Observational Study

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Final diagnoses and probability of new reason-for-encounter at an urban clinic in Japan

A 4-year observational study

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Abstract

Past clinical data are not currently used to calculate pretest probabilities, as they have not been put into a database in clinical settings. This observational study was designed to determine the initial reasons for utilizing home visits or visits to an outpatient urban clinic in Japan.

All family medical clinic outpatients and patients visited by the clinic (total = 11,688) over 1460 days were enrolled.

We used a Bayes theorem-based clinical decision support system to analyze codes for initial reason-for-encounter (examination and final diagnosis: pretest probability) and final diagnosis of patients with fever (conditional pretest probability).

Total number of reasons-for-encounter: 96,653 (an average of 1.2 reasons per visit). Final diagnosis: 62,273 cases (an average of 0.75 cases per visit). The most common reasons for initial examination were immunizations, physical examinations, and upper respiratory conditions. Regarding the final diagnosis, the combination of physical examinations and acute upper respiratory infections comprised 73.4% of cases. In cases where fever developed, the bulk of the final diagnoses were infectious diseases such as influenza, strep throat, and gastroenteritis of presumed infectious origin. For the elderly, fever often occurred with other health issues such as pneumonia, dementia, constipation, and sleep disturbances, though the cause of the fever remained undetermined in 40% of the cases.

The pretest probability changed significantly based on the reason or the combination of reasons for which patients requested a medical examination. Using accumulated data from past diagnoses to modify subsequent subjective diagnoses, individual diagnoses can be improved.

Abbreviations: CDSS = clinical decision support system, ICPC-2 = International Classification of Primary Care, 2nd Edition, NOS = not otherwise specified.

Keywords: Bayes theorem, diagnosis, medical coding, observational study, reason-for-encounter

1. Introduction

What is happening in the examination room? Though there is a vague understanding based on experience of the overall picture of what takes place, in terms of quantified data, there is an insufficient grasp of what really takes place.

In the 1990s, it was suggested that statistical data could be used in diagnosis if the probability theory proposed by Thomas Bayes in the 1700s (hereafter referred as Bayes theorem) was applied.[1,2] According to Bayes theorem, to estimate a patient's chances of being diagnosed with any disease, it is necessary to obtain the patient's pretest probability and likelihood ratio.[2,3] The likelihood ratio can be rationally calculated using the given sensitivity and specificity, which can be obtained from general observations concerning diagnosis. However, it is necessary to use the statistical data collected from all past diagnoses in that particular medical facility to assess the frequency of a given disease being diagnosed to determine the pretest probability; it would be difficult to obtain such information from a general database of electronic medical records.

Furthermore, to calculate the pretest probability of a patient who had come into the clinic, it is necessary to extract the data regarding the final diagnosis under relevant conditions. However, though past observational studies[4–12] have considered this based on the size of the medical facilities, regional characteristics, and physician skills, they have not sought to determine the relationship between the patient's chief complaint and the final diagnosis or its pretest probability.

Not only does the pretest probability change based on the examination location, such as the size of the medical facility or its specific location, a variety of conditions can affect the outcome of the probability; such conditions include the patient's age, whether or not there is a current epidemic of a given infection, or the time of the day when the patient is being examined. To be able to utilize ever-changing, dynamic statistical data in a clinical setting while providing medical care, there must be a feature within the electronic medical records that collects and analyzes all past diagnostic data and allows real-time referencing. Though there is one such reported case of an electronic medical record that has such a feature, it was developed for research purposes,[13] and no

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reports of implementation of such a system in actual clinical settings could be found.

To this day, clinicians diagnose their patients with subjective and arbitrary pretest probabilities; this is a concern as it means the individual experience of the clinicians could severely affect their estimates. Using such subjective pretest probabilities is fraught with danger, as it may lead to deciding on the wrong treatment or may worsen the prognosis.

Therefore, we have implemented a clinical decision support system (CDSS), which has as its basic function the ability to reference pretest probabilities based on all past medical data. The CDSS could be used to determine the pretest probability of clinical diagnoses based on all medical data of a family medical clinic.

