4) Performing HAZOP study

HAZOP study is performed by concentrating on a specific point, a specific section, or a specific operation stage of process called "a node (a study node)." The range of a process targeted by one study may determine according to experience of a team leader. It evaluates individual line or vessel most ordinarily. If the team leader of HAZOP study is well experienced, two or more lines in one node could be included.

HAZOP team investigates each node and specifies condition deviation of the process which may lead to disaster. The intention of the design is checked in order to clarify the purpose and process parameter of apparatus first. It is determined by comparison and contrast of keywords a deviation and main process parameters whether the process has deviated from ordinary conditions. The key for a successful HAZOP study depend on effective use of keywords. Therefore, keywords should be defined clearly to put it into practice and its usage among all the team members.

a) Process keywords (Primary keywords)

The keyword mentioned here is related to operation situation of design intention of process or object plant. The main process-related terms are listed below, and the following list is an object for reference to the last. According to the target plant, keywords should be decided to use by evaluation (Table 2.3).

For example, probably some members think it unreasonable that "corrosion" becomes a keyword in a design phase, since corrosion of unexpected site should not be intended at the time of plant planning. Although almost all plants are designed bearing in mind a certain amount of lifespan, and unintentional corrosion must not be tacitly generated in a designed intention, it is assumed that occurrence probability must not exceed a fixed level. Therefore, when a corrosion rate of incidence goes up under a certain situation, it will be called a deviation from the design intention.

Table 2.3 Process Keywords (First Group)

Flow	Temperature	Pressure
Level	Isolation (settle, filter, centrifuge)	Composition
Reaction	Mix	Attenuation (grind, crush)
Absorbance	Corrosion	Erosion

Considering that a word "operability" is contained in HAZOP, the necessity of adding the operation-related term to the above-mentioned keyword will come out.

The keyword of the second group is overlooked and considered not to be so important (Table 2.4). As a results, for example, a plant operator will take a thoughtless procedure which may lead to disaster, since the safe interception method is not directed, in order to perform repair, peripheral equipment is temporarily made into off-line. Moreover, since the manual release procedure of the safeguard is not directed, it can be judged during a test run that a plant cannot be operated.

Table 2.4 Process Keywords (Second Group)

Isolation	Drainage	Ventilation
Purge	Inspection	Maintenance
Start-up	Shutdown	

b) HAZOP Guidewords (Secondary keywords)

We can point out a possibility of deviations and problems combining the primary and secondary keywords listed blow (Table 2.5).

In HAZOP study, overt and covert problems become clear by combining keywords and guidewords systemically. More concretely, combination of process keywords and HAZOP guidewords are performed.

Tabe 2.5 HAZOP Guidewords

Keyword	Meaning
No / None	Not achieved (example: flow/no), not done (example: isolation/none)
Less	Decrease (example: pressure/decrease)
More	Increase (example: temperature/increase)
Reverse	Opposite event happens (example: flow/reverse)
As well as	Achieved but other event happens (example: flow/association of pollution of the flow)
Other than	Unexpected event happens (example: flow/leak at unexpected area, composition/unexpected mixed ratio of materials)
Fluctuation	Achieved only temporally with fluctuation (example: flow/air rock in the pipeline)
Early	Early in timing or out of order
Late	Opposite to early

Although it seems that the scenario of disaster cannot usually be considered, explosion and the fire accident of the large-scale tank have occurred on the jet fuel accumulation base in Britain in December, 2005 (http://news.bbc.co.uk/2/hi/uk_news/4520430.stm). It is supposed that neither safeguards which should function essentially, nor measures worked. This accident taught us the following lesson: even if there are already the safeguard and the measure, we cannot ensure true safety without checking its functions correctly.

Analysis and evaluation procedure of HAZOP can be applied as flows, such as, a flow of thinking, and a flow of action, to an inquiry and evaluation of the risk of various fields by thinking as a process (Figure 2.1).

B) Medical HAZOP

The Japanese Medical Safety-Measures Review Committee submitted "medical safe promotion package of measures" in 2002 and stated as follows:
Reservation of medical safety has so far been performed in the responsibility of the individual medical doctor. For this reason, medical treatment is characteristic to be offered individually under a medical worker's technical knowledge and technology to the patient who has a different condition.

