Abstract

Objective
To eliminate the risks in the prescription examination, marking, dispensing, checking, and review of non-integral-dosage drugs in PIVAS.

Method
A project team was assembled, and the failure mode and effect analysis management method was used to identify the risks present in the four steps of the non-integral-dosage drug dispensing process in PIVAS drug management: prescription verification, mixed allocation and verification. The degrees of severity, incidence, and detectability were scored for each step, and the risk priority number (RPN) of each step was calculated. Corresponding measures for improvement were formulated for the steps with top RPN ranking, and the changes in the RPN values before and after the implementation of the measures were compared to observe the effect of the implementation.

Results
A total of 31 risk factors were tabulated in the management process of non-integral-dosage drugs, with the primary risks involving the dispensing process. Corresponding measures were provided for 8 risks containing high RPN values. After three months of optimization and improvement, the RPN values and incidences of internal difference were significantly reduced, with the improvement measures exhibiting a good risk control effect. In this project, a comprehensive conversion system of partial-dose drug dispensing was established, which could be directly converted into a volume of suction fluid for dispensing personnel according to doctor orders, avoiding manual secondary calculation. Meanwhile, the project team conducted a dissolution test of 23 types of drugs with non-integral dosage drugs and found that the solvent volume of 11 types of drugs increased after dissolution. The dosage conversion of partial dosage should be calculated according to the volume of the final solution to ensure the accuracy of the dosage.

Conclusions
Based on failure mode and effect analysis, the risk management of non-integral-dosage drugs was carried out in PIVAS, addressing the safety risks present in the dispensing of non-integral-dosage drugs, reducing errors in the dispensing of non-integral-dosage drugs, and ensuring safe and precise medication for patients.

1 Introduction
Pharmacy intravenous admixture service (PIVAS) is a professional and technical service that provides an intravenous medicine-dispensing service for patients in medical institutions [1]. PIVAS provides high-quality, finished infusion that can be directly injected intravenously. PIVAS also provides pharmaceutical services, such as the review and implementation of prescription orders for intravenous medication and drug addiction and the evaluation of intravenous infusion use [2]. In recent years, remarkable progress has been made in the centralized distribution of intravenous drugs, avoiding the contamination of intravenous drugs to a large extent and ensuring the safety of medication for patients [3]. With the rapid development of clinical individualized precision therapy [4], an increasing amount of intravenous drug therapy has involved the dispensing of appropriate doses according to individual patient signs (e.g., body weight, body surface area, examination indicators, and degree of disease progression). Such doses involve drugs such as anti-tumor drugs, pediatric drugs, drugs for the elderly, and parenteral nutrition [5–8], and the specifications of intravenous drugs are fixed and uniform. Consequently, a large amount of drugs of non-integral doses are dispensed in PIVAS; non-integral (bottle) dosage of intravenous drugs refers to the amount of infusion in clinical use, whereby the entire bag of intravenous drug is not used or the amount of drug added is not the entire bottle available [9]. In the daily operation of PIVAS, we have found that there were various risks involved in the process of prescription examination, signature printing,
checking, dispensing, reviewing of the finished product, and other tasks involved in the distribution of non-integral-dosage drugs, requiring attention.

Risk management is a process that attempts to control risks in advance and minimize risks before they cause adverse consequences [10]. Failure mode and effect analysis (FMEA) is a forward-looking management model, which identifies and prevents problems before action is necessary [11]. FMEA consists of failure mode (FM) and effect analysis (EA). FM refers to the safety hazards that can be observed and prioritized according to the severity of their results, frequency of occurrence, and ease of detection. EA refers to the analysis of the impact of FM on the safety and function of the system, and the proposal of preventive reconstruction measures that can be pursued to reduce defects and improve quality [12]. At present, many medical institutions have applied FMEA to medical risk management, nursing risk management, and medical device safety management, among others [13–16]. In recent years, the application of FMEA in the prevention of medication errors and the risk assessment and management of unreasonable medical orders has been reported [17–19]; however, few studies have reported the use of risk management in the dispensing of non-integral-dosage drugs in PIVAS.

