Chinese centralised intravenous admixture service (CIVAS), an emerging pharmaceutical industry: survey of the recent advances of CIVAS in China

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ABSTRACT

Purpose To present the results of a survey involving 97 centralised intravenous admixture service (CIVAS) centres in China to review the recent advances of Chinese CIVAS.

Methods 103 CIVAS centres in first- or second-class Chinese hospital settings were surveyed by email questionnaire.

Results Ninety-seven centres responded (response rate 94%). With regard to scale and output issues, large CIVAS centres with a daily output of more than 10 000 bags accounted for 10% while the per workbench and per square metre output varied dramatically among different centres. For personnel structure, 80% of CIVAS centres chose the combination model of pharmacy and nursing. For the CIVAS operation model, more than 80% of centres adopted the drug centralised compounding model.

Conclusion CIVAS centres are playing an important role in Chinese hospital pharmacy and have developed into an emerging pharmaceutical industry. The development of Chinese CIVAS centres is very variable. With regard to the personnel structure, the pharmacy–nursing combination model is recommended, while the operation model should be selected according to specific hospitals. Universal guidelines for CIVAS operation and personnel training are urgently needed.

INTRODUCTION

With the largest population in the world, China is a giant in injectable drugs administration. Since 1991, more than 1000 Chinese CIVAS centres have been established, according to USP Chapter 797, which have dramatically reduced patient morbidity and mortality from contaminated or incorrectly mixed intravenous infusions.^{1–3} However, large numbers of intravenous fluids are compounded in Chinese CIVAS centres, partly due to the large population, which makes it different from CIVAS in other countries. As a result, Chinese CIVAS has developed into an emerging pharmaceutical industry and a sub-discipline in hospital pharmacy science. In spite of the success of CIVAS in China, there are still few reports on the development of Chinese CIVAS.

In this study, CIVAS centres in first- or second-class hospitals in eastern China with a relatively high level of medical care were surveyed. Advances in the scale and output, personnel structure and operation model of the involved centres are analysed and discussed.

METHODS

A total of 103 CIVAS centres were surveyed by email questionnaire or by a visit if necessary.^{4,5} All of the

involved CIVAS centres belong to first- or second-class hospitals (first-class hospitals accounted for 89%) covering 23 provinces (eastern provinces accounted for 73%). Data for January and February 2015 were collected. The scale and output, personnel structure and operation model of the CIVAS centres studied were analysed. To obtain the per square metre output and per workbench output, the relationship between compounding number, workbench number and CIVAS area was analysed. Furthermore, the numbers of intravenous fluids demanded by each patient were estimated based on the daily output of the involved CIVAS centre and the number of hospital staffed beds.

RESULTS AND DISCUSSION

The response rate of the survey was 94% (97 centres responded).

Scale and output

As shown in figure 1, the number of workbenches staffed in each CIVAS centre ranged widely from 1 to 29. One-third of the centres were staffed with 11–15 workbenches. The number of staffed workbenches increased with the area of the CIVAS centre and the staffed beds of the hospital.

Based on the above number of workbenches, dozens to thousands of intravenous fluids were compounded every day. As shown in figure 2, more than 1500 intravenous infusions were compounded per day in about 80% of CIVAS centres. Large centres with a daily compounding load of more than 6500 bags accounted for 10%. The outputs of a few new or partial service centres were relatively low. In total, the daily output of all the Chinese CIVAS centres was more than 333 000 bags.

As shown in figure 3, the per square metre output varied from less than 1 bag to more than 10 bags. More than 30% of CIVAS centres loaded approximately 4–6 bags per square metre. However, 16%

Figure 1 Distribution of staffed workbench numbers.

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Figure 2 Distribution of daily output.

of CIVAS centres loaded less than 1 bag per square metre while 12% loaded more than 10 bags per square metre. In other words, some CIVAS centres had low production with redundant space while others were overloaded. Therefore, the area of a considerable number of CIVAS centres did not match their outputs, which needs to be adjusted.