However, reservation of the medical safety of the system which was based on efforts of an individual medical staff, the system based on the medical technology and the knowledge for every conventional occupational description or specialty, is becoming difficult against the background of an advancement, complication of medical treatment in recent years, and it is necessary to improve the state of safety measures.

Medical service today is not supplied by individual doctor but by the system which consists of human resorce (multidisciplinary staff), things (medicine and medical instruments), organization (hospitals), and software. Even if anyone of these are unsuitable, service is not provided appropriately. For example, when medical treatment is offered by a team which consists of many occupational descriptions, if the rule in a team is inadequate or if there is not sufficient communication, it may develop into a medical accident. Therefore, it is a challenge

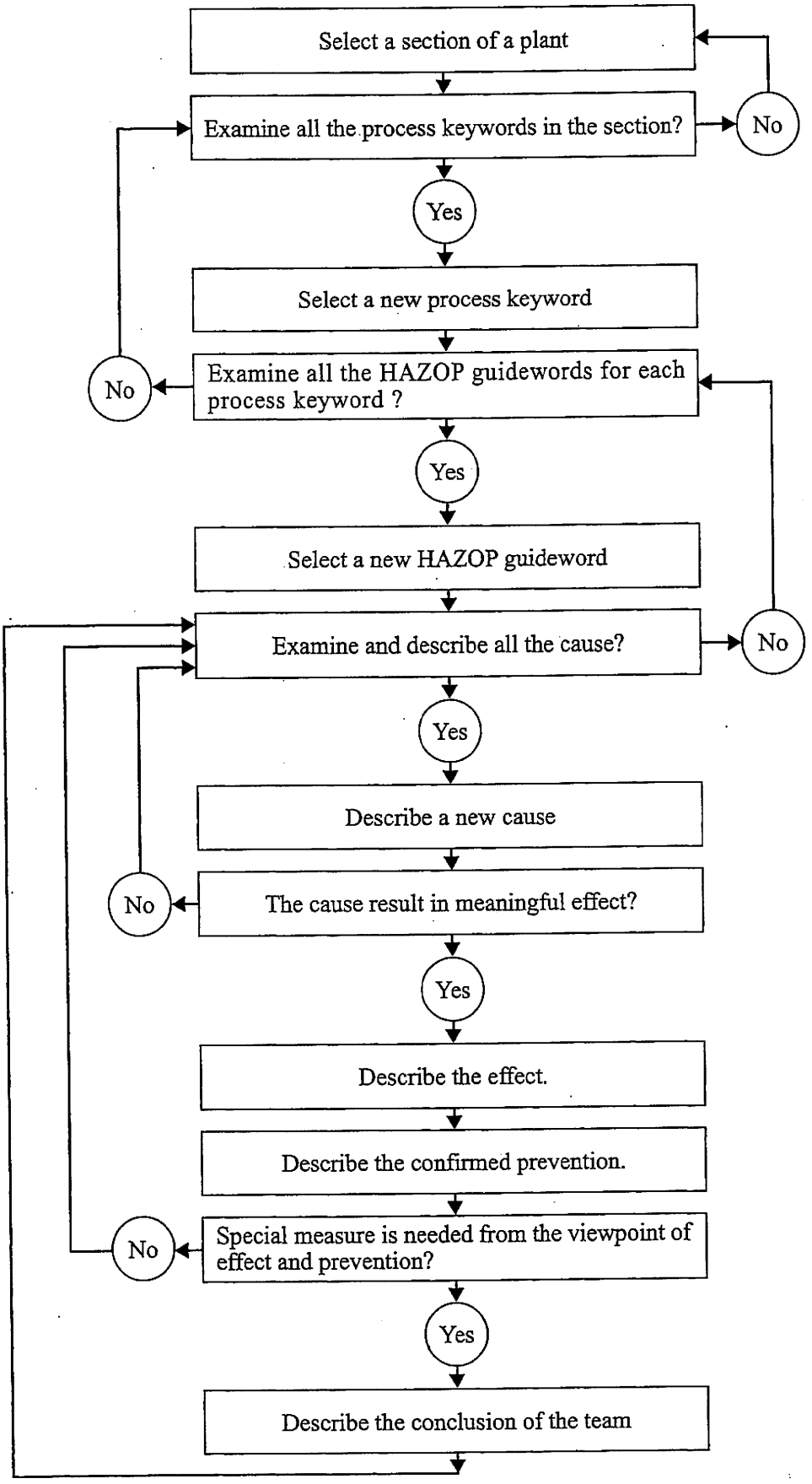

Figure 2.1 HAZOP Flow Chart

how the whole system perform safety in medicine, and how the quality of each element will be achieved.

