Journal of
Health Education Research & Development

Chiu and Wang, J Health Educ Res Dev 2016, 4:4
DOI: 10.4172/2380-5439.1000193

Research Article Open Access

Knowledge Extraction for Sleep Apnea Medical Diagnosis

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Abstract

This research aimed to extract medical diagnostic knowledge about sleep apnea by applying theories from process control management, library science, and knowledge management. We interviewed the President of the International Sleep Science Technology Association (ISSTA), a medical doctor, on the subject of sleep apnea, and validated the research findings with four other sleep apnea experts to achieve the following: A formal knowledge extraction procEduccre was established for sleep apnea. All medical knowledge pertaining to sleep apnea was mapped out.

Keywords: Sleep apnea; Knowledge management; Knowledge extraction; Library science

Introduction

Many sleep disorders have been documented, such as insomnia, obstructive and central sleep apnea, restless legs syndrome, and periodic limb-movement disorder. Sleep apnea is one of the most common sleeping disorders. According to the American Academy of Sleep Medicine (2005), approximately 4%-6% of adults in the United States are deeply troubled by sleeping disorders, this being the case especially for men, the elderly, and the obese (BMI ≥ 30 kg/m^2). Risk factors for sleep apnea include large neck circumference (male>17 inches; female>16 inches), and craniofacial or upper airway structure abnormalities. Without medical treatment, the recurrent sleep disruption and lack of oxygen, which characterizes sleep apnea, increases heart load and susceptibility to fatal diseases and causes hypertension, myocardial infarction, and angina pectoris.

Therefore, the authors of the present article believe that the appropriate and effective treatment of sleep apnea stands to benefit broadly from the health of patients with this disorder. Thus, it is critically important that physicians have at their disposal a correct and complete resource of sleep apnea diagnostic knowledge. By observing physicians specialized in sleep medicine, and validating results with the input of four other sleep medicine experts, this study aimed to map the theoretical and practical knowledge relating to sleep apnea in its entirety.

Literature Review

Theory of knowledge management

Gilbert and Cordey [1] demonstrated the importance of operational procEduccres and processes management in knowledge management. Quintas, Lefrere, and Jones [2] further noted eight categories about an organization knowledge: (1) market and customer information, (2) product information knowledge, (3) expert, (4) human resource information, (5) core business processes, (6) transaction-related information, (7) management information, and (8) vendor information. Borghoff [3] believed that a knowledge management framework should contain four elements: (1) knowledge flow, (2) a knowledge map, (3) knowledge workers, and (4) a repository of knowledge. In addition, Holsapple [4] proposed that a knowledge map should contain two parts: knowledge contents (e.g., keywords), and the relevant elements (e.g., experts, project teams, processes, articles, courses, etc).

The knowledge extraction process applied in the present study was therefore designed to include the following three elements of organization: (1) the organizational procEduccres/process, (2) the operator, and (3) the output documents. However, although much of the literature advises the inclusion of four elements, this literature fails to describe in detail how to use the tools espoused to extract knowledge. We therefore used methods developed in process management and library science to construct a knowledge extraction method for sleep apnea.

Theory of process management

The Work Breakdown Structure (WBS) deconstructs work through the application of top-down logic, rEducccing work to smaller and more manageable and controllable unitary systems. The International Project Management Institute believe that one can break-down tasks by the following steps: first, one must clearly identify the major deliverables of the process. Second, one must ensure that each deliverable has reached a level of detail sufficient to estimate the cost and time. Third, the deliverables must be verifiable results.

In the basic requirements of Create WBS, the following are specified: (1) a particular task should appear as only one place in the WBS; (2) the WBS of a task is the sum of all items under the WBS; (3) a WBS item only by a liability, and even though many people are likely to work on it, just one takes principle responsibility for it, all others are only participants; (4) a WBS must be consistent with the actual work of implementation; (5) the project team should be allowed to actively participate in creating the WBS, and consistency must be ensured; (6) each WBS item must be documented in detail, in order to ensure that all project stakeholders can understand them fully. Additionally, when an organization creates a WBS, they must consider the following: (1) the appropriate WBS level, corresponding to the lowest level WBS elements requiring tangible deliverables; (2) the WBS lifecycle and the development of activities at different stages of the project, including project management; (3) planning, performance reporting, integrated change control, and range management needs; (4) resource planning and risk management needs [5].

