Global trend of decision support over medical care

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Abstract

PURPOSE: The purpose of this study is to perform trend analysis of precedent studies in overseas on decision support and determine the directionality of self-determination and target support in medical service. METHODS: The authors picked up 4,366 original papers published in the past 52 years from PubMed with the keywords "clinical decision support" and "nursing" and analyzed them using the text mining method. RESULTS: The study themes of decision support were categorized into the following five categories; "Utilization of decision support system", "Disease-specific care", "Role of nurses", "Development of evaluation tool" and "Evidence-based medicine". CONCLUSION: As a premise of the decision support, confidential relations between subjects and supporters are required. Moreover, it has been suggested that the role of supporters is to allow subject to make decisions independently from multiple options.

Key words: decision support, self-determination, text mining, characteristic word analysis, nursing

I. Introduction

Difficulty in decision-making in medical care has been stated repeatedly from the era of Hippocrates. Factors that complicate decision making include increase and complexity of options accompanied with the progress of therapeutic methods, diversification of medical institutions, uncertainty of medical practice and change in life[1–3]. Nowadays, we can easily learn about our own diseases on the Internet while we fail to make decision due to information overload. Further, in Japan, the shortening of hospitalization by induction of DPC makes closely examined decision marking difficult. Since patients must move to different medical institution as their initial treatment is finished, the support system that they can continuously consult with primary contains problems[4]. Therefore, the purpose of this study is to perform trend analysis of precedent studies in overseas on decision support and determine the directionality of self-determination and target support in medical service.

II. Study method

1. Study design

Comprehensive literature survey.

2. Object of analysis

1) Analysis objects

In this investigation, we target literature published in PubMed. PubMed is a data base established by NCBI (National Center for Biotechnology Information) in NLM (National Library of Medicine)[5]. It is provided as part of the database integration search system Entrez (made by NCBI) and allows

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users to search papers published in major medical magazines in the world. The medical literature database MEDLINE, which is a major component of PubMed, has collected a total of 5,700 papers about biomedicine and health (including medicine, nursing, dentistry, veterinary medicine, pharmacy, health science and nursing) after 1946[6]. The collected documents are of 37 languages while more than 90% are English. Considering the above, we concluded that PubMed was an optimum database for reviewing studies in specific fields in overseas and selected it.

2) Choice of target literature

In order to target all papers published in PubMed, target years were set as 1946 - November 30, 2018. AND search was performed with "clinical decision support" and "nursing" as keywords. The target papers were limited to original papers and searched papers were employed for the study.

For the analysis, as a minimum data unit in which contents were summarized, subtitles were included with paper titles (phrase contained in the titles) as analysis subjects.

3. Method of analysis

For the phrases used for the titles of all papers, "dependency word network analysis", "word frequency analysis" and "characteristic word analysis by generation" were performed by the text mining method. Text Mining Studio 6.1.1 English add-on (NTT DATA Mathematical Systems Inc.) was used for an analysis. In the procedure, text data of searched papers were input into Excel to be computerized. Next, a morphological analysis was performed for text data that is not structured to shape the target data.

First, "words network" was created from the phrases used for the titles of all papers to overview of the study themes. This is a network chart which expresses the dependency relations of the phrases with lines based on extracted words or codes. The point is that the phases are connected with lines rather than the positions are arranged. The size of the circles reflect the number of times of occurrence, and the line width expresses strength of dependency relation. Since excessive amount of extracted words in one network would make the judgment difficult, phrases whose number of times of dependency was more than twice and frequency was within the top 50 were extracted. In the process of categorizing the study themes from the created network chart, the authors read the original data repeatedly and understood the entire contents so as to perform the analyses qualitatively and inductively. We secured stringency of the analyses confirming and collating if

the interpretation was not biased and if validity of contents was missed through the all analytical processes.

For the characteristic word analysis by generation, complement similarity was used as an index value. This is a value by which the words that appear in their attributes at a higher rate are regarded as more characteristic. Since the words with greater number of times of appearance less likely to appear in the attributes casually, they are regarded as characteristics[7]. The words with greater index values are more characteristic in their attributes. In this study, the words in the top 30 in each generation were extracted and arranged.