PIVAS has been in operation in our hospital for 12 years, since 2010, with a total of more than 10 million bags of finished infusion deployed. At present, 5000–6000 bags of intravenous infusion are deployed daily. Statistics show that approximately 49% of intravenous drug varieties and 7% of the total number of bags are involved in the allocation of drugs with non-integral doses. Meanwhile, error statistics show that errors involving various aspects of non-integral dose dispensing account for 20% of the total incidence of internal error. Based on this, to reduce the risk of errors in the dispensing of non-integral-dosage drugs in PIVAS, our hospital has used FMEA to perform the identification and assessment of risk, response to risk, and monitoring of the entire process of non-integral-dosage drug allocation. After three months, the risk of errors in non-integral-dosage drug dispensation in PIVAS was effectively reduced, as reported below.

2 Data and methods

2.1 Research Methods

The FMEA method mainly involves assembling a project team, determining and analyzing the FM of each aspect of the process, evaluating the FM severity (S), incidence (O), and detection degree (D) of each aspect, and calculating the FM risk priority number (RPN). RPN is equal to the product of the S, O, and D scores (RPN = S × O × D). The RPN value is the dominant quantization value of FM. A higher RPN value is associated with greater security risk. For the FM listed, the RPN value determines whether intervention is necessary and the severity of that intervention. FM with a high RPN value is in urgent need of timely improvement measures; prevention and improvement measures should be formulated, the implementation of such measures should be tracked, intervention effects should be evaluated regularly, and the scoring of the FM should be continuously updated [20].

2.2 Building a Team

After the aim was determined, the project team was assembled. The project team was composed of personnel involved in the partial-drug dispensing process, including 11 drug management pharmacists, prescription examiners, and pharmacists responsible for dispensing, mixing, and checking dosage (see Table 1). Project members received FMEA knowledge training before carrying out the project to ensure that they are familiar with the risk management organization process, master the FMEA method, and can jointly complete the series of planning tasks of process analysis and FMEA management.
Table 1
Statistical table of project team members

<table>
<thead>
<tr>
<th>category</th>
<th>total</th>
<th>major</th>
<th>Professional title</th>
<th>Job post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmacist/nurse</td>
<td>11</td>
<td>10/1</td>
<td>Advanced/intermediate/elementary</td>
<td>Prescription Drug management Dispense medicine Drug dispensing check</td>
</tr>
<tr>
<td>quantity</td>
<td>11</td>
<td>10/1</td>
<td>1/4/6</td>
<td>3</td>
</tr>
</tbody>
</table>

2.3 Risk identification and analysis

The project team members sorted out the areas of risk in non-integral-dosage drug management in the four aspects of PIVAS drug management, prescription labeling, mixing, and verification. Among them, eight instances of risk were identified in the three links of drug management, prescription labeling and mixed deployment, and seven instances of risk were identified in the verification process; in total, 31 risk factors were recognized (see Fig. 1).

2.3 Risk assessment

In view of the personnel, equipment, environment, and other factors that occurred at each instance of risk, the cause was found, and the possible consequences were analyzed. Quantitative standards were set for the severity of consequences, risk incidence, and degree of detection. The score range of S, O, and D for this project was 1–5 points (Table 2), and the RPN value range was 1–125. The project team members scored the S, O, and D of each of the 31 FM, calculated the average S, O, and D values for each FM, and multiplied the average values to obtain the RPN of the FM. FM with RPN values below 10 were considered as having acceptable risk, FM with values between 10 and 25 were low risk, and FM with RPN values above 25 were considered in urgent need of control. In this study, FM with RPN values > 25 were given priority for improvement.

Table 2
Scoring standards of risk points S, O and D of non-whole dose drug allocation

<table>
<thead>
<tr>
<th>Score</th>
<th>Severity(S)</th>
<th>Occurrence(O)</th>
<th>Detectability(D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No impact: No impact on patients</td>
<td>Every 1–3 years</td>
<td>Very easy to detect</td>
</tr>
<tr>
<td>2</td>
<td>Mild effects: May cause minor injury to the patient</td>
<td>Once a year</td>
<td>Easy to detect</td>
</tr>
<tr>
<td>3</td>
<td>Moderate impact: May cause injury to patients and prolong hospital stay</td>
<td>Several times a year</td>
<td>Mildly difficult to detect</td>
</tr>
<tr>
<td>4</td>
<td>Serious effects: May cause serious injury to the patient, including permanent or significant organ damage</td>
<td>Several times a month</td>
<td>Difficult to detect</td>
</tr>
<tr>
<td>5</td>
<td>Extreme impact: may lead to patient death or fatal injury</td>
<td>Several times a week</td>
<td>Impossible to detect</td>
</tr>
</tbody>
</table>

