6%)	26 (86.7%)	85 (79.4%)
Total	67 (100.0%)	40 (100.0%)	77 (100.0%)	30 (100.0%)	107 (100.0%)
<b>Saturation</b>					
0–10% of physicians' orders entered by CPOE	3 (4.5%)	2 (5.0%)	3 (3.9%)	2 (6.7%)	5 (4.7%)
11–50% of physicians' orders entered by CPOE	1 (1.5%)	1 (2.5%)	2 (2.6%)	0 (0.0%)	2 (1.9%)
51–90% of physicians' orders entered by CPOE	10 (14.9%)	3 (7.5%)	12 (15.6%)	1 (3.3%)	13 (12.1%)
91–100% of physicians' orders entered by CPOE	53 (79.1%)	34 (85.0%)	60 (77.9%)	27 (90.0%)	87 (81.3%)
Total	67 (100.0%)	40 (100.0%)	77 (100.0%)	30 (100.0%)	107 (100.0%)

\*The numbers indicate the number of hospitals that responded to the survey.

†() Percentage of the group.



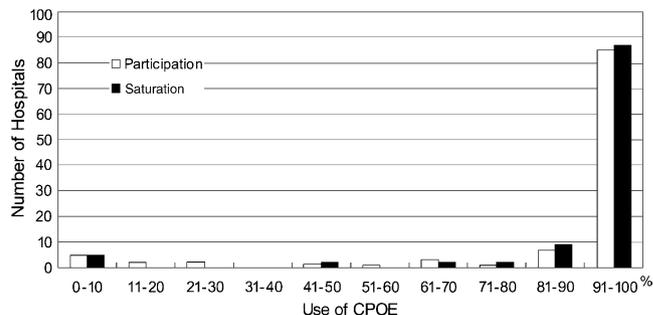
**Figure 3.** The comparison of availability of computerized physician order entry (CPOE) in the general hospitals and teaching hospitals: Almost all teaching hospitals (93.3%) have a complete CPOE system available, but only 76.1% of general hospitals have a complete CPOE system available. However, availability between the two groups was not statistically significant ( $p = 0.056$ ).

at all. Those who responded through the mail had a higher percentage of CPOE availability than did those who responded to the subsequent phone survey ( $p = 0.019$ ).

Nearly all the teaching hospitals (93.3%) surveyed had complete CPOE systems. In contrast, 76.1% of the general hospitals had complete CPOE systems. While 16.3% of general hospitals had no CPOE system available at all, all the teaching hospitals had at least some form of CPOE system available, as shown in Figure 3. However, the difference in CPOE availability between the groups was not statistically significant ( $p = 0.056$ ). No hospital responded that a system was formerly available but had been abandoned.

In response to the inducement question, 86.0% of hospitals replied that the use of CPOE was mandatory; an additional 9.3% said that the hospital encouraged its use, and 4.7% said that the use was optional. Although there were no significant differences in CPOE use requirements between the mail and phone response groups ( $p = 0.708$ ), almost all the teaching hospitals (96.7%) required their physicians to order by CPOE.

In addition, the hospitals were asked for the approximate percentage of physicians who routinely used CPOE for their medical orders. In 79.4% of hospitals that currently operated CPOE systems, the participation rate was apparently greater than 90%, based on marks recorded on the visual analog scale. Only 4.7% of these hospitals appeared to report use by less than 10% of physicians. There were no significant differences in the percentage of physicians using CPOE between the



**Figure 4.** Extent of physician use of computerized physician order entry (CPOE) in 2004. Most physicians use CPOE for most of their orders. Participation = proportion of physicians who use CPOE; Saturation = percentage of the total physicians' orders entered through CPOE.

mail and telephone response groups ( $p = 0.242$ ) or between the two hospital types ( $p = 0.227$ , teaching hospitals vs. general hospitals).

In response to the saturation question about the percentage of orders entered through CPOE by physicians, 81.3% of the hospitals appeared to indicate that 90% or more of orders were entered using CPOE; only 4.7% appeared to report a 10% or lower saturation. There were no significant differences between response groups ( $p = 0.707$ , mail vs. telephone respondents) or hospital groups ( $p = 0.242$ , teaching hospitals vs. general hospitals). Figure 4 shows that a majority of physicians entered most of their medical orders into a CPOE system.

The last question in the questionnaire addressed EMR availability; the results are shown in Table 2. Only 9% of the hospitals responded that they were equipped with a complete EMR system. Another 36.1% of the hospitals had only partial EMR systems running. In regard to the availability of EMRs, there was a significant difference between the mail and telephone response groups ( $p = 0.000$ ). Also, teaching hospitals tended to demonstrate a higher percentage of EMR use than did general hospitals ( $p = 0.024$ ). Figure 5 shows the differences in the distribution of EMR use. If we account for all forms of EMRs, including partial, then approximately two thirds of the teaching hospitals (66.6%) have least some form of EMRs, while only 38% of general hospitals replied that they used an EMR system. Every hospital that had some form of EMR system also had a CPOE system (90.9% in complete form, 9.1% in partial).