4. Ethical considerations

Care was taken to ensure that the personal information of research participants was protected; that the handling of personal information complied with the provisions of the Personal Information Protection Law, the Code of Ethics for Nurses, and the Ethical Guidelines for Clinical Research; and that copyright would not be infringed when quoting figures, tables, and text from the literature.

III. Result

Total 4,366 papers from the past 52 years were searched. Among the extracted papers, those from 1967 are the oldest, and papers from the period from 1946 to 1966 were not searched. As a result, the number of papers extracted was 2 from 1967 through 1979 (0.04%), 59 from 1980s (1.35%), 460 from 1990s (10.54%), 1,412 from 2000s (32.34%) and 2,433 from after 2010 (55.73%). As a result of text data calculation, 35,297 phrases were extracted. For each category, 19,366 nouns (54.87%), 3,162 verbs (8.96%), 762 adjectives (2.16%), 8,086 symbols (22.91%) and 3,921 other phrases (adverb, conjunction, preposition and so on) (11.10%) were extracted. Since characteristics of the themes were obtained from nouns in the papers, nouns were employed as analysis subjects. From the viewpoint of privacy protection, proper nouns, person's names, organization names and numerals not related to the analysis were excluded from the analysis subjects and total 17,089 words were analyzed.

1. Words network of all papers

The words network was roughly divided into five clusters (Fig.1). In the largest Cluster I located in the upper part of the network chart, arrows were concentrated towards "use" on the center from "clinical decision support system", "personal digital assistant", "clinical practice", "nursing practice"" simulation" and "electronic health record". Moreover, they were
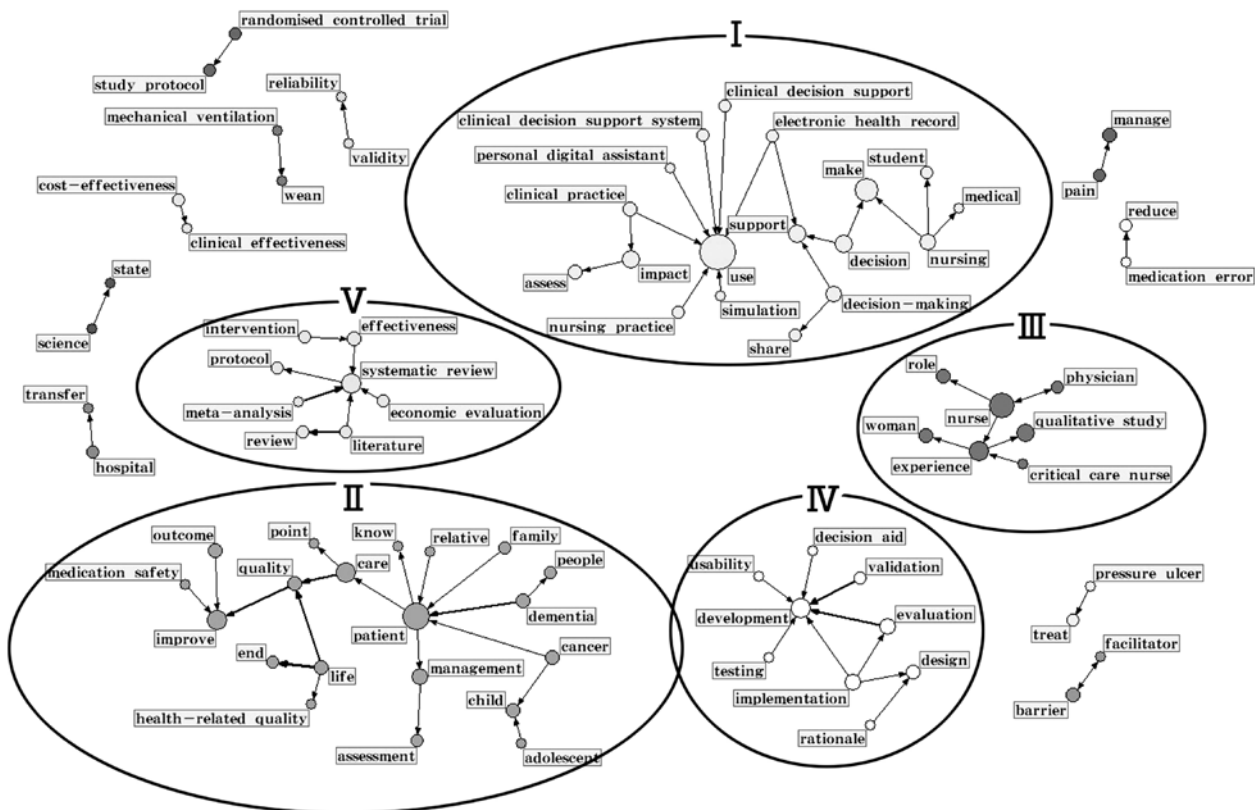
Fig.1. Words Network of All Papers in "Clinical Decision Support" and "Nursing". The words network was roughly divided into five clusters.