2.4 Risk Countermeasures

For FM that have been determined to be in need of priority improvement, project team members performed brainstorming, working out the best improvement measures, and then actively organized and implemented them. In the implementation process, all PIVAS staff participated in improving the scheme and clarifying their respective responsibilities, whereas FMEA project members were responsible for monitoring and tracking the implementation effect of the scheme.
2.5 Evaluation of intervention effect

The FM before intervention and that three months after intervention were evaluated. Project team members evaluated the projects that needed to be improved first after intervention and compared the S, O, and D scores and RPN values of each FM before and after intervention.

2.6 Statistical Methods

SPSS 22.0 software was used for the statistical analysis of the data before and after intervention, and a paired sample T-test was used to analyze the measurement data (P < 0.05 was considered statistically significant).

3 Results

3.1 Risk point assessment results

The distribution of S, O, and D and the RPN values of 31 risk factors scored by the project team members is shown in Fig. 2. It can be seen from the figure that compared with the other three steps, the risk in the drug mixing process in the warehouse resulted in the highest severity (median of 3.23), highest incidence (median of 3.43), highest undetectable risk (mean median of 3.65), and highest RPN value (median of 40.43). It can be seen that the main risk of non-integral-dosage drugs lies in the process of drug dispensing, and this is where the greatest focus should be placed.

3.2 Score changes before and after the implementation of measures

Members of the project team formulated corresponding rectification measures for eight FM items whose RPN value was above 25, and a comparison of the S, O, D, and RPN values before and after the implementation of the measures is shown in Table 3. By comparing the RPN values before and after the implementation of the measures, it was found that the RPN values of eight FM items decreased significantly after the implementation of the measures (P < 0.05), which was statistically significant. After the measures were implemented, the RPN were all lower than 15, indicating that the risk level was reduced to low. Meanwhile, the number of internal differences related to the dispensing of non-integral dosages of drugs decreased from two case per month before implementation to zero cases per month after implementation. The reduction of the RPN value and internal differences indicates that the improvement measures had a significant risk control effect.
Table 3
Statistical table of S, O, D and RPN values of non-integral drug dispensing risk points before and after the implementation of measures