In other industries, safety measures are already accepted with system-wide problem, and there are many examples under the advanced scientific technique. For instance, the improvement in the safety system by fail-safe (the system that does not result in disaster even if there is an error) or by fail-proof (error-proof, the system in which an error did not happen easily) is adopted in the manufacture industry in the technique of quality control of the product , in the nuclear industry, and in the airplane industry.

Although the system in other industries is not necessarily utilizable for medical area as it is, there are many points which should be considered as reference, such as having taken the systematic measure on condition of the thing which was a thin concept, and "for which people commit an error", and they need to take in such a technique at the medical spot from now on until now as positively as possible.

In addition, it is indispensable that all the related organizations are in agreement with each role assignment under cooperation, and tackle taking advantage of the position and capability while the medical institution which is the spot implements such a measure, respectively.

We tried application to analysis of dysphagia paying attention to the hazard operability study (HAZOP) technique in which it is used in the manufacture industry based on this measure from April, 2004.

1) Safety management system

The accident of each industry which occurred recently (outbreak of food poisoning in the food industry, death of the patient by malpractice in the medical industry, criticality accident in the nuclear industry, loan collection impossibilities in financial collapse, extensive disclosure of large-scale explosion and a fire, and a toxic substance in the chemical industry, trust loss in politics, and head-on collision in the railroad industry) are considered to be the worst result in each industry. These disasters are considered to be the result that the safety management system was not functioning.

It is our duty to construct the safety system so that such a maximum risk may not

be occur.

The common causes of latest accident and incident are as follows;

- schedule priority
- sense-of-mission not wanting to inflict damage on an organization
- missing of raising a question which is not checked and reconsidered
- not to carry out according to the procedure and standard
- decrease of a sense of maximum risk
- miscommunication between an employee, a cooperation company staff, and an organization
- misjudgment of the administrator
- different situation as usual (state of urgency)
- not to reconsider the past accidents or incidents
- wrong success experience (nothing occurred by violation of a rule)
- decline of the procedure, the education, or the governance for risk management

Those who took this book in their hand would like to carry out the self check of whether such a thing has broken out first. The guideline and indicator about a safety management system of a certain form are created in all countries. However, in Japan examination of the measures based on the scenario in consideration of the enforcement procedure and worst case of risk assessment about a process have been rarely performed systematically.

That is,

- Risk assessment is carried out about an operation, a present construction project, and present materials/product, to specification of a potential risk for man, equipment, operating loss, community, and environment.
- Pinpoint the dangerous place and presume the damage (shown qualitatively first) and the accident frequency rate (shown qualitatively first) at the time of the occurrence of an accident. Next, the measure against prevention/mitigation for managing a risk continuously is drawn up and implemented.

- It is the point that periodical risk assessment should be carried out by the member including suitable specialists who is not related to the examince (a parent company and a specialized agency with evaluation capability).
- Risk assessment should be carryed out, when the defined interval has passed and when change arises.
- A evaluated risk is judged by the manager of each section, and determined matter must be documented clearly.
- Carry out an internal audit for structure and function of the system.

According to the important item demanded by the safety management system from such a background, the safety control system for medical facilities was created.

Process safety management is imposed by the regulation from the 1990s in US and EU as a safety control system to operate a petrochemical plant safely. The item and the contents of enforcement which are listed there are not peculiar to a petrochemical plant, and can be applied to all business conditions as a common safety control system.

That is, if we define a series of process with various practice for the medical purpose as a medical process, a medical-process safety management system is required as a management system for ensuring medical safety. The required item of the process safety management system both in process-oriented chemical industry and in a medical-process safety management system in the clinical settings are summarized in Table 2.6.