connected with "impact", "assess", "support", "make" and "medical". In the second largest Cluster II on the left lower part of the figure, phrases such as "relative", "know", "family", "dementia", "cancer" and "management" toward "patient" were seen. Further, they were connected to "life", "quality", "improve" via "care" from "patient". Moreover, "medication safety", "outcome" were concentrated on "improve". In Cluster III on the central right, "nurse" was extracted on the center and toward "experience" and "role" from there. It was connected to "qualitative study", "critical care nurse". On its lower left, there was Cluster IV with "development" as a main word, and was formed with phrases such as "usability", "decision aid", "validation", "evaluation" and "implementation". Central right cluster V was comprised of "systematic review", "effectiveness", "economic evaluation", "literature" and "meta-analysis".

2. Categorization of study theme

The study themes were categorized from the created network chart. Clusters that were formed of two words were not connected with other phrases and no characteristic tendency was seen in the original data and therefore they were not in-

cluded in the categories. The five clusters extracted were categorized while their contents were confirmed and original papers were referred, and were named as "I. Utilization of decision support system", "II. Disease-specific care", "III. Role of nurses", "IV. Development of evaluation tool" and "V. Evidence-based medicine". Five categories and contents of the original papers are shown Table 1.

3. Frequency analysis of phrase used for title

Among the frequently appeared words in the titles of all papers, top 30 phrases were extracted from all papers published in the past 52 years. The 1st place was "patient", which appeared 216 times, the 2nd place was "nurse (192 times)", the 3rd was "development (130 times)", the 4th was "systematic review (128 times)" and the 5 the was "experience (117 times)" (Fig.2).

4. Characteristic word analysis by generation

The analysis subjects were classified into four periods, each of which was ten years, and characteristic words were extracted (Table 2). In the 1980s, phrases related to ethical sides such as "effect", "decision-making", "nursing home"

Table1. Words in dependency relation with categories of all research paper titles   (n=17,089)

	Category	Words in dependency relation	Original Text (Excerpt)
I	Utilization of decision support system	'use' 'clinical decision support system' 'personal digital assistant' 'clinical practice' 'nursing practice' 'simulation' 'electronic health record' 'impact' 'assess' 'support' 'make' 'medical'	"Use of simulation to study nurses ' acceptance and nonacceptance of clinical decision support suggestions." "Improving medication safety in primary care using electronic health records." "Infusing clinical decision support interventions into electronic health records." "Use of clinical decision support to increase influenza vaccination : multi-year evolution of the system." "Improving accuracy of pressure ulcer staging and documentation using a computerized clinical decision support system ."
II	Disease-specific care	'patient' 'relative' 'know' 'family' 'dementia' 'cancer' 'management' 'patient' 'care' 'life' 'quality' 'improve' 'improve' 'medication safety' 'outcome'	"Interstate data sharing of prescription drug monitoring programs and associated opioid prescriptions among patients with non-cancer chronic pain." "Treatment associated toxicities reported by patients with early stage invasive breast cancer." "There were more decisions and more options than just yes or no: Evaluating a decision aid for advanced cancer patients and their family caregivers." "Management of patients with venous leg ulcers: challenges and current best practice." "Evaluating the link between human resource management decisions and patient satisfaction with quality of care."
III	Role of nurses	'nurse' 'experience' 'role' 'qualitative study' 'critical care nurse'	"Lung cancer treatment rates and the role of the lung cancer nurse specialist : a qualitative study." "Nurses ' and community support workers ' experience of telehealth : a longitudinal case study." "The effects of clinical information presentation on physicians ' and nurses ' decision making in ICUs." "The role of the neonatal intensive care nurse in decision making: advocacy, involvement in ethical decisions and communication." "The role of nurses and patients ' involvement in the clinical decision - making process."
IV	Development of evaluation tool	'development' 'usability' 'decision aid' 'validation' 'evaluation' 'implementation'	"Development and implementation of a subcutaneous insulin clinical decision support tool for hospitalized patients." "Development and validation of a collaborative behaviors objective assessment tool for end of life communication." "Acute pain in adults admitted to the emergency room: development and implementation of abbreviated guidelines." "Development and evaluation of online evidence based guideline bank system." "Development and evaluation of data entry templates based on the entity - attribute - value model for clinical decision support of pressure ulcer wound management."
V	Evidence-based medicine	'systematic review' 'effectiveness' 'economic evaluation' 'literature' 'meta-analysis'	"A systematic review and economic evaluation of bisphosphonates for the prevention of fragility fractures." "Effectiveness of arm exercise on dyspnea in patients with chronic obstructive pulmonary disease: a systematic review." "Use of the physician orders for life sustaining treatment program in the clinical setting: a systematic review of the literature." "Effectiveness of professional oral health care intervention on the oral health of residents with dementia in residential aged care facilities: a systematic review protocol." "Effectiveness and cost effectiveness of computer and other electronic aids for smoking cessation: a systematic review and network meta-analysis."

