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Use of Computerized Clinical Support Systems in Medical Settings: United States, 2001–03

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Abstract

Objectives—This report presents information on the use of electronic clinical systems to support patient care in physician offices and hospital emergency and outpatient settings. Percentages of hospital emergency and outpatient departments with electronic patient medical records and automated drug dispensing systems are presented by selected hospital characteristics for 2001–02. Percentages of physicians using electronic patient billing records, electronic patient medical records, and computerized prescription order entry systems are presented by selected physician characteristics for 2003.

Methods—Data are from provider induction interviews from the National Ambulatory Medical Care Survey (NAMCS) and the National Hospital Ambulatory Medical Care Survey (NHAMCS), the ambulatory care component of the National Health Care Survey (NHCS). The NHCS is a family of provider-based surveys that collect information on the care provided in various medical care settings.

Results—During 2001–03, electronic medical records were used less often in physician offices (17 percent) than in hospital emergency (31 percent) and outpatient departments (29 percent). In physician offices, information technology was more frequently used for billing patients (73 percent) than for maintaining medical records electronically (17 percent) or ordering prescriptions electronically (8 percent). Automated drug dispensing systems were available in hospital emergency departments (40 percent) more frequently than in outpatient departments (18 percent).

Keywords: EMR • CPOE • ADDS • electronic medical records • NAMCS • NHAMCS

Introduction

This report examines use of clinical information technology applications in three medical care settings: office-based physician practices and hospital emergency and outpatient departments. Use of electronic medical records (EMRs) and automated drug dispensing systems (ADDS) in hospital emergency and outpatient departments during 2001–02 is examined using data from the National Hospital Ambulatory Medical Care Survey (NHAMCS). Use of electronic billing to submit claims, EMR, and computerized prescription order entry (CPOE) systems in physician offices is examined using data from the 2003 National Ambulatory Medical Care Survey (NAMCS). The NAMCS and the NHAMCS comprise the ambulatory care component of the National Health Care Survey (NHCS), a family of provider-based surveys that collects information on the care provided in various medical care settings. It is conducted by the Centers for Disease Control and Prevention's National Center for Health Statistics. These surveys collect information not only on the visits made to physician offices and hospital emergency and outpatient departments, but also on characteristics of the providers themselves.

Despite its potential to improve quality and reduce errors, use of information technology (IT) in the health sector lags behind other sectors of the economy in the United States (1). In 2004, David Brailer was appointed by the President as the National Coordinator for Health Information Technology. His report, ''The Decade of Health Information Technology: Delivering Consumer-centric and Information-rich Health Care,'' outlines steps needed to build a national electronic health information infrastructure with the goal of having EMR for most Americans within 10 years (2).

A key building block of this plan is encouraging health providers to adopt

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EMRs for storing clinical information (3,4). Ambulatory care EMRs typically include lists of problems, medications, allergies, tests, and other personal information (3). A comprehensive automated system may include medical history, patient demographics, nurse's notes, electronic prescription and diagnostic test orders, and evidence-based decision-support tools (2). Advantages of using EMRs include: reduction in the cost of dictation and ''chart pulls;'' improved efficiency (assisting in identifying the least expensive drug within a class of drugs, accessible 24 hours for 7 days a week, can be viewed by more than one physician at a time, is always legible); and providing better quality of care (computerized reminders and prevention guidelines for chronic conditions, improved communication during the referral process, improved coordination of care between specialty and primary care providers) (3,5,6). An EMR could also incorporate nonclinical care features such as billing, quality management, outcome reporting, and public health disease surveillance and reporting.

Other clinical IT applications include CPOE systems, ADDS, and bar codes and event monitors when administering medications (7). A CPOE system is a computer application that allows physician's orders for medications (and diagnostic tests) to be entered electronically instead of being recorded on prescription pads. The computer compares the order against standards for dosing, checks for allergies or drug interactions, and warns of potential patient problems. A 1998 study found that implementation of a CPOE system in a large teaching hospital reduced medication error rates by 55 percent (8). ADDS can reduce errors in dispensing drugs, including incorrect drugs or dosage. They operate like vending machines where the order is written and the machine dispenses the correct drug and dose for the patient. Bar codes may be used in hospital settings to uniquely identify the drug and the intended patient, thus reducing not only dispensing errors but also administration errors.