Although the medical-process safety management system consists of the following 15 items, many of them are performed in conventional education. (1) safety control plan, (2) organization and responsibility system, (3) safety control by medical staff, (4) medical safety information, (5) medical-process risk assessment, (6) medical practice and management of medical support system, (7) medical-facilities management, (8) education of medical personnel, (9) management concerning change of diagnoses, prescription, and treatment, (10) investigation of incident and major accident, (11) correspondence to the state-of-emergency, (12)

Table 2.6 Comparison of Process Safety Management in industry and medicine

	Indusry	Medicine
1	Leadership and safety guideline	Leadership and safety guideline
2	Organization and responsibility system	Organization and responsibility system
3	Safety management by workers	Safety management by medical providers
4	Information of process safety	Safety information (complication, contraindication)
5	Risk assessment (deviation from normal operation)	Risk assessment (deviation from normal treatment)
6	Management of operation and work	Management of medical procedure (clinical pathway)
7	Management of facilities	Management of facilities, information, and utility
8	Education of workers	Education of care providers
9	Change management (facilities, operations)	Change management (facilities, operations)
10	Investigation of accident	Analysis of incident reports
11	Emergency measures (mass destraction)	Emergency measures (incident/accident above 4b)
12	Risk communication (administrator, subordinate/ residents)	Risk communication (doctor, patient/care provider)
13	Management of the documents	Management of the medical chart, incident reports
14	Inspection	Inspection
15	Regular inspection of the system	Regular inspection of the system

risk communication, (13) documentation management, (14) audits, (15) periodical reexamination of systems.

Among these items, (5) medical-process risk assessment, and (9) management concerning change of diagnoses, prescription and treatment, (10) investigation of incident and major accident, (11) correspondence to the state-of-emergency, (12) risk communication, are thought to be important for preventing major medical accidents.

2) Medical-Process Safety Management System (MPSMS)

A medical accident can roughly be divided into two. One is a case caused by a doctor in their procedures. In this case a defense layer is the judgment of a doctor and the procedure itself. A different result may be followed by a moment act of a doctor. In order to prevent it, two or more defense layers are inherent in a doctor. A subtle mistake may cause a critical result in the medical practice performed in the situation where he/she is not conscious of two or more defense measures. It is because the doctor himself does not know that a small mistake may lead a big accident continuously.

Other case is caused by a malfunction of a systematic medical practice currently performed as clinical pathway in medical team. In this case, two or more defense layers exist and a medical worker and medical equipments can prevent a medical accident as protect layers.

The 5th item included in a medical-process safety management system; implementation of risk assessment is the contents which were lacking uniquely in conventional medical education. Although incident report contain the major accident more than 4b, risk assessment is evaluated according to a series of processes about incident below 4a. (Table 2.10)

However, if 15 items shown in Table 2.6 are not managed as a system, risk assessment could not be performed nor functioned correctly. 15 items of contents included in a medical-process safety management system are shown below.

Medical process safety management system (MSMS) contains 15 items of the following.

1. Leadership and safety control policy: The top of a medical organization must show medical safety control policy, and this should be performed and evaluated as a management system.
2. Organization and responsibility system: Each member should be aware of their role and responsibility for the management of a serious risk on total level of organization. Specific training for risk management should be specified, and regulation of training must be implemented. Participation of an employer and a subcontractor in a suitable case is also needed.
3. Safety control by medical worker's participation
4. Safety information : The contents about medical facilities, complications, and contraindications of medicine must be summarized as manuals or standard documents. It is important that the item of "9. Change management" should be corrected exactly.
5. Risk assessment: This portion is equivalent to risk source specified in the notification No. 86 from Japanese Administration of Economy, Trade and Industry and OSHA/PSM. In order to analyze the cause and measure on deviation from

regular medical practice or a state, solution would be conducted by a checklist system, What-if system, FMEA, HAZOP, ETA, FTA, or risk matrix evaluation. While the checklist is effective in analysis of procedures where the change is not made, HAZOP is effective in analysis in the act and the state where changes occur. Risk assessment specifies systematically a serious risk of producing from normal or unusual situation, and it carries out the adoption of procedure which evaluates the degree of seriousness, the possibility of the accident, and the influence of the risk.