The main purpose of this study was to diagnose all subjects who used a certain urban clinic using CDSS and determine (1) the initial reasons for patients seeking care (new encounters) and their final diagnosis (pretest probability) based on their age group and (2) the final diagnosis (conditional pretest probability) of patients with fever.

2. Methods

2.1. Study design

This was an observational study including a descriptive epidemiological study of the frequency of the reason-for-encounter and the final diagnosis (pretest probability) and a cross-sectional study regarding such diagnoses. This study was approved by the institutional review board.

2.2. Setting

The study took place in a newly established bed-less family medical clinic on the west side of Tokyo (hereafter referred to as the clinic). Because home visits were conducted, the setting included not only the clinic's examination room but also the residences of the patients as well as facilities for the elderly. The data collection period was 1460 days from the day the clinic opened its doors (June 1, 2011) to the date of analysis (May 31, 2015). There were 14 doctors (hereafter referred to as attending physicians) who attended to the patients during the study. Physicians in their initial clinical training and short-term medical interns were not included.

2.3. Participants

All outpatients to the clinic and the patients visited by the clinic for all reasons during the data collection period were the subjects. Therefore, this study includes visits that were only for physical examinations or immunizations.

The participants who came to the clinic for the first time to be examined were told that the patient's reason-for-encounter and diagnostic codes were collected anonymously and utilized for diagnoses, and the overview was explained in the inquiry system and then orally if there was any need to do so. Additionally, we posted a notice in the waiting room explaining that we would use the information for research purposes.

2.4. Data source

Age, sex, ID, day of visit, new reason-for-encounter codes, and diagnostic codes collected during the data collection period were entered into CDSS "Dr. Bayes" (Ver. 1, Windows Edition, Macros Japan Co., Ltd.), which was created by the present authors. These data were subsequently used for the analysis. The data were stored in a server computer in the clinic, and all of the analyses were conducted by delinking the patient's name in a way that the data could not be linked back to the specific patient.

The reason-for-encounter code and diagnostic codes conformed to the Japanese version of the International Classification of Primary Care, 2nd Edition (ICPC-2).[14] The reason-for-encounter codes were entered by the participants themselves or by those who accompanied them, such as a family member, directly into a Dr. Bayes through a touch panel by selecting (up to 2) answers in its inquiry system. When the information was gathered by the nurses or the staff or when the participants or their companions reported a condition while receiving care, the attending physicians entered the information at their own discretion. Data regarding all apparent current health issues, such as diseases for which they were being treated, were entered.

The diagnostic codes were entered by the attending physicians based on clinical decisions, at the end of each visit. (No diagnostic criteria were set, and it did not matter whether or not the diagnosis was confirmed through tests.) If a diagnosis was not made by the end of the visit based on the ICPC-2 protocol, the reason-for-encounter code was used as the diagnostic code.

If there were any outcomes, such as recovery, change of attending physician, hospitalization, or death, the attending physician entered the outcome information at the point the information became available. Until all health issues were resolved and the outcome was entered, every visit was considered and treated as 1 episode group. Even within the same episode group, if there were any new reasons-for-encounter or if a diagnosis was changed, the codes were added or changed in each case (Table 1).

The final diagnosis within each episode group was defined as the final diagnostic code that was entered at the point of the outcome; that is, upon resolution of the health problem, end of treatment, or death, the most recent diagnostic codes on the day of the analysis which were entered at the last visit (or if seen multiple times on the same day, codes were entered when each visit finished).

The diagnostic codes were displayed in the Dr. Bayes unresolved/acute/active column and utilized as a problem list. The attending physicians could decide to move chronic diagnostic codes to the chronic/inactive column at their discretion. However, unless there was an outcome such as recovery, discontinuation, or death, they were tallied as ongoing health issues. Ongoing, chronic, or inactive issues were excluded from the current analysis.

To prevent the attending physicians from using mismatching codes, we added search features in Dr. Bayes to look up ICPC-2 codes as well as a way to display, in order of frequency, the entry codes from past diagnostic data based on sex or age group. If, for example, the attending physicians found that the codes did not align, or if they were unable to determine the relevant codes, they sought each other's opinions and shared information.