<table>
<thead>
<tr>
<th>FM</th>
<th>S</th>
<th>O</th>
<th>D</th>
<th>RPN</th>
<th>Risk reduction measure</th>
<th>S</th>
<th>O</th>
<th>D</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dose unit of non-whole drug in prescription is not uniform, leading to the conversion error of dispensing personnel</td>
<td>3.7</td>
<td>3.5</td>
<td>3.3</td>
<td>43.2</td>
<td>Using the operating system, the prescription unit is converted into a unified unit.</td>
<td>2.5</td>
<td>1.9</td>
<td>2.2</td>
<td>10.5</td>
</tr>
<tr>
<td>For pediatric drugs with small doses, incomplete syringe specifications lead to inaccurate dose suction of partial drugs</td>
<td>3</td>
<td>3.5</td>
<td>4.4</td>
<td>46.4</td>
<td>According to the minimum dose unit, specify the syringe selection specifications; At the same time add small size syringe</td>
<td>1.9</td>
<td>2.4</td>
<td>2.2</td>
<td>10.0</td>
</tr>
<tr>
<td>As non-whole medicines are checked in the dispensing warehouse, if dispensing errors occur, the finished products cannot be found in the checking process</td>
<td>3.8</td>
<td>3.4</td>
<td>4</td>
<td>51.4</td>
<td>Strengthen the awareness and process training of non-integral check; Strengthen supervision and management on a daily basis</td>
<td>2.6</td>
<td>2.1</td>
<td>2.4</td>
<td>13.1</td>
</tr>
<tr>
<td>In the process of dispensing, the residual liquid of non-whole drug is easy to pollute the dispensing environment and increase the risk of occupational exposure</td>
<td>2.5</td>
<td>3.4</td>
<td>3.5</td>
<td>30.4</td>
<td>The remaining liquid medicine shall be independently sealed in small packaging</td>
<td>2.5</td>
<td>1.7</td>
<td>1.7</td>
<td>7.2</td>
</tr>
<tr>
<td>Partial dose conversion is calculated by the calculators in the warehouse, which is prone to error</td>
<td>3.5</td>
<td>3.4</td>
<td>3.7</td>
<td>43.3</td>
<td>The dose calculation formula is directly input into the system, and the unit suction dose is directly calculated by the system, avoiding manual calculation.</td>
<td>1.9</td>
<td>1.5</td>
<td>1.6</td>
<td>4.6</td>
</tr>
<tr>
<td>If the residual liquid after the dispensing of non-whole drugs is used again, it is easy to be contaminated by alcohol disinfection</td>
<td>3.1</td>
<td>3.0</td>
<td>3.9</td>
<td>36.2</td>
<td>The remaining partial liquid should be placed at the clean air outlet of the dispensing table to avoid pollution.</td>
<td>2.3</td>
<td>1.9</td>
<td>2.1</td>
<td>9.2</td>
</tr>
<tr>
<td>Many anti-tumor drugs have special dispensing methods, and the dispensing staff cannot completely remember the operation methods of each drug, and the dispensing is not carried out according to the drug instructions, resulting in unqualified infusion quality of finished products after the dispensing.</td>
<td>3.1</td>
<td>3.7</td>
<td>3.2</td>
<td>36.7</td>
<td>Sort out the drug list of special dispensing method, input the dispensing method in the drug instructions into the magnetic strip, and display it on the dispensing table screen for reference when dispensing personnel operate.</td>
<td>1.9</td>
<td>2.2</td>
<td>2.1</td>
<td>8.8</td>
</tr>
<tr>
<td>The volume of concentrated solution after dissolution is different from the injected volume of some powder injection form, which leads to the deviation of dosage calculation</td>
<td>3.3</td>
<td>2.6</td>
<td>3.1</td>
<td>26.6</td>
<td>The dissolution test of powder injection was carried out to obtain the optimal dissolution dose of each drug and the volume of concentrated solution, and the dose of non-whole dose was calculated according to the volume of concentrated solution.</td>
<td>2.3</td>
<td>1.6</td>
<td>1.7</td>
<td>6.3</td>
</tr>
</tbody>
</table>

3.3 Set up the automatic dose calculation program
In view of the risk factor that "mistakes were easy to make in the conversion of non-integral dosage when calculated by the calculator used by the dispatcher in the warehouse," the project team communicated and coordinated with the information system engineer, implemented the calculation formula into the system, and confirmed that the system directly calculated the volume to be pumped according to the drug dose of the patient. Both water-injection form and powder-injection form were considered in the calculation formula. For the water injection form, the drug concentration was calculated according to drug specifications, and the volume of liquid to be aspirated was calculated according to the following formula: volume = mass/concentration. For the powder-injection dosage form, the dosage of each drug solubilization agent was pre-set according to drug instructions and/or the volume of the bottle. The concentration of the concentrated solution was calculated according to the formula of concentration = mass/volume; then, the final suction volume was calculated according to the clinical drug dosage. The calculated results of each drug were displayed on the screen of the dispensing table, and the corresponding solvent volume and concentrated solution volume were pumped according to the set solvent volume and calculated results (Fig. 3) by the dispensing staff to complete the dispensing of the non-integral-dosage drug. This was done to avoid the error risk caused by the manual calculation of the suction dose of non-integral-dosage drugs in the warehouse.

3.4 The dissolution test of powder injection was carried out

In view of the risk factor of "the volume of concentrated solution after the dissolution of some powder injection was different from that of the injected volume, leading to a deviation in the dosage calculation," the project team conducted solvent dissolution tests on 23 types of sterile powder for injection commonly used in the clinical use of non-integral dosage, among which 12 types of drugs had no change in solvent volume after dissolution. Solvent volume increased after the dissolution of 11 drugs (Table 4). For drugs that do not change before or after dissolution, the concentration of the concentrated solution can be calculated by the solvent volume in the conversion of partial dose; then, the volume requiring aspiration can be calculated according to the dose ordered by the doctor. For drugs with increased solvent volume after dissolution, the volume of the dissolved concentrated solution is used to calculate the concentration of the concentrated solution in the conversion of the partial dose. Afterwards, the volume to be aspirated is calculated according to the dosage ordered by the doctor. For example with fosfomycin sodium for injection, the size was 2 g. During the preparation, 4 ml sterilizing water was injected, and the concentrated solution was changed to 5 ml, with a final concentrated solution concentration of 0.4 g/ml. If the prescribed dosage was 0.5 g, the volume of the concentrated solution that should be pumped was 1.25 ml.
4 Discussion