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Received October 06, 2016; **Accepted** October 28, 2016; **Published** October 31, 2016

Citation: Chiu H, Wang BJ (2016) Knowledge Extraction for Sleep Apnea Medical Diagnosis. J Health Educ Res Dev 4: 193. doi: 10.4172/2380-5439.1000193

We believe the WBS to be well suited to the separation and analysis of activities, and it can also reinforce the knowledge extraction process. In addition, because the topic of this study, sleep medicine, is a highly specialized area of medicine, this research aimed to bring together the classification methods from library science to improve knowledge extraction.

Theory of library science

In general, the classification element of library science includes three design elements: the category table, category tag, and index. The category table is the table refers to all categories of classification in accordance with a system in order to show them out. An effective classification table should contain the following elements: (1) a category covering all knowledge; (2) systematic categories; (3) flexibility and scalability; (4) the category clearly. The category tag is composed of the category number and author number. It main purpose of the order is sorted by category tag. As the index is a tool, which to label content material to facilitate data query out.

The medical classification method employed in the present study is that of the US National Library of Medicine Classification (NLM; NLM, 2016) [6], which in 1951 was officially dedicated to the Medical and Health Sciences. The US National Library of Medicine Classification is divided into two parts, namely, the classification code (QS-QZ) for Medical Science (Preclinical Sciences), pre-classification number (W-WZ) for Medicine and Related Subjects. For example, the WB classification category is used for medical practice. It begins with WB1-177 for reference data, and thereafter comprises the following: WB120-130, family health; WB141-293, diagnosis; and WB300-962, therapy for 4 major categories. Each category starting with a WB class under 0-9 has a decimal classification number. Table 1 below describes the classification system applied to forensic science and related disciplines.

Sleep medicine

According the International Classification of Sleep Disorders Second Edition, general common sleep disorders can be divided into the following categories: (1) insomnia: the inability to fall asleep, stay asleep, or to feel fatigue even after sleeping; (2) obstructive and central sleep apnea: upper respiratory tract muscle relaxation and/or obesity resulting in a repeated obstruction of the airway, causing apnea; (3) loss of airflow within the upper respiratory tract for at least ten seconds; (4) restless legs syndrome and periodic limb movement disorder: common neurological diseases characterized by urgency and constant movement of the feet, especially during sleep, these symptoms will be more obvious. Three diagnostic modalities are typically applied to sleep problems: scale analysis, measuring instruments, and medical history assessment. Sleep disorders are generally treated by the following methods: (1) continuous positive airway pressure during sleep; (2) snoring mouthpiece during sleep; (3) upper respiratory tract reconstructive surgery [7].

The medical profession is one rich with knowledge. Good knowledge management can rEduccce the uncertainty of medical services and improve the quality of medical care [8]. Wennberg reported that the way of physicians to treating or surgical, which have significant exist between different hospitals [9]. Hence, if one were to build an extraction mechanism, which from physicians diagnose process, to collate, sharing and exchange knowledge, it would likely have a significant impact upon the medical profession.

Research Methods

The research framework

Based on the previous chapters, the research architecture of this study is represented by Figure 1 and described in detail in Table 2. Those two used theories from knowledge management, process management, and library science to complete the following four knowledge extraction procEduccres as applied to the sleep apnea medical diagnosis: (1) expert interviews and content analysis; (2) knowledge of the construction work description table; (3) knowledge classification; (4) verification of results by other experts in the field.