2.5. Statistical methods

All information within the Dr. Bayes database was extracted based on the following 3 age groups: children (under 15 years), adults (over 15, under 65 years), and elderly (over 65 years). New reasons-for-encounter were displayed based on the number of cases and the ratio (number of cases/all new reasons-for-

Table 1

Example of specific codes (fictitious case).

Episode	Date	New /Old		Reasons-for-encounter		Diagnosis	Outcome	Date
1	2012/9/2	N	A03	Fever	R74	Upper respiratory infection acute		
		N	R21	Throat symptom/complaint				
	2012/9/4	O	R74	Upper respiratory infection acute	R74	Upper respiratory infection acute		
		N	H01	Ear pain/earache	H71	Acute otitis media/myringitis		
	2012/9/9	O	R74	Upper respiratory infection acute	R74	Upper respiratory infection acute	Resolved	2012/9/9
		O	H71	Acute otitis media/myringitis	H71	Acute otitis media/myringitis	Resolved	2012/9/9
		N	R07	Sneezing/nasal congestion	R97	Allergic rhinitis	Resolved	2012/10/30
		N	R05	Cough	A85	Adverse effect medical agent	Resolved	2012/10/30
		N	D11	Diarrhea				
2	2012/10/30	N	-44	Preventive immunization/medication	A98	Health maintenance/preventive medicine	Finished	2012/11/30

A patient presented on September 2, 2012 with a fever and a sore throat and was diagnosed with acute upper respiratory infection. On September 4, the patient developed an earache, came to the clinic, and was diagnosed as having developed complications from acute otitis media. On September 9, the patient experienced symptoms of nasal congestion, cough, and diarrhea, came to the clinic, and was consequently diagnosed with complications from allergic rhinitis; it was determined that the diarrhea was a side effect of the medication. On October 30, the patient presented for immunization, and the attending physician learned that the patient had already recovered from allergic rhinitis and diarrhea. In this case study, the events from September 2 through the 9 are considered as a single episode group, and events following October 30 would be considered as a separate episode group.

encounter code numbers) based on the cumulative percentage in order of frequency. The final diagnoses were displayed by the number of cases and pretest probability (number of cases/number of episode groups) in order of frequency.

When the reason-for-encounter displayed A03 Fever in the code, the final diagnoses of such patients were also displayed per age group based on the number of cases, conditional pretest probability (number of cases/number of episode groups that included A03) in order of frequency. Additionally, in the case of children, we displayed not only the A03 Fever code but also any of the cases that expressed R05 Cough, R21 Throat symptom/complaint, S06 Rash localized, D06 Abdominal pain localized other, D10 Vomiting, and D11 Diarrhea in the symptoms; these were displayed based on the number of cases and conditional pretest probability (number of cases/the number of episode groups that included the relevant codes) per age group in order of frequency. The changes in the conditional pretest probability were also expressed with a positive likelihood ratio (LR+) as well.

For the current study, we defined the pretest probability by calculating the number of episode groups as the denominator. This was to more properly reflect the corrections being made on the diagnoses for still open cases. Alternatively, because of the possibility of multiple entries pertaining to the same reasons-for-encounter within 1 episode group, there was a tendency for the pretest probability to be calculated as slightly higher than the actual value.

3. Results

3.1. Participants

A total of 11,688 participants used the services of the clinic until the day of the analysis. The total number of times our services were used was 83,523 (average use, 7.1 times per person); in 46.8% of cases, the services were used by those under 15 years (Table 2). There were 36,706 episode groups (average, 3.1 episode groups per person).

There were 96,653 codes of new reasons-for-encounter (average, 1.2 cases per visit and 2.63 cases per episode). There were 62,273 codes of final diagnosis (average, 0.75 cases per visit and 1.70 cases per episode). For each case of final diagnosis, there was an average of 1.4 cases of reasons-for-encounter.