The five clusters extracted were categorized while their contents were confirmed and original papers were referred, and were named as "I. Utilization of decision support system", "II. Disease-specific care", "III. Role of nurses", "IV. Development of evaluation tool" and "V. Evidence-based medicine".
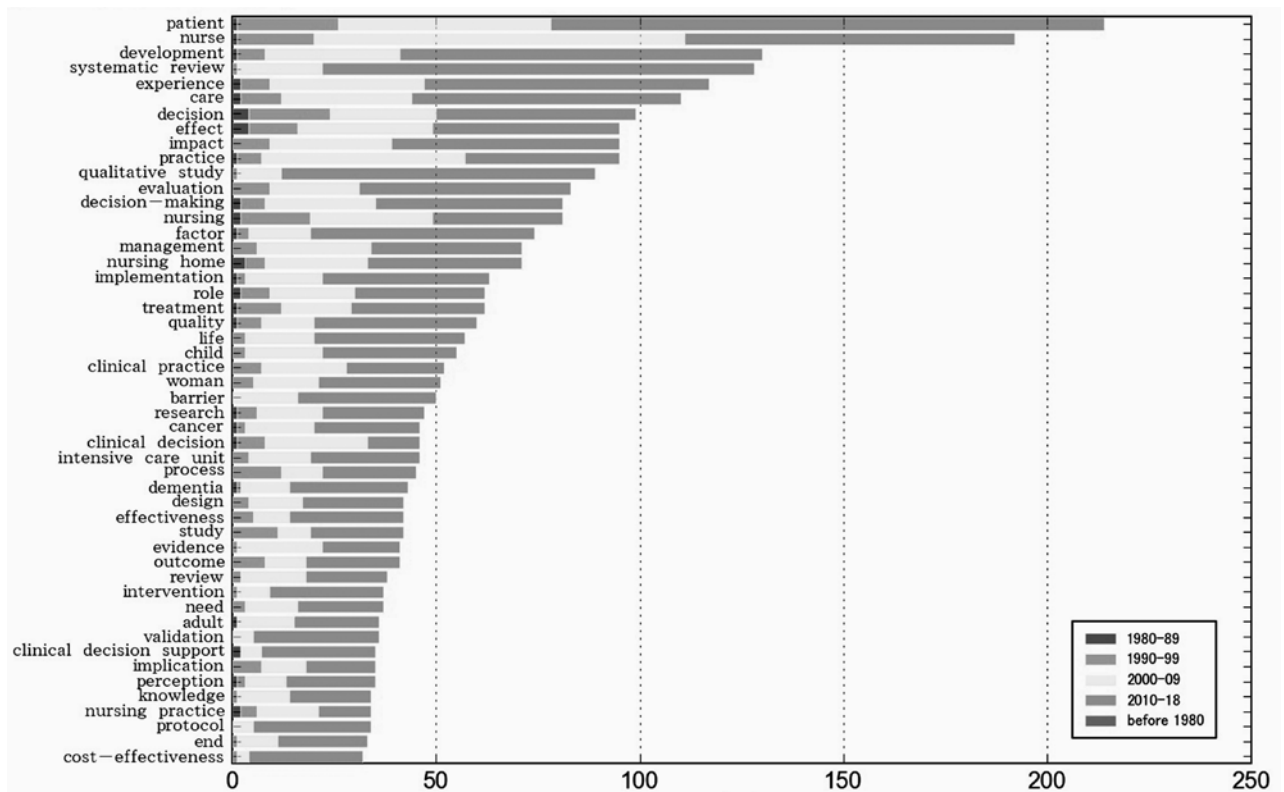