Description of interviewee background

We were permitted by Dr. Chiang Rayleigh Ping-Ying, a sleep medicine expert of Taiwan, to interview him and extract his sleep apnea diagnostic knowledge. Dr. Chiang Rayleigh Ping-Ying graduated from the Institute of Clinical Medicine of National Taiwan University, and

W-WB (General Health and Medicine)	
Classification Number	**English Name**
W	Health Professions
WA	Public Health
WB	Practice of Medicine
WC-WD (Diseases of the Whole Body)	
Classification Number	**English Name**
WC	Communicable Diseases
WD100	Nutrition Disorders
WD200	Metabolic Diseases
WD300	Immunologic and Collagen Diseases, Hypersensitivity
WD 400	Animal Poisons
WD 500	Plant Poisons
WD 600	Disorders and Injuries of Environmental Origin
WD 700	Aviation and Space Medicine
WE-WL (Systems of the Body)	
Classification Number	**English Name**
WE	Musculoskeletal System
WF	Respiratory System
WG	Cardiovascular System
WH	Hemic and Lymphatic Systems
WI	Digestive System
WJ	Urogenital System
WK	Endocrine System
WL	Nervous System
WM-WZ (Specialty Areas of the Health Science)	
Classification Number	**English Name**
WM	Psychiatry
WN	Radiology, Diagnostic Imaging
WO	Surgery
WP	Gynecology
WQ	Obstetrics
WR	Dermatology
WS	Pediatrics
WT	Geriatrics, Chronic Disease
WU	Dentistry, Oral Surgery
WV	Otolaryngology
WW	Ophthalmology
WX	Hospitals and Other Health Facilities
WY	Nursing
WZ	History of Medicine

Table 1: The united states national library of medicine [6].

ProcEduccre	Significance and Description	Tools/Theory Used	Outputs/Achievements
Expert Interviews	We used an interview outline designed for the present study to interview physicians specializing in sleep apnea while recording their responses verbatim.	1. Interview outline for organization knowledge Expert (Appendix A) 2. In-depth interviews for qualitative research	1. Interview outline for medical experts 2. Interview record 3. Analysis of interview records
Knowledge Worksheet Construction	Through construct of interview records to do knowledge operation process description table.	1. Interview record 2. Record analysis 3. Tools of process control management	1. Sleep apnea medical diagnostic work description table 2. Sleep apnea diagnostic process and medical knowledge correspondence table
Knowledge Classification	Knowledge classification through the use of the following four tools: NLM, WBS, sleep apnea medical diagnostic work description table, sleep apnea diagnostic process, and medical knowledge correspondence table	1. NLM 2. WBS 3. Sleep apnea medical diagnostic work description table 4. Sleep apnea diagnostic process and medical knowledge correspondence table	The clinical diagnosis of sleep apnea knowledge classification structure table
Other Expert Verification	Four sleep medicine physicians provided expert opinions on the research results listed in the next column	1. Interview outline for organization knowledge expert 2. Sleep apnea medical diagnostic work description table 3 Sleep apnea diagnostic process and medical knowledge correspondence table 4. The clinical diagnosis of sleep apnea knowledge classification structure table	Medical expert verification table

Table 2: Research architecture.

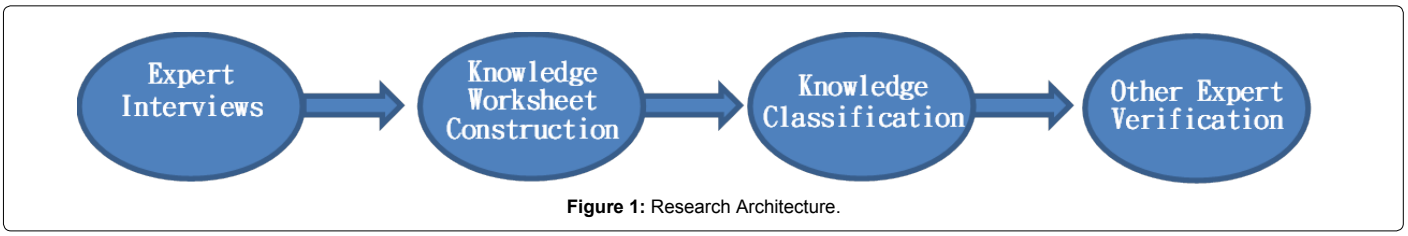

Figure 1: Research Architecture.