6. Medical facilities, medical information system, and utility management: Grasp medical facilities, information system, and the advance level of degradation and damage by periodical inspection, evaluate a result, and check having the reliability to which these equipment and a system can be equal to continuous use. Repair/ replacement maintenance based on inspection method and interval degradation/ damage evaluation is also included.
7. Adoption and enforcement of procedure about safe medical institution management should be performed including maintenance at time of skill maintenance of medical worker, medical information system, medical equipment, and temporary business suspension.
8. Education of medical personnel

Figure 2.2 Frame of risk management (BS31100)

9. Change management (diagnosis, prescription, and medical treatment):

When partial change of diagnosis, prescription, and medical treatment, or complete change have done, implementation of common knowledge thoroughness procedure of contents of change should be performed. In business, it is the most important part. It is ctirical to be managed in the form in which record contains with the form of 5W1H. Objects are changes of all the items shown here and reflection of an evaluation result, and they are candidate for HAZOP analysis. The major cause of the big accident or the everyday accident of all fields reveals to be insufficient change management.

The objects of change management are standards and equipments (medical equipment, ward equipment, medical information system), which required for management of medical facilities, and a medical worker. It must be evaluated and managed so that it may fit in the level which the risk of safe and health produced by these change as small as possible. Therefore, the following systems should be formed and functioned. When a change is made, it is also important that risk assessment is carried out according to risk assessment procedures, such as HAZOP.

The system which manages both temporary and lasting change should be formed and is functioning.

The system for management of change needs following factors:

- Authorization of admission of change
- Analysis on safety, health, and environment
- Observance of the rule and the recognized standard
- Acquisition of the permission needed
- Document including the reason for change
- Common knowledge about the degree of a potential influence and the measure needed for the results
- limitation of duration
- training

It ensures that a temporary change does not exceed the recognized original range

or an original period without examination or recognition.

10. Investigation and analysis of incident reports: When an accident occurs, investigation conducted in order to clarify the cause of an accident and to prevent a recurrence. Although the cause of an accident is often reported as human error, if the primary cause (root cause) for the human err is not clarified, another accident will occur repeatedly. Only by the FTA technique, the primary cause could be clarified. Implementation of analysis and evaluation which combined What-if, ETA, HAZOP is also needed.
11. Plan of management for emergency: Possible risk will be clarified with systematic analysis, and the procedure which conduct preparation, examination, and inspection for specifying to the crisis should be chosen and performed in order to prevent from the risk. In the state of emergency in the clinical settings or an organization, is it possible to clarify in advance the role of the measures and person in charge, who makes the scale of the damage reduce. It is important to perform a simulation and an exercise in everyday life and to raise the capability corresponding to the state-of-emergency.
12. Risk communication: Medical risk is located under the circumstances where staff says the following comments, "It must have been pointed out before", "from which having meant is not transmitted", "as for wrong interpretation", and "wrong belief".

    There is a risk in the communication between a doctor and a patient, a doctor and a medical worker, and a medical worker and a cooperation company employee's.
13. Documentation management: To carry out risk management, it is also important that the monitoring of the enforcement situation is carried out by internal audit, that the system and the organization will make an improvement according to the advise for the problem, and that there are documents which have accountability.

    Moreover, all the items should be recorded on a documentation management system, and the latest version after change must be managed, and these procedures should be announced to the medical worker.

14. Monitoring of performance: If all the process leaves unfinished, a management system does not function. The contents of enforcement and the improvement of business are evaluated according to all the items of 1 to 13 listed above, and an improving point will be pointed out and performed if there is a problem. These evaluation cycles should be repeated and carried out. Adoption and enforcement of procedure which evaluate continuously the conformity to the target which the medical institution management person's major accident prevention plan and medical safety control system (MSMS) are needed. Mechanism of investigation, and the mechanism of the correction measure when not working is also needed. Suppose that the system of the medical-facilities management person who reports the near mistake of a major accident, especially the malfunction of measures, and the ex post facto measure based on near mistake investigation and its teachings are included in procedure. (It is a subject for a hospital manager and a general risk manager)
15. Audit and inspection: This is adoption and enforcement of a periodical systematic evaluation procedure about the validity and conformity of a medical safety control system (MSMS). Creation and updating of an inspection document about this plan by a senior executive, and the performance function of a medical safety control system shown. The correspondence which linked these to the documentation management system or the information system is needed. (Subject for a hospital manager and a general risk manager)

3) Medical-process risk assessment

As foregoing paragraph showed outline of 15 items included in a medical-process safety management system, the methodology of medical-process risk assessment is described here.

Medical practice is an aggregate of various medical processes, and is realized by the teamwork of the medical worker of each field. For detailed application example will describe in Chapter 3.