Estimates of the use of clinical IT applications (electronic billing systems, EMR, CPOE, and ADDS) in physician offices and hospital emergency and outpatient departments presented in this report can provide baseline estimates for monitoring the progress of this Federal initiative.

Methods

Data Sources

The NAMCS is an annual national probability sample survey of visits to the offices of physicians classified by the American Medical Association and American Osteopathic Association as primarily engaged in ''office-based, patient care.'' Federally employed physicians and those who specialize in anesthesiology, radiology, or pathology are excluded. The NAMCS utilizes a multistage probability sample design involving selection of 112 geographic primary sampling units (PSUs), physicians within PSUs, and patient visits within physician practices. The PSUs are counties, groups of counties, county equivalents (such as parishes or independent cities), or towns and townships for some PSUs in New England.

In 2003, 3,000 physicians were sampled, of whom 2,011 were eligible for the survey, and 1,114 responded to the initial interview for induction into the survey. Data presented in this report are based on physician responses to the Physician Induction Interview (PII) questionnaire. During the induction interview, physicians are asked questions to determine their eligibility for the survey, as well as to gather information about their practice. The response rate was 55 percent (15 percent were unavailable at the time of the interview, and 30 percent refused to participate). Sampling weights used to make national annual estimates of physicians were adjusted for nonresponse.

The NHAMCS is an annual probability sample survey of visits to emergency and outpatient departments occurring in approximately 500 non-Federal, general, and short-stay hospitals (i.e., hospitals with an average length of stay less than 30 days) located in the 50 States and the District of Columbia. The scope of the survey is hospitals that have a 24-hour emergency department (ED) or an outpatient department (OPD) that provides physician services directly to outpatients. Hospitals that offer only ancillary services, such as radiology or pharmacies in their outpatient department, are excluded from the NHAMCS. The NHAMCS utilizes a multistage sample design with the selection of the same 112 PSUs as the NAMCS, a selection of hospitals within PSUs, and visits within hospital emergency and outpatient departments.

Estimates presented in this report are based on hospital responses from the induction interview during which interviewers explain the survey, verify the hospital's eligibility for the survey, and collect basic information about the hospital. Results presented from this interview are representative only of hospitals with emergency or outpatient departments within the scope of the NHAMCS. About 85 percent of sampled hospitals were eligible for the survey. Data from the 2001 and 2002 NHAMCS were combined to provide more reliable results at the facility level. A total of 817 sampled hospitals had eligible EDs or OPDs. Data from 390 hospitals in 2001 and 390 hospitals in 2002 were combined for a response rate of 95 percent. Sampling weights used to make national annual estimates of hospitals were adjusted for nonresponse.

The data collection agent for both the NAMCS and NHAMCS is the U.S. Census Bureau, and the data are centrally processed by Constella Group, Inc. There is 100 percent independent keying of the induction forms with a quality control error rate of 0.1 percent. More information about the data collection procedures and survey background may be found elsewhere (9,10).

Statistical Analysis

Estimates of physician use of IT applications are based on three items collected during the 2003 NAMCS induction interview:

- Does your practice use electronic medical records (not including billing records)?

- Does your practice submit claims electronically (electronic billing)?
- For the medication prescriptions written in your practice, do you use a computerized prescription order entry (CPOE) system?

For each item, response categories were: yes, no, and unknown. Estimates presented include unknowns in the denominator of percentages. The percentage of missing data was: 8 percent for the electronic claims billing item, 1 percent for the EMR item, and 2 percent for the CPOE system item. The distributions would vary slightly if missing responses were excluded from the denominator.

It should be noted that the acronym for computerized prescription order entry (CPOE) used in this report varies from typical citations in the literature where CPOE signifies computerized physician order entry (7,8). Although the wording for CPOE used in this report and the literature varies, the intent of this term is the same.

Estimates of hospital emergency and outpatient department use of IT applications are based on four data items collected during the NHAMCS induction interview in 2001 and 2002:

- Does your hospital have electronic patient medical records (EMR) in ED?
- Does your hospital have electronic patient medical records (EMR) in OPD?
- Does your hospital have an automated drug dispensing system (ADDS) in ED?
- Does your hospital have an automated drug dispensing system (ADDS) in OPD?