was a researcher at the Sleep Medicine Center of Stanford University. He is the Deputy executive director of the sleep medicine center of Taipei Veterans General Hospital, the Grandparent Somnologist of European Union and the President of ISSTA [10,11]. His specialties include poor sleep quality (including insomnia), snoring and sleep apnea, etc. In 2016, Dr. Chiang became the President of ISSTA.

After 45 working days, we finished the collection of two datasets: first, using the proprietary "knowledge feature set and extraction interview outline" (Appendix A) in-depth interview, and second, the interview records and all knowledge charts, tables, and discussion meeting. Each meeting lasted 2.5 hours, and meeting data were recorded by a stenographer. The following is an excerpt from Dr. Chiang's interview manuscript:

Interview paragraph A

Interviewer: I would like to ask you in the implementation of the medical diagnosis process, such as the bottleneck or obstacles, what are the ways or the activity can help you to solve those difficult problem?

Dr. Chiang: Most of the patients is sleep special outpatient. When sleep specialist physicians believe that the case shall need the other doctor consultation, or referral. It will held a consultation meetings to discuss how to carry out the subsequent treatment decisions. In addition to we will also participate in the global sleep medicine annual meeting or seminar to study new knowledge or ask to my teachers: Professor Nelson B. Powell and Professor Christian Guilleminault in Stanford.

Interview paragraph B

Interviewer: When patients completed clinic and sleep screening process, which will output what document?

Dr. Chiang: It were be outcome an inspection report after the sleep examination process. And then, we will make treatment recommendations, which based on inspection data from this report and other medical history of the disease.

Verification method

In this research, we invited four sleep medicine physicians, all of whom had otolaryngology and sleep medicine experience in difference general hospitals. They verified four research results:

(1) the interview outline for sleep apnea experts; (2) the sleep apnea medical diagnostic work description table; (3) the sleep apnea diagnostic process and medical knowledge correspondence table; (4) the clinical diagnosis of sleep apnea knowledge classification structure table.

Verification began by requesting the four doctors' agreement to participate by telephone. We then sent all of our research data to them by e-mail. Table 3 tabulates the comments of the four doctors:

According to the verification results provided by these four sleep medical specialists, several verification conclusions were drawn. Firstly, the "Sleep apnea medical expert interview outline" provides structured sleep apnea diagnosis knowledge; secondly, the four expert physicians unanimously agreed that the contents of two forms can clearly express

ProcEduccre	Significance and Description	Tools/Theory Used	Outputs/ Achievements
Expert Interviews	We used an interview outline designed for the present study to interview physicians specializing in sleep apnea while recording their responses verbatim.	1. Interview outline for organization knowledge Expert (Appendix A) 2. In-depth interviews for qualitative research	1. Interview outline for medical experts 2. Interview record 3. Analysis of interview records
Knowledge Worksheet Construction	Through construct of interview records to do knowledge operation process description table.	1. Interview record 2. Record analysis 3. Tools of process control management	1. Sleep apnea medical diagnostic work description table 2. Sleep apnea diagnostic process and medical knowledge correspondence table
Knowledge Classification	Knowledge classification through the use of the following four tools: NLM, WBS, sleep apnea medical diagnostic work description table, sleep apnea diagnostic process, and medical knowledge correspondence table	1. NLM 2. WBS 3. Sleep apnea medical diagnostic work description table 4. Sleep apnea diagnostic process and medical knowledge correspondence table	The clinical diagnosis of sleep apnea knowledge classification structure table
Other Expert Verification	Four sleep medicine physicians provided expert opinions on the research results listed in the next column	1. Interview outline for organization knowledge expert 2. Sleep apnea medical diagnostic work description table 3 Sleep apnea diagnostic process and medical knowledge correspondence table 4. The clinical diagnosis of sleep apnea knowledge classification structure table	Medical expert verification table

Table 3: Research architecture.