3.2. Main results: (1) descriptive data and pretest probability

New reasons-for-encounter and final diagnoses are displayed by age group in Tables 3 and 4, respectively. In the new reasons-for-encounter, in all age groups, immunization, physical examination, and upper respiratory conditions were the dominant reasons. In the final diagnosis, A98 Health maintenance/preventive medicine accounted for 26.2% of all diagnoses, and at 44.4%, it had the highest pretest probability, followed by R74 Upper respiratory infection acute, which accounted for 17.1% of all diagnoses with a pretest probability of 29.0%. Out of all new health issues, these 2 items comprised more than 70% (pretest probability, 73.4%) of the cases.

3.3. Main results: (2) pretest probability with fever

The final diagnoses in the cases where A03 Fever was coded as a new reason-for-encounter are displayed in Table 5. In children and adults, R80 Influenza, D73 Gastroenteritis presumed infection, and R72 Strep throat, which are infection-related codes, comprised an overwhelming majority of the cases. In the elderly, R81 Pneumonia, P70 Dementia, D12 Constipation, and

Table 2

Number of participants.

Year	Children (n)	(%)	Adults (n)	(%)	Elderly (n)	(%)	Total (n)
2011 (July to Dec)	2636	60.3	1291	29.5	442	10.1	4369
2012	10,320	59.7	4879	28.2	2089	12.1	17,288
2013	11,414	49.1	7250	31.2	4568	19.7	23,232
2014	10,888	39.7	8310	30.3	8222	30.0	27,420
2015 (Jan to May)	3827	34.1	3404	30.4	3983	35.5	11,214
All	39,085	46.8	25,134	30.1	19,304	23.1	83,523

Table 3

New reasons-for-encounter.