Fig.2. Frequency Analysis of Phrase Used for Title. The 1st place was "patient", the 2nd place was "nurse", the 3rd was "development", the 4th was "systematic review" and the 5th was "experience."

Table2. Characteristic words in each period

(n=17,089)

Rank Order	1980–1989 Word	CSM*	1990–1999 Word	CSM*	2000–2009 Word	CSM*	2010–2018 Word	CSM*
1	clinical judgment	26.28	decision	36.24	nurse	63.76	systematic review	65.93
2	effect	25.42	nursing	31.83	practice	42.22	qualitative study	52.51
3	decision	24.97	process	26.41	clinical decision	22.14	development	29.24
4	nursing home	19.10	study	23.96	patient safety	19.17	patient	26.88
5	expert system	17.48	treatment	17.49	evidence	16.98	factor	25.41
6	staff nurse	17.37	ethical dilemma	16.92	physician	15.25	study protocol	20.97
7	ethical decision	17.26	patient preference	16.92	PDA-based decision support system	14.61	validation	20.94
8	elderly patient	17.03	ethic	16.28	clinical information system	12.55	emergency department	19.81
9	informed consent	17.03	patient	16.10	strategy	12.23	cost effectiveness	19.51
10	level	17.03	critical care nurse	15.95	management	11.46	protocol	19.22
11	clinical decision making	16.58	outcome	14.05	doctor	10.41	clinical decision support	16.04
12	issue	15.69	Alzheimer disease	13.51	technology	10.41	intervention	13.72
13	nursing home resident	15.12	breastfeeding	12.86	clinical practice	9.45	people	12.88
14	nursing practice	14.23	clinical decision making	12.86	nursing practice	8.90	scoping review	12.08
15	clinical decision support	14.11	implication	12.57	nursing	8.90	randomized controlled trial	12.02
16	role	11.08	decision support	12.39	introduction	8.86	feasibility	11.48
17	decision making	8.95	nursing research	11.39	personal digital assistant	8.86	quality	11.32
18	nursing	8.95	problem	10.74	decision support	8.63	cross sectional study	11.21
19	cancer chemotherapy	8.91	issue	10.28	evidence based practice	8.54	end of life care	11.16
20	clinical ethicist	8.91	effect	10.23	review	8.31	perspective	11.16
21	critical care area	8.91	risk	9.63	datum	8.17	integrative review	10.92
22	dying child	8.91	benefit	9.45	clinical supervision	8.08	barrier	10.78
23	inconsistency	8.91	cardiac output	9.27	evidence based nursing	8.08	implementation	9.86
24	institution	8.91	expert nurse	9.27	nutrition	7.49	response	9.76
25	life edge	8.91	informatics	9.13	way	7.39	birth	9.19
26	nurse characteristic	8.91	clinical decision	9.01	case management	7.30	randomised controlled trial	9.14
27	practice position	8.91	patient autonomy	8.62	clinical practice guideline	7.08	evaluation	8.91
28	research technique	8.91	meaning	8.30	cardiac surgery	6.71	palliative care	8.87
29	treatment control	8.91	clinical reasoning	8.16	information technology	6.71	dementia	8.78
30	supportive care guideline	8.91	preference	8.16	prevention	6.66	life	8.73