Categories / Task Name	Principal	Tools Used	Delivery	Outcome Document	Users
1. Preliminary Interrogation	Sleep Doctor	Outpatient tool	Patient record system	Outpatient records	Sleep Doctor
2. Executive Sleep Inspection	Sleep Doctor, Examiner, Nurse	Sleep inspection report	Patient record system	Sleep inspection report	Sleep Doctor
3. Diagnose Sleep Apnea	Sleep Doctor	Sleep inspection report	Patient record system	Diagnosed proof	Sleep Doctor
4. Treatment	Sleep Doctor	1. Continuous positive airway pressure 2. Snoring mouthpiece 3. Surgical equipment	Patient record system	Treatment records	Sleep Doctor
5. Subsequent Visit	Sleep Doctor	Outpatient tool	Patient record system	Treatment records	Sleep Doctor

Table 4: Sleep apnea clinical diagnostic protocol.

the corresponding processes and related knowledge and concepts; thirdly, it is easy to read, although two of the four experts suggested merging two forms; finally, the four sleep doctors accepted that using classification principles is a good way to represent the entirety of the disorder. Besides using WBS and NLM, it provides information on medical professional relationships and cases to enrich the reader's knowledge of the field.

The verification opinions of the four sleep experts are positive. The work reflects effective knowledge extraction from the medical professionals, and covers all aspects of sleep apnea.

Results

After finishing this research, which is based on the literature review, Figure 1 and Tables 2 and 3 of research procEduccre design, it completed several research results. Table 4 which is based on the interviews content, shows five categories that correspond to the patient treatment process. Those categories are the responsible officer, use of tools, delivery, output documents, and users. In this form, it demonstrates a relationship between the diagnostic procEduccres for sleep apnea and the "Persons, Tools, and Documents" categories. It was order to become an important simple job description table, which use for clinical references to the sleep apnea medical diagnosis process.

Table 5 shows the correspondence between the three categories: (1) the process task of sleep apnea diagnosis; (2) the principal who executive sleep apnea diagnostic processes; (3) the medical theoretical knowledge and medical clinical knowledge in the process of the diagnosis of sleep apnea. For example, the sleep doctor accountable process task in process 1 is called "newly diagnosed". This process used theories related to the respiratory system, sleep medicine, otolaryngology, and patient observation, as well as the Pittsburg Sleep Quality Index to define "newly diagnosed." A detailed description of sleep apnea diagnostic processes and related knowledge is provided below in Table 5.

This research also separates sleep apnea medical diagnostic knowledge into two categories, transverse and straight, and used Table 6 to show mutual correspondence between these categories. The transverse category, which for this research was defined as the "clinical knowledge category," comprised three subcategories: interrogation knowledge, detection knowledge, and treatment knowledge. These