According to UA OSHA 29CFR.1910.119, the Compliance Guidelines and Recommendations for Process Safety Management (Non-mandatory), the purpose of this section is to introduce the created medical-process risk assessment:

(1) Medical-process risk assessment (MPRA) is called medical process risk assessment, and it is the most important item of a medical-process safety management system.

(2) MPRA is the technique of enumerating probable serious risk, and analyzing risk factors, and evaluating these risks and risk factors systematically in medication which may cause the act and the critical sequela of a doctor or a medical worker.

(3) The result of risk analysis and evaluation which became clear by enforcement of MPRA should be shared by the medical workers, make safety system more active at the time of execution of medical practice and medication, and make a medical worker perform a judgment which can reduce an unexpected bad influence.

(4) MPRA analyzes and evaluates the result and the cause of medical practice, an accident, and enforcement of procedure.

(5) Analyze and evaluate MPRA at a narrow sense about the flow of steady business and the flow of unsteady business about doctor and medical staff, patient, medical equipment, medical information system. Although it was required for the wide sense to examine the external factor which may have influence above, the interpretation in a narrow sense was adopted here. MPRA is a method which clarifies a risk of lurking in a medical process.

4) Process analysis for medical procedure

In analysis of various risks of lurking in medical practice, it is required to clarify the element which divides medical practice into every process and role. In the industrial world, the method called Work Breakdown Structure (WBS) on the occasion of a plan and execution of a project has been widely used as fundamental method for project management. This method can be utilized when creating a clinical pathway. Commercial project management software can also be used.

By making WBS, the roles of a doctor, a nurse, a pharmacist, an engineer, medical equipment, and medical information system utility are clarified, and the information of the stage and the duration that they participate and of the skill which they required would be shared. The example of WBS sheet is shown in Table 2.7.

In the industrial field, the WBS information is prepared as drawing and

Table 2.7 Work Breakdown Structure (WBS) Sheet

Harvard Manage Mentor - PROJECT MANAGEMENT TOOLS			
Work Breakdown Structure			
Develop a Work Breakdown Structure (WBS) to ensure that you do not overlook a significant part of a complex activity or underestimate the time and money needed to complete the work. Use multiple pages as needed.			
Describe the overall project:			
Major Task	Level 1 Sub Tasks	Level 2 Sub Tasks	Level 3 Sub Task Duration
Total Duration (minutes/hours/days/weeks)			

(From Harvard Manage Mentor on Project Management)

specifications (Piping & Instrument Diagrams: P&IDs) in the design phase of a process.

Although medical workers, such as a doctor, a nurse, a pharmacist, and an engineer, originally know what should be done with each role (motion and function of a stationary state). Here, an understanding as a team can be advanced by clarifying what should be done with a role, and by identifying a role of the defense layer (preventive measures).

5) Inquiry of incident report for analysis and an accident example

While creating above-mentioned WBS, technique and empirical rules of procedure are described by the point of a problem and a work. Furthermore, the description of the subnode, where an incident and an accident occur, advances HAZOP enforcement

smoothly. It is desirable for these information to be able to pull out from a medical information system.

6) Medical HAZOP

As for enforcement of the medical HAZOP, it is desirable to divide into two types to carry out. First targets are the incidences above 4a, whose frequency is rare but whose effect is large (Table 2.10). One example is the operation which a doctor conducts. Another is a inpatient care whose frequency is high but whose effect is comparatively small. Dysphagia corresponds to the former and the latter.

As Figure 2.3 shows the Heinrich's law, serious accidents can be analyzed by HAZOP analysis, and it becomes possible to analyze even the middle-scale accidents and incidents. On the contrary, a possibility that analysis of a serious accident cannot be reached from the number of cases in the analysis from incident reports is high. As shown in Figure 2.4, HAZOP analysis considers the result from a deviation from the stationary state and speculates various causes (human, environment, equipment, and exterior) indirectly and conducts the analysis for incidents below 3b.

The influence, which occurs when gap arises from the regular medical act compulsorily according to a basic guideword, is considered also in medical HAZOP. A secondary guideword is shown in Table 2.8; this is the same as secondary general guideword. The difference of HAZOP used in the medical field is only primary guideword for medical terminology.

The guideword "No/None" means not to carry out (or unable to do) the purpose or the act. If it does so, you have to consider the cause which is not carried out (or it cannot do).