For each item, response categories were: yes, no, unknown, and not applicable (no ED or OPD). Estimates presented include unknowns, but exclude not applicable cases in the denominator of percentages. The percentage of missing data for the EMR item was: 4 percent of EDs and 8 percent of OPDs. The percentage of missing data for the ADDS item was: 6 percent for EDs and 16 percent for OPDs. The distributions would vary if missing responses were excluded from the denominator.

Because estimates presented in this report are based on sample surveys rather than the universe of office-based physicians and hospitals, they are subject to sampling variability. The standard errors are calculated using Taylor series approximations in SUDAAN, which take into account the complex sample design of the NAMCS and NHAMCS (11). Estimates whose standard error represents more than 30 percent of the estimate have an asterisk to indicate that they do not meet the reliability standard set by NCHS. Chi-square tests using SUDAAN were performed to detect significant associations between clinical IT use and provider characteristics. All other tests of statistical significance between estimates were based on the two-tailed *t*-test at the 0.05 level of significance, unless otherwise noted. Terms relating to differences such as ‘‘greater than’’ or ‘‘less than’’ indicate that the difference is statistically significant. A lack of comment regarding the difference between any two estimates does not mean that the difference was tested and found to be not significant.

Results

In 2003, the most frequent IT application used in physician offices was an electronic billing system (figure 1). Nearly three-fourths (73 percent) of physicians submitted claims electronically. Electronic submission of claims was more likely among physicians in the Midwest and South, in nonmetropolitan areas, among physicians under 50 years of age, and for physicians with 10 or more managed care contracts (table 1). Physicians in medical specialties (12) such as psychiatry, dermatology, or sports medicine (among others) were least likely to submit claims electronically.

EMRs were used more frequently in hospital settings (31 percent in EDs and 29 percent in OPDs) than in physician offices (17 percent) (table 2). Among physician office practices, there were no statistically significant differences in EMR use by region, metropolitan status, specialty, physician age, type of practice, or number of managed care contracts. There was also no variation in

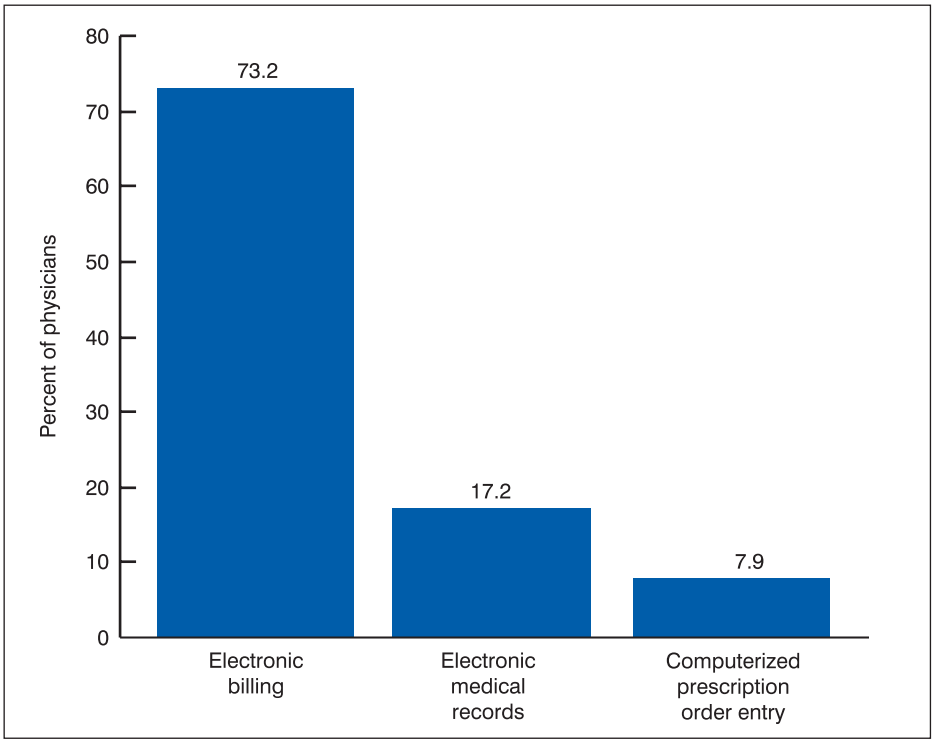

Figure 1. Percent of office-based physicians using selected information technologies: United States, 2003

use of EMRs in hospital EDs or OPDs by location or hospital characteristics.