Process Task	Principal	Theoretical Knowledge	Clinical Knowledge
1. Newly diagnosed			
1.1 Ask patients: Do you have daytime Fatigue? How frequently do you doze?	Sleep Doctor	Respiratory system, sleep medicine, otolaryngology, clinical medicine, sleep disorders (sleep apnea, snoring, limb hyperactivity disorder)	Patient observation and dialogue
1.2 Ask patients and their families: have sleep snoring, snoring interrupted, Sleep up half will, apnea stop?			
1.3 Ask patients: have heart disease, diabetes, or hypertension?			
1.4 Ask patients: Do you have limb pain when you get up?			
1.5 Observation of the patient: have not focus on the spirit, fatigue?			
1.6 Pittsburgh Sleep Quality Scale (PSQI) [Note 1] measurement			PSQI Completion instructions
1.7 Interpretation of typical sleep apnea and arrange inspection of sleep			PSQI Indicator interpretation
2. Inspection			
2.1 Blood test, radiography, issuing inspection cover, alternate instructions, teaching	Sleep Specialist Physicians, Examiner, Nurse	Respiratory system sleep medicine, otolaryngology, clinical medicine, metabolomics, neuroscience, endocrinology, respiratory physiology, nursing, sleep disorders (sleep apnea, snoring, limb hyperactivity disorder)	SaO2 indicator interpretation [Note 2]
2.2 Inspection of vital signs, neck circumference, body type, facial bone type, upper respiratory detailed theoretical inspection, craniofacial X-ray measurements, fiber endoscopy			PNC indicator interpretation [Note 3]
2.3 Inspection of upper respiratory tract stenosis or collapse extent (nasal cavity, oropharynx, hypopharynx, larynx)			Upper respiratory tract Stenosis or subsidence of the respiratory tract as a whole accounted for more than 50%
2.4 Inspectors detected multifunction overnight sleep physiology Nursing care during the night shift			Patient care knowledge, detection equipment operational knowledge
2.5 Physicians confirmation			1. RDI Indicator interpretation [Note 4] 2. AHI Indicator interpretation [Note 5]
3. Diagnosed as sleep apnea	Sleep Specialist Physicians	Sleep Medicine	Inspection data interpretation knowledge
4. Treatment			
4.1 Wearing snoring mouthpiece	Sleep Specialist Physicians, Dentist	Otolaryngology, respiratory system science, dentistry	Snoring mouthpiece using knowledge
4.2 Wearing continuous positive airway pressure (CPAP) device	Sleep Specialist Physicians	Otolaryngology, respiratory system science, pediatrics	CPAP using knowledge
4.3 Upper airway reconstructive surgery [Note 6]			Upper airway reconstructive surgery capacity
4.3.1 Uvulopalatopharyngoplasty surgery + hydroxylamine genioglossus advancement surgery			
4.3.2 Upper/lower jaw forward surgery			
4.3.3 Removal of hypertrophic tonsils and adenoids jaw surgery (obstructive sleep apnea for children)			
5. Return to outpatients			
5.1 Observation of the patient: have focus on the spirit, good spirit?	Sleep Specialist Physicians	Clinical Medicine	Patient observation and dialogue
5.2 Ask patients: still have daytime fatigue? Dozing how frequently?			
5.3 Ask patients: the status wear respirator/ snoring braces/postoperative			
5.4 Comparison with initial outpatient records - Significant improvement?			
5.5 Continued return to outpatients 2-3 times			

[Note 1] PSQI: Pittsburg Sleep Quality Index. PSQI>5 (good quality of sleep), PSQI ≤ 5 (poor quality of sleep).
[Note 2] SaO2: oxygen saturation index. SaO2>85 (low), 65 ≤ SAO2 ≤ 85 (moderate), SAO2<65 (severe).
[Note 3] PNC: perimeter of neck circumference. PNC<43 cm (low probability), 43-48 cm (moderate probability), PNC>48 cm (high probability).
[Note 4] RDI: respiratory disturbance index. RDI<5 (normal), 5 ≤ RDI<15 (low), 15 ≤ RDI<30 (moderate), RDI ≥ 30 (severe).
[Note 5] AHI: apnea-hypopnea index. AHI>5 (sleep disorder).
[Note 6] First type of surgery: uvulopalatopharyngoplasty surgery+ hydroxylamine genioglossus advancement surgery (for adults), second type of surgery: removal of hypertrophic tonsils and adenoids jaw surgery (for children).

Table 5: Sleep apnea diagnostic processes and related knowledge.