In the 1980s, phrases related to ethical sides such as "effect", "decision-making", "nursing home" were seen. In the 1990s, phrases such as "decision", "nursing", "process", "study" and "treatment" to evaluate clinical situations were seen. In the 2000s, role of nurse became important and therefore "nurse", "practice", "clinical decision" and "patient safety" were seen. In the 2010s, "systematic review" appeared in the 1st place. "End -of-life care" and "palliative care" were seen as phrases that expressed ideas for nursing.

and "ethical decision" including "clinical judgment" were seen. In the 1990s, phrases such as "decision", "nursing", "process", "study" and "treatment" to evaluate clinical situations were seen. "Ethical dilemma" and "Alzheimer disease" appeared as new phrases for dilemma and disease. In the 2000s, role of nurse became important and therefore "nurse", "practice", "clinical decision" and "patient safety" were seen, and the phrase "evidence evidence-based nursing" appeared. In the 2010s, "systematic review" appeared in the 1st place. "End -of-life care" and "palliative care" were seen as phrases that expressed ideas for nursing. Moreover, "clinical decision support" and " dementia" were characteristic.

IV. Discussion

1. Overview of decision support

Study themes for decision support were classified in five categories. Each of them is analyzed and discussed here.

1) Category of utilization of decision support system

Computerization of medical information promoted information sharing for medical personnel. The flow of provision of explanation that is easy for the subjects is seen. Moreover, computer-assisted diagnosis for medical diagnoses is included. However, the support aims at treating subjects' disease to the last and promoting their health. Considering that it was introduced to achieve the goals quickly and precisely. The purpose of the support should not be positioned as a medical judgment support system for medical personnel, but as a self-determination support system for subjects. Therefore, for using the system, the support here indicates collaborated work by the subjects and the supporter, and its core always is subjects" in any scene. It is indicated that construction of the support system intends even improvement in quality of support, promotion of subjects' empowerment and development of social resources[8–12].

2) Category of disease-specific care

This is a category for the support by subjects' disease. The point of informed consent is that the subject makes autonomous and spontaneous decisions based on a sufficient information supplement and therefore informed consent suggests that provision of sufficient information to make decision must be guaranteed. What was extracted as a problem was support for pediatric and pubertal patients, dementia elderly, patients in the terminal phase and cancer patients, It is described that support should not be separated from the self-determination, but should be incorporated in the decision making process as

an option for the subjects. Problems are recognized in support methods and contents by disease, role of medical personnel, influence factors and discharge adjustment process. Moreover, as a content of decision-making, gaps of the intention among subjects, families and medical personnel for decision of treatment place after discharge are regarded as a major focus[13–17].

3) Category of role of nurses

Roles of nurses in self-determination are summarized. It has been confirmed by referring to the original papers that the basics of supported decision-making basics is the presence of confidential relation between the persons who provide support and receive the supports. Moreover, appropriate information supplement and provision of individual medical care to subjects are required under the current situation that medical functionalization advances[18–22]. One of the functions of nursing is to support subjects' life, and the concept of "patient-centered medicine" spread had spread in nursing science relatively earlier than in other health care occupations. From this category, it is guessed that the importance of roles of nurses is recognized abroad.

4) Category of development of evaluation tool

This category is for development of evaluation tools based on screening of support needs and electronic recording systems. Support required for maximizing the subjects' ability for decision making is sought for, regarding support in daily life, direct support to decision marking, indirect support to environment and institutionalized support. Subjects' decision marking and information supplement have come to be focused nowadays, and maintenance of a medical provision system from the viewpoint of medical functionalization and subjects has been studied as support to the aging society[23–27].

5) Category of evidence-based medicine

This is a category for investigation that assumes a role of examination of the contents. Not only the types or quantity of support such as time spent on support but also quality of support such as concrete support content and methods are described[28–32]. Since studies are a process to verify and to create existing intellect that influences the practice, promotion of practice based on evidence and execution of the study to produce evidence in clinics are vital so as to improve quality of support[33]. The increase in the number of papers on EBM proves that researchers have attempted to elucidate nursing based on scientific findings.

2. Transition of study theme by generation

The results of the characteristic word analysis by generation shows that study themes changed with time and that they change in conjunction with a social background and policies. Here, we examine social backgrounds and study themes by generation.