**Discussion**

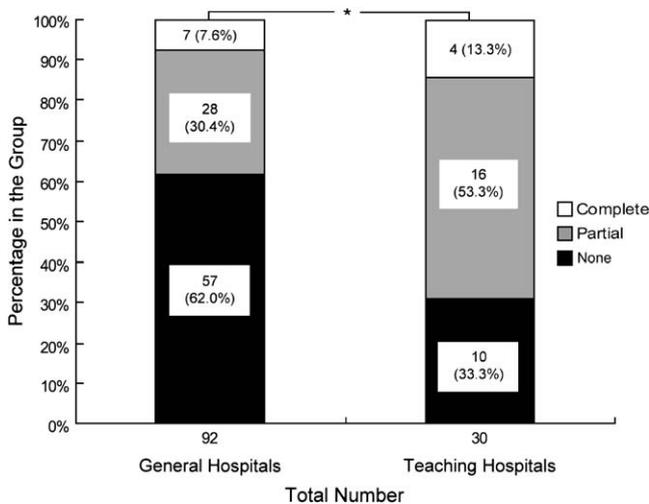
Our survey revealed that the Republic of Korea has a relatively high percentage of CPOE use, while the use of an

**Table 2 ■ Hospitals That Operated an Electronic Medical Record (EMR) System in 2004**

Category	Analysis of EMR Status				
	Mail Response Group	Phone Response Group	General Hospitals	Teaching Hospitals	Total
Availability					
Complete	8* (11.3%)†	3 (5.9%)	7 (7.6%)	4 (13.3%)	11 (9.0%)
Partial	40 (56.3%)	4 (7.8%)	28 (30.4%)	16 (53.3%)	44 (36.1%)
Not available at all	23 (32.4)	44 (86.3%)	57 (62.0%)	10 (33.3%)	67 (54.9%)
Total	71 (100.0%)	51 (100.0%)	92 (100%)	30 (100%)	122 (100%)

\*Number of hospitals that responded to the survey.

†() Percentage of the group.



**Figure 5.** For electronic medical record availability, the teaching and general hospitals showed a significant difference ( $p = 0.024$ ). The figure shows different distribution of availability between the groups. \* $p = 0.024$ .

EMR system is less popular in both teaching and general hospitals. Statistical analyses of our data revealed significant differences regarding the availability of both CPOE and EMRs between the mail and telephone response groups. Hospitals with systems were more likely to respond to the mail survey. Those who required telephone follow-up had lower rates of use of CPOE and EMRs. This suggests that nonrespondents may have even lower rates of use of computerized systems. Teaching hospitals were better equipped with CPOE and EMR systems. They also tended to mandate that their physicians enter every order into a CPOE system. However, to our surprise, there were no correlations between the bed size and either CPOE or EMR availability.

Our survey results were somewhat similar to those in the 2003 Korean domestic publication.<sup>10</sup> Our study design was simple but had been previously used in the United States; hence, the Korean data could be compared with the U.S. data. Although 36.1% of teaching and general hospitals reported that they had partial EMR systems, the exact meaning and extent of "partial availability" were not defined and should be regarded as a significant limitation of this simple postcard survey.

There could be several possible explanations for Korea's higher rate of CPOE use relative to rates in some other countries. These include pervasive high-speed Internet connections, a population that is in general "technology prone" and "less resistant" to digital changes in their environment, lack of strict laws or regulations regarding security and privacy of electronic patient information, and changes in the Korean medical community over the past decade that have influenced the use of technology in hospitals. Several large corporate-invested tertiary hospitals with affiliated medical schools came into existence. They have been setting new standards with their modern facilities and equipment, as well as elaborate hospital information systems that greatly appeal to patients.

Probably most important, however, is the government's drive to steer the health care industries toward computerized systems in order to reduce the cost of health care and facilitate

the exchange of patient information. Under Korean National Health Insurance, Korea has a single-payer system in which nearly all claims are processed electronically. When filing insurance claims to the government health insurance agency, electronic data interchange permits immediate processing of the claims and reimbursement within two weeks. If a hospital makes claims on conventional paper, payments may take six months or longer. The use of a traditional paper system could be a financial burden in the Korean health care system, where hospitals operate under very tight budgets.

In a single-payer system that is dominated and controlled by the government, hospitals may react sensitively to government policies. For example, since 1999 when the Korean government offered financial incentives to install picture archiving and communications systems (PACS), 88.1% of tertiary hospitals, 59.8% of general hospitals, and 23.4% of private hospitals have begun using them (the Korean Health Insurance Review Agency, September 2004). In addition, while the government offers financial benefits and encourages the use of CPOE, there are no incentives for using an EMR system and no disadvantages for not using an EMR system. Consequently, hospitals are generally hesitant to invest heavily in EMR system development.

Also, there is a general perception that the use of a complete EMR system may retard the clinical flow of patients because most Korean doctors, except for those in a training hospital setting, are not accustomed to typing English text. Additionally, there is a lack of standards and standardized database forms for EMRs. All these factors may have contributed to the lack of popularity of EMRs in Korean hospitals. However, based on our personal communications and experience, we know that many teaching hospitals in Korea are now preparing to go completely "paperless." We expect that most teaching hospitals in Korea will become equipped with complete EMR systems within the next few years.

Several other characteristics of the Korean hospital information markets are worth noting. In any given individual hospital in Korea, it is customary that one company provides a comprehensive solution to all the different components of a hospital information system. In other words, the vendor designing CPOE also provides the laboratory information system, PACS, and administrative information system. However, there is no single standard solution that can be bought "off-the-shelf" or any noncommercial product provided by the national government for general use.

## Conclusion

The majority of Korean teaching and general hospitals are equipped with CPOE systems. There are approximately 283 teaching and general hospitals in Korea. Of the 43.1% of these hospitals that responded to our survey, 80.3% have a complete CPOE system in operation. Among hospitals with a CPOE system, 86.0% require its use. In 81.3% of the hospitals, greater than 90% of physicians' orders are entered through CPOE. The high CPOE availability in Korean teaching and general hospitals appears to be attributable to a combination of governmental efforts and incentives, cultural characteristics, and Korea's unique health care system.

On the other hand, the EMR system in its complete form seems to be less popular and is used in only 9.0% of the hospitals. Based on our experience with CPOE, the adoption of

EMR systems in Korea will probably increase dramatically in the near future, especially if the government encourages the use of EMRs and offers financial incentives.

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