Currently, the workbenches staffed in Chinese CIVAS centres mainly consist of laminar airflow workbenches (LAFWs) for ordinary drug admixtures and biological safety cabinets (BSCs) for antibiotics and hazardous drugs. As shown in [figure 4](#), the daily output per LAFW ranges from 0 to 1000 bags, with half of the centres ranging from 200 to 600 bags; 30% of the centres loaded less than 200 bags per workbench per day while the other 18% loaded 70% (600 bags) more than the former. The daily output per BSC ranged from 0 to 300 bags, which was much lower than that of LAFWs because the demand for antibiotics and hazardous drugs is lower and the compounding complexity is higher ([figure 5](#)).

As discussed above, both the output per square metre and the output per workbench of the CIVAS centres studied showed considerable variation. However, neither the redundant space nor the overloaded workbenches improved the safe and efficient development of CIVAS centres. Universal standards for the establishment and operation of CIVAS centres are therefore urgently needed.

Furthermore, the demand for intravenous fluids in over 90% of the hospitals studied has dramatically reduced to no more than 4 bags per patient per day. Since control of the irrational use of intravenous drugs is one of the main responsibility of CIVAS centres, the decline of demand for intravenous fluids should be mainly attributed to the efforts of CIVAS centres.

Personnel structure

There were more than 3700 members engaged in the CIVAS centres studied. Generally, the personnel in CIVAS centres were composed of pharmacy staff, nursing staff and handymen with

Figure 3 Distribution of per square meter output.

Figure 4 Distribution of the per LAFW output.

proportions of 52%, 32% and 16%, respectively. With regard to the specific personnel structure, 16% of the CIVAS centres consisted of pharmacy staff only while more than 80% adopted a pharmacy–nursing combination model. Among the combination models, 27% were pharmacy-based (pharmacy staff more than nursing staff) and 21% were nursing-based (pharmacy staff less than nursing staff), while others were equally based (pharmacy staff equal to nursing staff).

Professionally, pharmacy staff have superior knowledge of pharmacology, pharmaceuticals and pharmaceutical chemistry while nursing staff are more professional in aseptic techniques and more familiar with the clinic routine. Thus, the combination model is recommended for its integrity of pharmaceutical knowledge and compounding techniques, ensuring the safe and efficient operation of CIVAS centres.

Operation model

The core operation procedures in Chinese CIVAS centres are commonly composed of prescription reviewing, batch arrangement, drug dispensing, labelling, admixture, checking, packaging and transportation. However, several kinds of different operation models have been developed and optimised to achieve the high compounding target, eliminate compounding errors and improve the infusion quality.

As shown in [figure 6](#), the operation models of Chinese CIVAS can be mainly divided into a 'one order one basket' model and a drug centralised model. For the 'one order one basket' model, compounding is operated on an 'order by order' basis and both the drug and the infusion solution belonging to the same prescription order are dispensed in the same small basket ([figure 7A](#)). On the other hand, for the drug centralised compounding model, which is used by 81% of the centres studied, orders including the same drug are centralised and compounded on the same LAFW or BSC. Furthermore, the centralised model can be divided into one ward centralised (orders including the same drugs in the same ward are centralised), partial ward centralised and whole

Figure 5 Distribution of the per BSC output.

Figure 6 Distribution of the operation models.

ward centralised models according to the extent of centralisation. Among the above models, the whole ward drug centralised compounding model is the most popular, being adopted by more than 60% of the CIVAS centres studied.

The advantages and disadvantages of the 'one order one basket' model and the drug centralised model are compared in table 1. For the 'one order one basket' model, all related procedures including dispensing, labelling, admixture and checking are operated basket by basket. Consequently, large numbers of small baskets are piled up, occupying much space and leading to unavoidable drug breakage (figure 7B). The biggest problem is that almost all movements have to be repeated numerous times, which is rather labour intensive and time consuming. However, a relatively lower level of personnel quality and management and a shorter training period are required in the 'one order one basket' model.