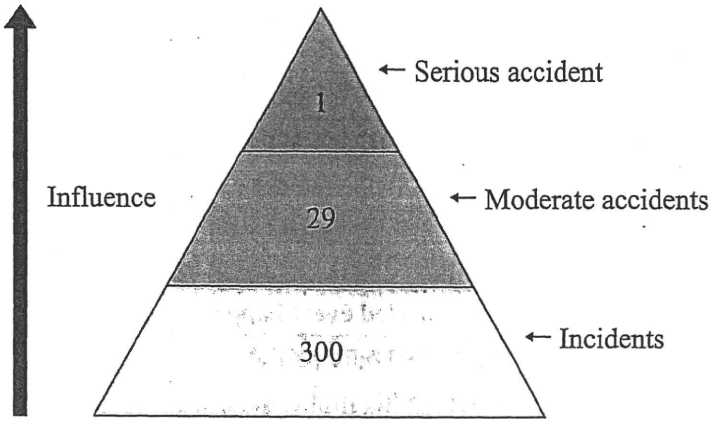

Figure 2.3 Heinrich's law

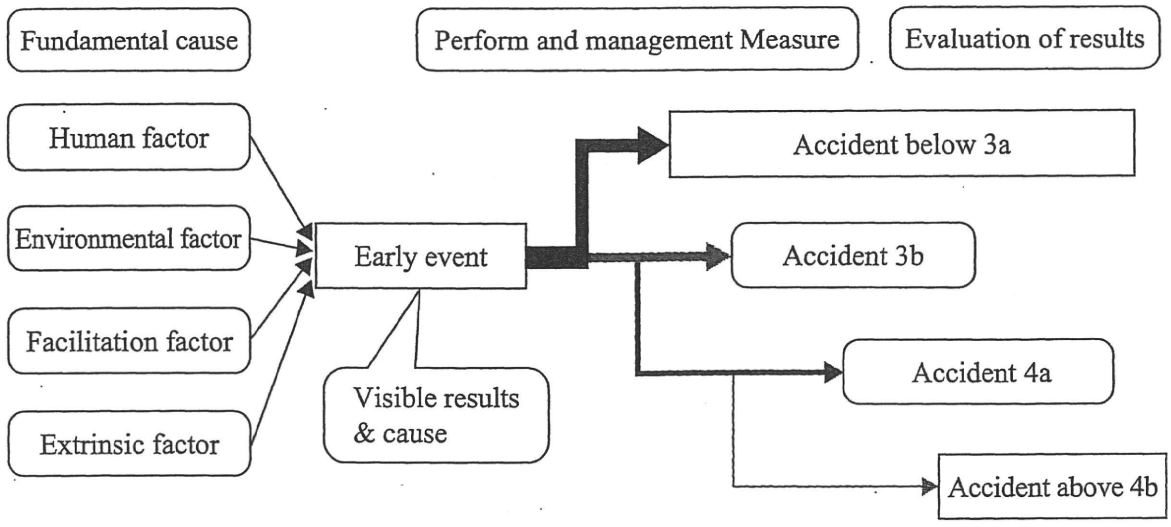

Figure 2.4 Objectives and procedure for HAZOP

With the guideword "Less", we can consider that an act is inadequate and is not attained with the purpose. Similarly, we have to consider the cause for it.

Creation of WBS and a series of accompanying procedures select and combine primary guideword, and support creation of a deviation scenario. The deviation scenario of HAZOP is created combining the product of subwork (primary keyword) and the secondary keyword shown in Table 2.8, which described the contents of the medical process. For example of central venous puncture, since an act and a procedure peculiar to this technique are explained from the WBS sheet, deviations in the act in the basic node of local anesthesia are listed, which kicks the puncture act (primary keyword) in the stationary state shown here by combining with the

Table 2.8 Basic Guidewords (secondary keywords)

Deviation	Meaning
None/No	Not happen: denial of intension
More	Quantitative increase above limit or standard
Less	Quantitative decrease below limit of standard
Reverse	Opposite event happens
As Well As (AWA)	Achieved but other event happens
Other Than (OT)	Unexpected event happens
Part Of (PO)	Achieved only partially
Early	Early in the timing and misjudgment
Late	Late in the timing and misjudgment

basic guidewords. A basic node can be divided, the check of an local anesthesia ⇒ diagnostic puncture ⇒ puncture ⇒ check of the catheter position.