4.1 Dissolution test of powder-injection form

During the development of the project, we found that the volume of concentrated solution after the dissolution of some powder-injection form was different from that of the injected volume, which may lead to a deviation in the dosage calculation. According to the principle of substance dissolution [21], after the solution dissolves substances, the volume of the solution may change, and
there is space between the molecules in the solvent. If the solute particles are completely dissolved in the space of the solvent, the volume of the solvent will not change after the solute dissolve. If the void size of the solvent is not sufficiently large to accommodate the solute particles, the distance between the solvent molecules will increase, resulting in an increase in the volume of the solution (Fig. 4). For drugs whose volume does not change before or after dissolution, when calculating the suction dose of non-integral-dosage drugs, the solvent volume can be directly used to calculate the solution concentration; then, the suction volume can be calculated according to the dosage prescribed by the doctor. For drugs with increased volume after dissolution, the solution concentration should be calculated according to the volume of dissolved solution, followed by the calculation of the suction volume according to the doctor's ordered dose. The volume of the solvent cannot be uniformly calculated, and the dosage and volume should be converted according to the results of the dissolution test. Particularly for drugs used by newborns, the clinical dosage is very small, and there can be no mistake. However, for the whole dosage of sterile powder for injection, there is no need to consider such a problem, because after the entire amount of drug is dissolved, no matter whether the volume of the solvent is increased or not, the dispenser needs to pump the concentrated solution clean and inject it into the large infusion to complete the dispensing of the entire drug. Therefore, the influence of the solvent volume change on dose calculation should be considered in the dose conversion of non-integral-dosage drugs.

4.2 Risk point analysis

From the distribution of S, O, D, and RPN values of risk factors, it can be seen that the risk caused by the in-warehouse dispensing of drugs was the most severe, with the highest incidence, highest undetectable degree of risk, and highest RPN value. It can be inferred that the main risk of non-integral-dosage drugs in PIVAS involved the mixing process. This process included the dose calculation, solution suction, dose review, syringe size selection, drug combination, and other processes involved in the management of non-integral-dosage drugs, each of which may lead to dispensing errors, resulting in major drug safety accidents [22]. Therefore, attention should be paid to the risk control of non-integral-dosage drug dispensing in the warehouse.

4.3 There are risks in the conversion of non-integral dosage of drugs

At present, the dose conversion of most of the non-integral-dosage of PIVAS in China is calculated on the spot by the dispensing personnel in the warehouse [23], involving large security risks: (1) When the pharmacist mixes the liquid in the warehouse, it is with a fast rhythm. Meanwhile, owing to the biosafety cabinet/horizontal laminar flow table and operation of the fan and air conditioning system in the warehouse, the pharmacist is in a state of mental tension and anxiety. If complicated dose conversion is carried out, conversion error can easily result. (2) The non-integral-dose conversion method lacks consistency and simplicity, especially for sterile powder dosage for injection; dispensing personnel do not fix the volume of solvent uniformly, with all choosing the solvent volume according to their own dispensing habits, such that it is easy to make mistakes in the conversion process. (3) Without considering the effect that the volume of the concentrated solution is not necessarily equal to that of the dissolved solvent, which is directly used to calculate the concentration of the concentrated solution, leading to inaccurate suction doses. In particular, the dosage of a newborn is one-tenth that of an adult. If there is any error in the drug dose conversion, serious or even life-threatening consequences to the patient may occur [24]. (4) The adjacent dispenser is responsible for checking the partial batch of drugs after dispensing. Once a dose calculation error occurs, the pharmacist and clinical nurse outside the warehouse cannot find the error, making the safety risk greater than that of the whole batch of drugs. (5) In the process of dosage conversion, the calculation of powder-injection dosage form require two or more steps; the results of the first step cannot be recorded when the calculation is performed by the dispenser, which leads to errors in the calculation process. Meanwhile, the cross-contamination of the dispensing can result from the back-and-forth transmission between the calculators, bringing safety risks to the infection control of the finished infusion. The automatic conversion system developed and designed in this project can be directly converted into the volume of suction fluid for dispensing personnel according to the prescribed dose, avoiding manual secondary calculation while promoting the homogenization, standardization, and automation of the dispensing of partial doses in PIVAS. This avoids the error of measurement conversion in the allocation of partial doses and ensures the safety and precision of medication for patients. It has good practical value.
4.4 Method of dispensing antitumor drugs with partial dose