	Children (0–14 y)		49,627			Adults (15–64 y)		34,113			Elderly (≥65 y)		12,913	
	ICPC-2	Reasons-for-encounter	n	Incidence (%)		ICPC-2	Reasons-for-encounter	n	Incidence (%)		ICPC-2	Reasons-for-encounter	n	Incidence (%)
1	-44	Preventive immunization/medication	10,956	22.1	1	-44	Preventive immunization/medication	4082	12.0	1	-60	Result test/procedure	928	7.2
2	A03	Fever	7486	15.1	2	R21	Throat symptom/complaint	3862	11.3	2	-44	Preventive immunization/medication	874	6.8
3	R05	Cough	7414	14.9	3	R05	Cough	3633	10.6	3	-30	Medical examination/health evaluation complete	559	4.3
4	R07	Sneezing/nasal congestion	6674	13.4	4	A03	Fever	3122	9.2	4	R05	Cough	522	4.0
5	R21	Throat symptom/complaint	1590	3.2	5	R07	Sneezing/nasal congestion	2851	8.4	5	A03	Fever	505	3.9
6	D11	Diarrhea	1367	2.8	6	N01	Headache	1549	4.5	6	-50	Medication/prescription/renewal/injection	498	3.9
7	D10	Vomiting	1361	2.7	7	-60	Result test/procedure	1110	3.3	7	R07	Sneezing/nasal congestion	326	2.5
8	S06	Rash localized	1314	2.6	8	D11	Diarrhea	1012	3.0	8	R21	Throat symptom/complaint	323	2.5
9	-62	Administrative procedure	866	1.7	9	A04	Weakness/tiredness general	794	2.3	9	-41	Diagnostic radiology/imaging	261	2.0
10	N01	Headache	791	1.6	10	D09	Nausea	671	2.0	10	K86	Hypertension uncomplicated	258	2.0
11	S07	Rash generalized	760	1.5	11	-50	Medication/prescription/renewal/injection	668	2.0	11	D12	Constipation	253	2.0
12	D06	Abdominal pain localized other	664	1.3	12	-30	Medical examination/health evaluation complete	532	1.6	12	S06	Rash localized	208	1.6
13	-30	Medical examination/health evaluation complete	535	1.1	13	D06	Abdominal pain localized other	525	1.5	13	-61	Result examination/test/record/letter from other provider	200	1.5
14	-50	Medication/prescription/renewal/injection	370	0.7	14	D10	Vomiting	460	1.3	14	D11	Diarrhea	178	1.4
15	F03	Eye discharge	350	0.7	15	A02	Chills	440	1.3	15	R25	Sputum/phlegm abnormal	174	1.3
16	H01	Ear pain/earache	334	0.7	16	L20	Joint symptom/complaint NOS	393	1.2	16	P70	Dementia	161	1.2
17	D09	Nausea	291	0.6	17	R25	Sputum/phlegm abnormal	349	1.0	17	D10	Vomiting	159	1.2
18	S21	Skin texture symptom/complaint	238	0.5	18	D02	Abdominal pain epigastric	324	0.9	18	-62	Administrative procedure	155	1.2
19	-60	Result test/procedure	194	0.4	19	R97	Allergic rhinitis	310	0.9	19	L03	Low back symptom/complaint	143	1.1
19	D12	Constipation	194	0.4	20	S06	Rash localized	261	0.8	20	T03	Loss of appetite	140	1.1
21	F13	Eye sensation abnormal	185	0.4	21	R23	Voice symptom/complaint	237	0.7	21	K07	Swollen ankles/edema	137	1.1
22	R25	Sputum/phlegm abnormal	170	0.3	22	N17	Vertigo/dizziness	192	0.6	22	P06	Sleep disturbance	127	1.0
23	S87	Dermatitis/atopic eczema	167	0.3	23	-62	Administrative procedure	187	0.5	23	N17	Vertigo/dizziness	120	0.9
24	D20	Mouth/tongue/lip symptom/complaint	166	0.3	24	-61	Result examination/test/record/letter from other provider	184	0.5	24	A29	General symptom/complaint other	119	0.9
25	R03	Wheezing	157	0.3	25	F13	Eye sensation abnormal	172	0.5	24	D06	Abdominal pain localized other	119	0.9
26	S02	Pruritus	148	0.3	26	-34	Blood test	153	0.4	26	T93	Lipid disorder	113	0.9
27	S16	Bruise/contusion	147	0.3	27	U01	Dysuria/painful urination	146	0.4	27	R02	Shortness of breath/dyspnea	111	0.9
28	R97	Allergic rhinitis	137	0.3	28	L01	Neck symptom/complaint	136	0.4	28	N01	Headache	109	0.8
29	R96	Asthma	130	0.3	29	L03	Low back symptom/complaint	131	0.4	29	U02	Urinary frequency/urgency	104	0.8
30	S98	Urticaria	112	0.2	30	P06	Sleep disturbance	127	0.4	30	T90	Diabetes non-insulin dependent	103	0.8
31	F02	Red eye	106	0.2	31	K86	Hypertension uncomplicated	125	0.4	31	D09	Nausea	102	0.8
32	S17	Abrasion/scratch/blister	103	0.2	32	L02	Back symptom/complaint	111	0.3	32	L14	Leg/thigh symptom/complaint	99	0.8

ICPC-2 = International Classification of Primary Care, 2nd Edition, NOS = not otherwise specified.

Table 4

Final diagnosis.