The NAMCS estimate of EMR use is somewhat similar to an estimate (14 percent) found among family physicians in an Indiana study (13), but lower than that from a 2002 Health Information and Management Systems Society (HIMSS) physician study, which estimated that 29 percent of responding doctor offices were using EMR in all (21 percent) or some (8 percent) of their departments (14). The HIMSS estimate differs in part because the survey included government-owned practices (excluded from the NAMCS). It could also differ because HIMSS respondents reported for practices at the corporate level, and NAMCS physicians reported for their own practice, which could have been part of a larger group. Although the HIMSS physician survey response rate (56.6 percent) (14) was not very different from the NAMCS response rate, their data were not adjusted for nonresponse, unlike the NAMCS data.

The NHAMCS estimates of EMR use (29–31 percent) fall midway between another HIMSS survey estimate (13 percent) of hospitals currently using EMR in both 2001 and 2002 (15) and recent American Hospital Association (AHA) survey estimates of EMR implementation in 42 and 53 percent of hospitals in 2001 and 2002, respectively (16). These differences in estimates reflect differences in the question wording used in each survey. The smallest estimate, 13 percent, was for hospitals currently using EMR (HIMSS survey), and the largest estimates (AHA survey) identify implementation of EMR within a hospital, but staff may not be actively using it. The NHAMCS estimates were based on questions asking about the presence of EMR within the ED or within the OPD—more similar to the implementation question. Differences in estimates may also be due, in part, to respondent biases because AHA survey respondents were more likely to be large hospitals and urban hospitals in contrast to the universe of hospitals (16).

The NAMCS found that CPOE systems were rarely used in physician offices (8 percent). Because the sample is fairly small for looking at differences among rare attributes, some estimates of CPOE use were unreliable. No differences were found among the characteristics observed, with the exception of higher use among physicians under 50 years of age (11 percent) than those 50 years and over (5 percent) (table 3).

The NAMCS estimate of physician use of CPOE (8 percent) is lower than an estimate (14 percent) from the HIMSS physician study of prescriptions placed electronically using handheld technology (14). Although information on CPOE use within EDs and OPDs was not available from the NHAMCS, a 2002 study found that about 10 percent of U.S. hospitals had CPOE completely available (17). The 2002 AHA study reported that 12 percent of pharmaceutical orders were placed electronically in hospital settings (16).

Automatic drug dispensing systems (ADDS) were found more frequently in EDs than in OPDs (40 percent vs. 18 percent, respectively). ADDS use in EDs was lowest in the Midwest and highest in hospitals located in metropolitan statistical areas. EDs with annual visit volumes greater than 25,000 were more likely to use an ADDS compared with smaller EDs (approximately 60 percent vs. 20 percent) (data not shown). Use of ADDS, however, was more frequent in OPDs in hospitals affiliated with medical schools than nonaffiliated hospitals (table 3).

Discussion

This report presents nationally representative estimates of information technology (electronic billing, EMR, and CPOE) use in office-based physician practices. It also presents estimates of EMR use and ADDS availability in hospital EDs and OPDs. In general, EMRs were available more often in hospital EDs (31 percent) and OPDs (29 percent) than in physician offices (17 percent). Use of ADDS, introduced in the 1980s, was observed in 40 percent of EDs and 18 percent of OPDs. Estimates of EMR (17 percent) and CPOE (8 percent) use in office-based practices were lower compared with use of electronic billing systems (73 percent). Previous estimates of use of these technologies have been either subnational or potentially biased by responding organizations.

The NAMCS and NHAMCS estimates reflect a slow rate of clinical information technology adoption by the health care industry. Expenditures for IT also reflect this pattern. In 2001, U.S. providers spent more than $20 billion for IT, but less than a third ($6.5 billion) was spent for hospital clinical systems. The majority of expenditures went toward upgrading and maintaining financial (billing) systems (1).