1) Study and background in the 1980s

This was the period when the era in which information on medical care was entrusted to discretion of doctors based on paternalism to the one when disclosure of medical information to subjects was pushed forward. Further, outcome studies that focused on aiming at not only curing the subject's disease physiologically but also satisfying patients' needs from the point of view of QOL were important. In Europe and America, intention expression by advance directive (AD) was promoted[34], and "WMA DECLARATION OF LISBON ON THE RIGHTS OF THE PATIENT" was adopted in 1981[35]. In Japan, cancer became the first place of cause of death in 1981, and cancer measures are strengthened by the government. As part of the measures, cancer policy started with "the first anti-cancer ten-year broad strategic view" in 1984, and National Cancer Center and cancer research facilities were established based on the measures[36]. The trend is seen in overseas, and studies on cancer therapy and prevention progressed in the medical field. The phrases such as "clinical judgment", "decision-making" and "ethical decision" were extracted as characteristic words in 1980s, which suggests that studies on medical ethics in clinics increased.

2) Study and background of the 1990s

In the 1990s, it was revealed that processes that led to decision making were unclear and advance directive (AD) was not spreading out enough[34]. The phrases such as "decision", "nursing", "process", "treatment" and "ethical dilemma Alzheimer disease" were extracted as characteristic words in the 1990s. In this era, Japan's medicine met with criticism under the influence of medical accidents and HIV-tainted-blood scandal, and protection of patients' human rights and self-decision rights and empowerment came to be focused[37]. Concepts such as life ethics, euthanasia and death with dignity spread, and consciousness of people changed, and the concept of QOL has begun to spread throughout the world in this stage[38]. Moreover, it was the era when management and computerization of medical records and medical information began[39].

3) Study and background of the 2000s

For the 2000s, a great change is seen in extracted characteristic words. The phrases "nurse", "practice", "clinical decision", "patient safety" and "evidence evidence-based nursing" are ranked high in the characteristic words. While aging and chronic disease increased from this stage, treatment progressed with medical development, and patients who lived at home while undergoing medical treatment in their home increased. The theme "How do I live with the disease?" attracted attention, and the importance of roles of nurses in supporting patients' life came to be recognized. As the phrases "PDA-based decision support system," "clinical information system" and "strategy" appeared in 6th, 7th and 8th places, construction of decision support systems began in this stage.

Moreover, the hospice movement spread worldwide from around 2000, and action for palliative care was started[37]. Moreover, the movement for concluding Convention on the Rights of Persons with Disabilities started with the adoption of "Comprehensive general international treaty to protect and promote the right and dignity of persons with disabilities" in the 56th United Nations General Assembly of 2001. In 2006, after the adoption of "Convention on the Rights of Persons with Disabilities" of the United Nations, argument for "Supported Decision Making" became active at home and abroad 40). In other words, in the 2000s, people's consciousness about cancer, disease and disability changed, and the concept of QOL spread.

4) Study and background of the 2010s

The phrase "systematic review" appeared in the first place, followed by "qualitative study" and "development". Moreover, "end-of-life care" and "palliative care" are seen, and the characteristic words "clinical decision support" and "dementia" reflects the background of the era that the care system changed from the hospital-centered care changed to the regional comprehensive care system. The concept of "QOL" and "palliative care" which spread in the 1990s took root, and medical care shifted to "client-centered"[41]. Practice that overseas life support plays a key role in medical care. It is needed not only to take care of the patients while they are in the hospital or the facilities but also to foresee how they have lived their lives and how they are going to live. This means not ad hoc problem solving but support for patients so that they can fully demonstrate the power they have while viewing their life and future image in a long-term viewpoint. In order to achieve it, it is necessary not only to acquire medical knowledge but also to develop individual support understand-

ing well about the patients[42]. The extracted characteristic words are the results of presentation of the attitude to support decision markings by subjects and their families while providing information based on expertise and understanding on subjects' needs in a holistic way.

V. Conclusions

In this study, the global trend of the studies on decision support has been clarified through the analysis on titles of 4,366 original papers published in the past 52 years. Moreover, the following three points have been suggested as directionality of self-determination and patient support in medical care.

1. The premise of decision support is establishment of confidential relation between the subject and supporter.

2. The supporter's role is to provide support that enables the subject to make decision independently from multiple options.

3. Construction of a decision support system that is able to deal with the global scale aging is desired.

Acknowledgement

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