On the other hand, for the drug centralised model all the procedures including dispensing, labelling, admixture and checking are centralised and practised according to the drug category. All the same drugs are one-time dispensed in one common big box while the appropriate infusion solutions are labelled together and collected in one common big basket (figure 7C and D). Moreover, drugs belonging to the same category are centralised and mixed on the same workbench. Consequently, all of the scattered movements in 'one order one basket' procedures are gathered into one-time movement, avoiding any repetitive labour and resulting in higher efficiency.

Taking the largest Chinese CIVAS centre as an example, 13 000 infusions are compounded by 52 members every day under the drug centralised model while 32 members could hardly achieve 2000 bags under the preliminary 'one order one basket' model. In addition, a large amount of space has been released as thousands of small baskets are replaced by several big baskets and boxes, resulting in a lower breakage rate. Furthermore, from the economic and ecological point of view, both the syringes

Figure 7 Baskets and boxes of different compounding models. (A, B) Baskets of the 'one order one basket' model. (C, D) Baskets and boxes of the drug centralised model.

and drugs can be reasonably shared under the drug centralised model.^{6,7} Nevertheless, a relatively high level of management and personnel quality are required for this drug centralised operation model so a long training period is needed.

CONCLUSIONS AND PROSPECTS

CIVAS is playing an important role in the Chinese hospital pharmaceutical service. To some extent, the large demand for intravenous fluids in China has prompted the Chinese CIVAS to develop into an emerging pharmaceutical industry. The total output of all the Chinese CIVAS centres has reached more than 120 million bags per year, which amounts to that of a large domestic pharmaceutical factory. Furthermore, more than 3700 persons are now engaged in CIVAS, which is equivalent to that of a medium-sized domestic pharmaceutical factory. With regard to profit, the CIVAS consumptive materials fee has always been an important part of the hospital pharmacy revenue. Besides, a universal charge for compounding is on the way after the implementation of drug zero-profit policy in hospitals. There is no doubt that profit generated from CIVAS will be a more considerable source of hospital pharmacy income.

As an emerging service, the development of Chinese CIVAS centres shows a high level of diversity, especially in scale and output, with relatively unbalanced development. Most of the imbalance can be attributed to the lack of official CIVAS administration rules. With regard to the personnel structure, the pharmacy–nursing combination model is recommended. The choice of operation model will vary in different centres, but the efficient drug centralised model is recommended for centres with a heavy compounding load.

From the point of view of the development of an emerging industry, universal guidelines for CIVAS design and operation and a standardised personnel training programme are urgently required for the establishment and development of CIVAS centres.

Table 1 Comparison of the advantages and disadvantages of the 'one order one basket' model and the drug centralised compounding model

Items	'One order one basket' model	Drug centralised model
Repetitive movements	More	Less
Baskets	More	Less
Space occupation	More	Less
Consumptive material	More	Less
Efficiency	Lower	Higher
Breakage rate	Higher	Lower
Training period	Shorter	Longer
Personnel quality requirement	Lower	Higher

Key messages

What is already known on this subject?

- ▶ More than 1000 CIVAS centres have been established in China since 1991.
- ▶ Large numbers of intravenous infusions are required in China, which makes the Chinese CIVAS special.
- ▶ However, reports on the current status of Chinese CIVAS are still lacking.

What this paper adds?

- ▶ The results of this study provide basic information about the scale and output, personnel structure and operation model of CIVAS centres in China.
- ▶ Chinese CIVAS has developed into a considerable part of hospital pharmacy with some diverse development phenomena which urgently require universal guidelines.

Contributor XL: design of ideas and the program. WM: conducting the survey and writing the manuscript. LL and YZ: helped with conducting the survey and data analysis. PM and PY: data analysis.

Competing interests None to be declared.

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