Implementation of EMRs in the health care industry is slow because it requires a large investment of both time and human resources. According to the Leapfrog Group, a national coalition of large health care purchasers, a 200-bed hospital can expect to spend $1–$7 million to implement EMR (1). In addition, for EMR to be more widely adopted, researchers are calling for uniform national standards for data entry and security, as well as expanded support from both the public and private sector (18).

NAMCS data show that fewer than 1 in 12 physicians utilize CPOE. Similar to EMR adoption, the cost of the initial investment and lack of national standards may pose barriers for CPOE adoption as well. Even if CPOE improves the efficiency of practice, given the scope of office practice and common payment arrangements, physicians may not reap the benefits in additional net revenue (18).

To streamline and promote quality of care in medical settings, the Leapfrog Group has identified CPOE as one of the key safety standards that hospitals should adopt. The Joint Commission on Accreditation of Healthcare Organizations indirectly promotes adoption of EMR and CPOE by measuring hospital compliance with patient safety standards needed for accreditation. Although the use of IT is not explicitly identified in these goals, it is clear that improved technology can play a major role in helping health care organizations meet these standards. The recent Federal government support for building an electronic health information infrastructure in the United States could

also spur IT adoption within the health sector (2). There are plans for electronic health records from the Department of Defense and the Veteran's Administration to follow common standards for electronic interchange and for those nonproprietary systems to be made available to providers. Additionally, the Centers for Medicare and Medicaid Services expects to issue standards for electronic prescribing, and the Federal government intends to fund research and demonstration projects for electronic health records systems (2). These efforts should help promote the use of electronic medical systems.

Starting in 2005, the NAMCS and NHAMCS will collect information not only on the use of EMRs for tracking extent of penetration, but also on selected attributes of the systems employed.

For more information concerning the NAMCS and NHAMCS, contact the Ambulatory Care Statistics Branch at (301) 458–4600 or visit the Web site: http://www.cdc.gov/nchs/about/major/ahcd/ahcd1.htm.

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Table 1. Percent of office-based physicians using electronic billing (with standard errors): United States, 2003

Physician characteristic	Percent of physicians
Total	73.2 (1.7)
Region[1]	
Northeast	63.7 (4.2)
Midwest	79.6 (3.7)
South	78.0 (2.7)
West	69.2 (3.4)
Metropolitan status[1]	
MSA[2]	72.3 (1.8)
Non-MSA[2]	81.4 (3.5)
Physician specialty[1]	
Primary care	77.5 (2.6)
Surgical	75.3 (2.7)
Medical	62.2 (3.7)
Age of physician[1]	
Under 50 years	79.9 (2.1)
50 years and older	66.6 (2.6)
Type of physician practice[1]	
Solo	67.6 (2.9)
Single-specialty group	79.0 (2.7)
Multi-specialty group	71.8 (4.3)
Number of managed care contracts[3]	
None	45.5 (6.3)
Less than 10	76.2 (2.5)
10 or more	79.4 (2.8)

[1]Chi-square test of association is statistically significant at the $\alpha \leq 0.05$ level.
[2]MSA is metropolitan statistical area.
[3]Trend is statistically significant at the $\alpha \leq 0.05$ level.

Table 2. Percent of office-based physicians and hospital emergency and outpatient departments using electronic medical records (with standard errors): United States, 2001–03