There were many anti-tumor drugs involved in partial-dose drug varieties, and the dispensing methods of anti-tumor drugs were complicated [25], especially monoclonal drugs. The dispensing methods needed to be strictly followed, requiring the mastery of such methods by the dispensing personnel to ensure accurate drug deployment. However, in reality, it was difficult for pharmacists or nurses to completely remember all drug dispensing methods. Therefore, project team members input each non-integral-dosage drug dispensing method into the system and linked it with a drug magnetic stripe. When the drug was dispensed by the dispensing personnel, the dispensing method of the drug was displayed on the screen for reference, guaranteeing that the dispensing personnel is in complete accordance with the dispensing method of the drug to ensure the dispensing quality.

In recent years, with the rapid development of clinical individualized precision therapy, more intravenous drug therapy has involved the dispensing of appropriate doses according to individual patient signs, and more types and bags of drugs have been deployed in PIVAS with non-integral dosage. There are various safety risks throughout the entire process of drug dispensing with non-integral dosage. Therefore, it is necessary to perform risk management of non-integral-dosage drugs based on FMEA. This project identified 31 risk factors in the entire process of handling non-integral-dosage drugs, with the main risks involving the dispensing process, requiring extra attention. Corresponding measures for improvement were implemented for eight risks with high RPN value. After three months of optimization and improvement, the RPN value and incidence of internal differences were significantly reduced, demonstrating that the improvement measures had a significant risk control effect. In this project, a comprehensive conversion system of non-integral-dose drug dispensing was established, which could facilitate the direct conversion into the volume of suction fluid for dispensing personnel according to doctor orders, avoiding manual secondary calculation and making the dispensing of non-integral-dose drugs in PIVAS homogenized, standardized, and automated. Meanwhile, the project team conducted dissolution tests on 23 types of non-integral-dose drugs and found that the solvent volume of 11 types of drugs increased after dissolution. The dose conversion of non-integral-dose drugs should be calculated according to the volume of the final solution to ensure the dose accuracy. In conclusion, the risk management of non-integral-dose drugs in PIVAS based on FMEA mitigates the safety risks in the dispensing of non-integral-dose drugs, avoiding errors in the dispensing of such drugs and ensuring safe and precise medication for patients.

Declarations

Ethics approval and consent to participate This study is the risk management of non-integral-dosage drug dispensing and does not involve ethical approval and patient awareness.

Consent for publication Not applicable.

Availability of data and material All data generated during this study are included in this published article.

Competing interests The authors declare that they have no conflict of interest. All participants agreed to publish identifiable information/images in an open access journal.

Authors’ contributions All authors contributed to the study conception and design; K Geng designed the subject and wrote the manuscript, prepared figure 1,2,3,4 and prepared table 3; J He conducted risk assessment; S Rong counted the variety of non-integral-dosage drugs, prepared table 2 and 4; Z Jia and X Zhang carried out the drug dissolution tests, prepared table 1; T Shi contributed to the review of the data and quality control. All authors read and approved the final manuscript.

Funding This research was supported by the Pharmaceutical Research Exploration Fund of the First Affiliated Hospital of University of Science and Technology of China, number: YJKJJ04.

Data availability All data generated during this study are included in this published article.

Code availability Not applicable.

Acknowledgements Other participants in this study were Jin-ning Wang, Zhou Liu, Wan-zhen Zhu, Xue-cui Xu, Chen Li, Li-fang Chen, The authors are grateful to all participants.
References


Figures

Figure 1

Distribution of risk points in PIVAS with partial dosage
Figure 2

Distribution of S, O, D and RPN values at 31 risk points of non-integral drug

Figure 3

Conversion results of non-whole dose drugs

(water injection form on the left, powder injection form on the right)
Figure 4

Schematic diagram of drug dissolution test