The important point for performing medical HAZOP is to consider deviation according to basic guidewords, based on the performance procedure normally performed according to the main nodes in the medical treatment and medical system. Deviations can be easily considered from incident reports or experience of medical experts. Eaven though incidents which the participating member has not experienced or accidents which nobody knows could not imagined, deviations can be created mechanically according to basic guidewords. As long as the created scenario is theoretically possible, the deviations should not be deleted from the candidates for examination. Thus, it becomes possible to clarify the rare cause of an accident. The example of the medical HAZOP sheet which added improvement is shown in Table 2.9.

Table 2.9 HAZOP Sheet

Code No	Guidewords	Deviations	Effect 1 Event 1	Frequency	Cause	Person	Measure
A-BC-001	Select from None Less More OT AWA R	Make deviation scenario from subnode in WBS	Event result from deviation	often (1 per Month)	cause of deviation	doctor	examination for deviation
A-BC-002			Event result from deviation	sometimes (1 per year)	cause of deviation	doctor	examination for deviation
A-BC-003			Event result from deviation	often (1 per Month)	cause of deviation	nurse	examination for deviation
A-BC-004			Event result from deviation	seldom (1 per several years)	cause of deviation	doctor	examination for deviation

7) Evaluation with risk matrix

From the results of medical HAZOP in medical procedure or incidents we can evaluate the significance of the risk with risk matrix.

To prevent medical accidents it is important to decrease an incident below 3b (Table 2.10), however, it is also needed to decrease one above 3b from the viewpoint of social influence. According to the result in HAZOP, when the effect of 4b happens, the risk position is located in C, D, or E according to the frequency. Classification of

Table 2.10 Level of medical accident/incident in Japan

Risk Rank	Degree	Duration	Report	Contents
5	deadly injured		accident report	death caused by accicents
4b	seriously injured	continuous	accident report	serious injury which remains continuously
4a	moderately injured	continuous	accident report	moderate injury which remains continuously
3b	seriously injured	temporarily	accident report	serious injury which needs procedures and recovers
3a	moderately injured	temporarily	incident report	moderate injury which needs procedures and recovers
2	lighty injured	temporarily	incident report	injury which does not need procedures
1	no	no	incident report	incident happens but cause no harm to a patient
0	no	no	incident report	incident do not happens to a patient

Table 2.11 Classification of frequency

Classification	Definition
Highly Frequent	several times in a month
Frequent	several times in a year
Occational	once in several years
Uncommon	once in ten years
Remote	once in twenty years
Rarely	once in a future

frequency is shown in Table 2.11.

Figure 2.5. represent a matrix with two axis: consequence and frequency of a risk. Category A to E refers to the priority to take measure. Although if it seems that the accident of the same incident level 4b, measures must be immediately taken for one occurred "frequently", while for one occurred "seldom" or "low" to perform reexamination of a safeguard or a measure periodically are possible measures. It becomes possible to assign limited resources (a man, a thing, and gold) to the large measure against an accident of an effect by performing such evaluation. As a result, while becoming possible to reduce the accident more than level 4b, it is a level 4a by the analysis peculiar to the medical treatment HAZOP like an event tree. It can carry out by combining the measure against the following incident report levels.

Risk Rank

Level 5
Deadly injured

Level 4b
Seriously injured

Level 4a
Monderately injured

Level 3b
Seriously but temporally injured

Level 3a
Moderately and temporally injured

Level 2
Injury without procedures

Level 1
No harm to patients

D	D	E	E	E	E	E	E
C	C	D	D	E	E	E	E
B	B	C	C	D	D	E	E
A	A	B	C	C	D	D	D
A	A	A	B	B	C	C	C
A	A	A	B	B	B	B	C
A	A	A	A	A	B	B	B
Remote	Uncom-mon	Occati-onal	Someti-mes	Frequent	Highly frequent H	Highly frequent HH	Highly frequent UH
Once in 20 years	Once in 10 years	Once in several years	Once in a year	several times in a year	once in a month	once in a week	once in a day

Frequency

E	Need a prompt measure to take
D	Proceed safeguard and procedure
C	Regular inspection of safeguard and procedure
B	Reannaunce of safeguard and procedure
A	Keep ongoing safeguard and procedure

Figure 2.5 Risk Matrix