	Children (0–14 y)		32,946	21,631		Adults (15–64 y)		20,863	12,881		Elderly (≥65 y)		8464	2194
	ICPC-2	Diagnosis	n	Incidence (%)		ICPC-2	Diagnosis	n	Incidence (%)		ICPC-2	Diagnosis	n	Incidence (%)
1	A98	Health maintenance/preventive medicine	10,809	50.0	1	A98	Health maintenance/preventive medicine	4428	34.4	1	A98	Health maintenance/preventive medicine	1067	48.6
2	R74	Upper respiratory infection acute	6227	28.8	2	R74	Upper respiratory infection acute	4078	31.7	2	R74	Upper respiratory infection acute	347	15.8
3	D73	Gastroenteritis presumed infection	1108	5.1	3	D73	Gastroenteritis presumed infection	932	7.2	3	K86	Hypertension uncomplicated	316	14.4
4	R80	Influenza	1070	4.9	4	R97	Allergic rhinitis	867	6.7	4	D12	Constipation	210	9.6
5	A03	Fever	951	4.4	5	R80	Influenza	772	6.0	5	T93	Lipid disorder	207	9.4
6	H71	Acute otitis media/myringitis	783	3.6	6	N01	Headache	456	3.5	6	P70	Dementia	206	9.4
7	R07	Sneezing/nasal congestion	674	3.1	7	R05	Cough	379	2.9	7	A03	Fever	157	7.2
8	R97	Allergic rhinitis	649	3.0	8	R96	Asthma	295	2.3	8	T90	Diabetes non-insulin dependent	129	5.9
9	R05	Cough	622	2.9	9	A03	Fever	277	2.2	9	P06	Sleep disturbance	112	5.1
10	R78	Acute bronchitis/bronchiolitis	579	2.7	10	R78	Acute bronchitis/bronchiolitis	275	2.1	10	A91	Abnormal result investigation NOS	107	4.9
11	D11	Diarrhea	469	2.2	11	F71	Conjunctivitis allergic	234	1.8	11	K07	Swollen ankles/edema	91	4.1
12	R72	Strep throat	464	2.1	12	R21	Throat symptom/complaint	232	1.8	12	R81	Pneumonia	84	3.8
13	R96	Asthma	441	2.0	13	D11	Diarrhea	228	1.8	13	L03	Low back symptom/complaint	83	3.8
14	S87	Dermatitis/atopic eczema	390	1.8	13	R75	Sinusitis acute/chronic	228	1.8	14	D11	Diarrhea	82	3.7
15	S06	Rash localized	370	1.7	15	D06	Abdominal pain localized other	223	1.7	15	R05	Cough	80	3.6
16	D10	Vomiting	352	1.6	16	R72	Strep throat	198	1.5	16	K91	Cerebrovascular disease	78	3.6
17	D06	Abdominal pain localized other	278	1.3	17	D02	Abdominal pain epigastric	187	1.5	17	S97	Chronic ulcer skin	77	3.5
18	S98	Urticaria	261	1.2	17	D09	Nausea	187	1.5	18	K85	Elevated blood pressure	74	3.4
19	R76	Tonsillitis acute	226	1.0	19	R76	Tonsillitis acute	182	1.4	18	T03	Loss of appetite	74	3.4
20	A76	Viral exanthem other	217	1.0	20	A04	Weakness/tiredness general	180	1.4	20	K77	Heart failure	71	3.2
21	N01	Headache	215	1.0	21	T93	Lipid disorder	176	1.4	21	K78	Atrial fibrillation/flutter	70	3.2
22	S07	Rash generalized	212	1.0	22	R07	Sneezing/nasal congestion	153	1.2	21	R97	Allergic rhinitis	70	3.2
23	S21	Skin texture symptom/complaint	203	0.9	23	U71	Cystitis/urinary infection other	152	1.2	23	A29	General symptom/complaint other	68	3.1
24	R75	Sinusitis acute/chronic	201	0.9	24	K86	Hypertension uncomplicated	149	1.2	24	D10	Vomiting	66	3.0
25	D12	Constipation	175	0.8	25	A97	No disease	128	1.0	25	N17	Vertigo/dizziness	63	2.9
26	F71	Conjunctivitis allergic	167	0.8	26	P06	Sleep disturbance	120	0.9	26	U71	Cystitis/urinary infection other	61	2.8
27	S84	Impetigo	163	0.8	27	N17	Vertigo/dizziness	102	0.8	26	Y85	Benign prostatic hypertrophy	61	2.8
28	S88	Dermatitis contact/allergic	149	0.7	28	S98	Urticaria	100	0.8	28	D73	Gastroenteritis presumed infection	60	2.7
29	A72	Chickenpox	148	0.7	28	A91	Abnormal result investigation NOS	100	0.8	28	U06	Hematuria	60	2.7
30	S16	Bruise/contusion	137	0.6	30	D10	Vomiting	94	0.7	30	R25	Sputum/phlegm abnormal	56	2.6
31	F70	Conjunctivitis infectious	117	0.5	30	K85	Elevated blood pressure	94	0.7	31	S06	Rash localized	55	2.5
32	A97	No disease	106	0.5	32	D12	Constipation	89	0.7	32	D06	Abdominal pain localized other	53	2.4
32	R21	Throat symptom/complaint	106	0.5	33	P17	Tobacco abuse	83	0.6	32	R99	Respiratory disease other	53	2.4
32	S12	Insect bite/sting	106	0.5	34	L03	Low back symptom/complaint	78	0.6	34	R21	Throat symptom/complaint	52	2.4
35	A77	Viral disease other/NOS	103	0.5	35	S87	Dermatitis/atopic eczema	76	0.6					