Clinical Knowledge Category Theory Knowledge Category	Interrogation Knowledge	Detection Knowledge	Treatment Knowledge
WB (Practice of Medicine)			
WB200 (Physical Diagnosis) WB305 (Instructions for devices)	Foundation interrogation methods	Sleep detector operation method	
WF (Respiratory System)			
WF39 (Handbooks. Resource guides)	1. PSQI [Note 1] 2. The medical records		
WF141 (Diagnostic Methods)			
WV (Otolaryngology) WV150 (Diagnostic Methods)	Ask patients: have sleep snoring, snoring interrupted, sleep up half will, apnea stop?	1.RDI indicator [Note 2] 2.AHI indicator [Note 3] 3.PNC indicator [Note 4] 4. Upper respiratory tract stenosis or subsidence of the respiratory tract as a whole accounted for more than 50%	
WG (Cardiovascular System) WG141 (Diagnostic Methods)	Ask patients: Do you have hypertension or heart disease?	SaO2 indicator [Note 5]	
WK (Endocrine System) WK810 (Diabetes mellitus)	Ask patients: Do you have diabetes?	SaO2 indicator [Note 5]	
WL (Nervous System) WL141 (Diagnostic Methods)	Ask patients: Do you have limb pain when you get up?	Patients involuntarily jitter in the thumb, foot, ankle, knee, or when bending more than 15 times per hour during monitored sleep	
WF145 (Therapeutics)			Using snoring mouthpiece/continuous positive applied pressure device
WV (Otolaryngology) WV168 ENT Surgery WS (Pediatrics) WS366			Upper airway reconstructive surgery capacity [Note 6]
WY(Nursing)			
WY163 (Respiratory System Nursing		Night care for patient	

[Note 1] PSQI: Pittsburg Sleep Quality Index. PSQI>5 (good quality of sleep), PSQI ≤ 5 (poor quality of sleep).
[Note 2] RDI: respiratory disturbance index. RDI<5 (normal), 5 ≤ RDI<15 (low), 15 ≤ RDI<30 (moderate), RDI ≥ 30 (severe).
[Note 3] AHI: apnea-hypopnea index. AHI>5 (sleep disorder).
[Note 4] SaO2: oxygen saturation index. SaO2>85 (low), 65 ≤ SAO2 ≤ 85 (moderate), SAO2<65 (severe).
[Note 5] PNC: perimeter of neck circumference. PNC<43 cm (low probability), 43-48 cm (moderate probability), PNC>48 cm (high probability).
[Note 6] First type of surgery: uvulopalatopharyngoplasty surgery+ hydroxylamine genioglossus advancement surgery (for adults), second type of surgery: removal of hypertrophic tonsils and adenoids jaw surgery (for children).

Table 6: Clinical diagnosis of sleep apnea knowledge classification schema [6].

subcategories were used in the classification tools from the work breakdown structure and the sleep apnea diagnosis process, which from interview records to do category classification. For example, newly diagnosed patients must complete the Pittsburgh Sleep Quality.

Scale test to measure the quality of their sleep. The interpretation knowledge of the patients filled out answers and fractions for scale. This was classified as diagnostic knowledge in the present study.

The straight category, which for this research was defined as the "medical theoretical knowledge category," comprised three subcategories: WB (Practice of Medicine), WF (Respiratory System), and WY (Nursing). These subcategories were used in the classification tools from the US National Library of Medicine Classification to separate the medical knowledge of sleep apnea. Every subcategory based on actual condition to do some small category, which still follows the principle of US National Library of Medicine Classification. For example, the WF classification is based on three components: handbooks and reference materials, diagnostic knowledge, and therapeutic knowledge regarding WF39 (Handbooks and Resource guides), WF141 (Diagnostic Methods), WF145 (Therapeutics). In WF141 of this category, it would be provided with required medical theoretical, which basis on US National Library of Medicine Classification, into the more detailed categories. Those categories are WV (Otolaryngology), WG (Cardiovascular System), WK (Endocrine System), and WL (Nervous System).

Table 6 shows the interactions between the transverse category (clinical knowledge) and straight category (theoretical knowledge).

Conclusions and Contribution

A comprehensive preceding chapters contents, this research base on the research executive producer of Table 2, to present complete sleep apnea medical diagnosis knowledge. This study also provides a complete and readily applicable knowledge extraction mechanism, and the associated procEduccres, for use in the field of sleep medicine.