Characteristic	Physician offices	Emergency departments	Outpatient departments
	Percent of physicians[1]	Percent of hospitals[2]	
Total[3]	17.2 (1.9)	31.2 (3.6)	28.6 (3.8)
Region			
Northeast	13.1 (2.9)	35.9 (4.6)	36.9 (5.7)
Midwest	25.5 (5.6)	*23.7 (7.4)	*28.4 (9.0)
South	12.9 (2.8)	35.1 (6.1)	21.4 (3.9)
West	18.9 (3.3)	31.3 (5.4)	*32.0 (9.8)
Metropolitan status			
MSA[4]	17.2 (2.0)	33.4 (3.0)	28.6 (4.0)
Non-MSA[4]	16.8 (4.7)	27.2 (7.8)	26.0 (7.2)
Hospital ownership			
Voluntary	. . .	30.4 (3.5)	24.1 (3.4)
Government	. . .	26.8 (7.9)	44.4 (13.0)
Proprietary	. . .	43.9 (7.1)	34.1 (7.0)
Hospital affiliation with medical school			
Yes	. . .	36.0 (4.7)	28.4 (4.6)
No	. . .	28.9 (4.5)	28.1 (5.2)
Physician specialty			
Primary care	16.7 (2.6)	. . .	. . .
Surgical	17.0 (2.5)	. . .	. . .
Medical	18.3 (3.6)	. . .	. . .
Age of physician			
Under 50 years	19.5 (2.8)	. . .	. . .
50 years and over	14.9 (2.0)	. . .	. . .
Type of physician practice			
Solo	13.2 (2.5)	. . .	. . .
Single-specialty group	19.4 (3.5)	. . .	. . .
Multi-specialty group	20.1 (3.7)	. . .	. . .
Number of managed care contracts			
None	20.4 (4.5)	. . .	. . .
Under 10	15.6 (2.4)	. . .	. . .
10 or more	17.1 (3.2)	. . .	. . .

. . . Category not applicable.
* Estimate does not meet standard of reliability.
[1]Data reported for 2003.
[2]Average annual data reported for 2001–02.
[3]Differences between physician and hospital total percentages (emergency and outpatient departments) are significant at the $\alpha \leq 0.05$ level.
[4]MSA is metropolitan statistical area.

Table 3. Percent of office-based physicians using computerized prescription order systems (with standard errors) and percent of hospital emergency and outpatient departments with automated drug dispensing systems (with standard errors): United States, 2001–03

Characteristic	Uses CPOE[1]	ADDS[2] available	
	Physician offices	Emergency departments	Outpatient departments
	Percent of physicians[3]	Percent of hospitals[4]	
Total	7.9 (1.5)	39.9 (3.4)	17.9 (2.8)
Region[5]			
Northeast	*7.9 (2.5)	41.9 (5.5)	15.8 (3.6)
Midwest	*9.6 (4.4)	25.6 (5.1)	*14.0 (4.6)
South	*5.4 (2.0)	47.8 (6.5)	16.7 (4.2)
West	9.8 (2.7)	45.3 (7.3)	*33.0 (11.1)
Metropolitan status[5]			
MSA[6]	8.3 (1.6)	53.8 (3.5)	27.9 (3.7)
Non-MSA[6]	4.8 (1.9)	19.0 (4.9)	*1.0 (1.1)
Hospital ownership			
Voluntary	. . .	42.8 (3.2)	17.1 (2.9)
Government	. . .	27.8 (7.9)	*23.6 (7.7)
Proprietary	. . .	48.7 (9.6)	*13.6 (7.8)
Hospital affiliation with medical school[7]			
Yes	. . .	47.7 (5.7)	24.5 (4.6)
No	. . .	36.9 (4.8)	13.2 (3.1)
Physician specialty			
Primary care	10.2 (2.1)	. . .	. . .
Surgical	*5.3 (1.7)	. . .	. . .
Medical	*6.1 (2.1)	. . .	. . .
Age of physician[8]			
Under 50 years	11.0 (2.5)	. . .	. . .
50 years and older	4.8 (1.0)	. . .	. . .
Type of physician practice			
Solo	*4.6 (1.9)	. . .	. . .
Single-specialty group	*7.8 (2.5)	. . .	. . .
Multi-specialty group	14.6 (3.4)	. . .	. . .
Number of managed care contracts			
None	*3.7 (2.3)	. . .	. . .
Under 10	8.4 (2.0)	. . .	. . .
10 or more	8.6 (2.5)	. . .	. . .

. . . Category not applicable.
* Estimate does not meet standard of reliability.
[1]CPOE is computerized prescription order entry.
[2]ADDS is automated drug dispensing systems.
[3]Data reported for 2003.
[4]Average annual data reported for 2001–02.
[5]Chi-square test of association for emergency departments and characteristic is statistically significant at the $\alpha \leq 0.05$ level.
[6]MSA is metropolitan statistical area.
[7]Chi-square test of association for outpatient departments and characteristic is statistically significant at the $\alpha \leq 0.05$ level.
[8]Chi-square test of association for physicians and characteristic is statistically significant at the $\alpha \leq 0.05$ level.

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