Knowledge Extraction Questions Table
01. What are the “critical activity processes” in your field of specialization?
02. Which complementary “critical knowledge” do you need to complete these key activitely processes?
03. What ich “predisposing knowledge” do you think needs to be first learned to possess the critical knowledge?
04. Which “extended knowledge learning” do you think is needed to improve your specialty after obtaining the critical knowledge?
05. In the aforementioned critical activity processes, which complementary “critical resources (project scope) do you think you need to complete these processes?
06. Do you think there are areas of concern or to pay attention to regarding “the acquisition of critical resources (project scope)?
07. In critical activity processes, which “critical partners (people scope) do you think are needed to complete the processes through collaborative efforts?
08. When executing critical activity processes, which methods ways or activities will help you “solve problems” when bottlenecks or obstacles are encountered (such as seminars, participating in expert forums, searching for data online, etc.)?
09. When engaging in the abovementioned problem-solving activities or methods, which method do you use to contact or communicate (such as e-mail, telephone, etc.)? What are the content, form, and format?
10. Which “result and relevant record document files” are produced after executing and completing the critical activity processes?
11. “Where within the organization do you store” your the results and document files? What “retrieval mechanisms and tools” are provided by the organization?
12. Further In continuation to question Q10, what do you think is the “retrieval process” of the results and document files? Is there a control program? If so, what is it?
13. Further to question in continuation to Q10, which “subsequent processes” within the organization do you think will access these results and document files?
14. Further to question in continuation to Q10, which “personnel” within the organization do you think will subsequently use these results and document files? How do they use them?
15. To what What do you think is “the degree is of integration between the knowledge and the organization interior integrated”? Has the knowledge been “fully integrated into our products and services”? What is are “lacking?” “What can be improved?” “How can we start providing what are needed?”

Appendix A: Knowledge extraction questions table.

We successfully extracted sleep apnea medical diagnosis knowledge from the interview data of a sleep medicine specialist, Dr. Chiang Rayleigh Ping-Ying, and verified our results with the input of four other sleep medicine doctors. This confirms that one can use the theories of process management, library science, and knowledge management in the organization of medical knowledge. More importantly, we believe our research results provide a general principle of knowledge extraction applicable to other medical specialties, and one which medical experts may use for such purposes.

Finally, the results tabulated in the present article not only present knowledge in a clear and digestible fashion, but also represent a more systematic process by which to display whole subjects of knowledge. We believe that our findings will assist in the Educccation of medical professionals, improving the teaching, dissemination, and sharing of sleep apnea medical diagnosis knowledge.

Recommendations for Future Research

In the present study, based on in-depth interviews and qualitative research, and supported by project management, library science, and knowledge management, sleep apnea diagnostic knowledge was successfully extracted. However, in this field of medical diagnostic knowledge, there are still many different types of sleep disorders upon which knowledge extraction is yet to be conducted. The present study did not concern itself with the storage and sharing of knowledge via computer systems. Therefore, further research is warranted in the following areas.

(1) Knowledge extraction for medical diagnosis illustrations

The present study was conducted to collect knowledge and extraction work, while output corresponding to the relevant chart. However, is it can apply to other institutions? Are there different industry knowledge extraction differentiation exist? What is it variable? It shall be the relevant research can extend the follow-up.

(2) Innovation research in knowledge management computer systems

In this study, only do the existing knowledge extraction of research. And construction the various types of schematic diagram, which is the structure knowledge type by this research.

The knowledge document for organization process outcome, can also use metadata tables, which design by this research, to construction can easy automated document search mechanism. However, this research did not explore the use of computer systems for knowledge management. For example, while this research presented knowledge in the form of charts, nowadays the computer system, is it design computer auto showing corresponding knowledge document or knowledge graph when the computer point refers to the knowledge operation process? And then, when the user double click the knowledge document or the knowledge graph, which can auto link or open corresponding screen content (like some web site, some knowledge explanation document, etc.) This design should not have technical problems. But it can let computer systems make friendly and more automation to do knowledge management be showing for users. It should be a very meaning full extended research issue.

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