ICPC-2 = International Classification of Primary Care, 2nd Edition, NOS = not otherwise specified.

Table 5

Final diagnosis of patients with fever.

		Fever, children (0–14 y)	12,226	6427			Fever, adults (15–64 y)	5344	2916			Fever, elderly (≥65 y)	1883	382
	ICPC-2	Diagnosis	n	Incidence (%)		ICPC-2	Diagnosis	n	Incidence (%)		ICPC-2	Diagnosis	n	Incidence (%)
1	R74	Upper respiratory infection acute	3398	52.9	1	R74	Upper respiratory infection acute	1327	45.5	1	A03	Fever	153	40.1
2	R80	Influenza	988	15.4	2	R80	Influenza	680	23.3	2	A98	Health maintenance/preventive medicine	128	33.5
3	A03	Fever	945	14.7	3	D73	Gastroenteritis presumed infection	306	10.5	3	R74	Upper respiratory infection acute	89	23.3
4	A98	Health maintenance/preventive medicine	898	14.0	4	A03	Fever	277	9.5	4	R81	Pneumonia	72	18.8
5	H71	Acute otitis media/myringitis	574	8.9	5	R97	Allergic rhinitis	207	7.1	5	P70	Dementia	51	13.4
6	D73	Gastroenteritis presumed infection	429	6.7	6	R72	Strep throat	162	5.6	6	D12	Constipation	50	13.1
7	R72	Strep throat	387	6.0	7	A98	Health maintenance/preventive medicine	137	4.7	7	S97	Chronic ulcer skin	30	7.9
8	R78	Acute bronchitis/bronchiolitis	377	5.9	8	N01	Headache	134	4.6	8	A91	Abnormal result investigation NOS	28	7.3
9	R97	Allergic rhinitis	266	4.1	9	R76	Tonsillitis acute	125	4.3	8	P06	Sleep disturbance	28	7.3
10	R96	Asthma	245	3.8	10	R78	Acute bronchitis/bronchiolitis	101	3.5	8	R99	Respiratory disease other	28	7.3

		Children (0–14 y)					Children (0–14 y)					Children (0–14 years)		
		Fever+Cough	6623	2881			Fever+Throat symptom/complaint	1769	914			Fever+Rash generalized	1164	345
	ICPC-2	Diagnosis	N	Incidence (%)		ICPC-2	Diagnosis	n	Incidence (%)		ICPC-2	Diagnosis	n	Incidence (%)
1	R74	Upper respiratory infection acute	2003	69.5	1	R74	Upper respiratory infection acute	473	51.8	1	R74	Upper respiratory infection acute	183	53.0
2	A98	Health maintenance/preventive medicine	623	21.6	2	R72	Strep throat	233	25.5	2	A98	Health maintenance/preventive medicine	148	42.9
3	R80	Influenza	486	16.9	3	R80	Influenza	154	16.8	3	S07	Rash generalized	100	29.0
4	R78	Acute bronchitis/bronchiolitis	336	11.7	4	A98	Health maintenance/preventive medicine	93	10.2	4	A76	Viral exanthem other	61	17.7
5	H71	Acute otitis media/myringitis	332	11.5	5	R97	Allergic rhinitis	88	9.6	5	A03	Fever	58	16.8
6	R96	Asthma	208	7.2	6	R76	Tonsillitis acute	54	5.9	6	H71	Acute otitis media/myringitis	56	16.2
7	A03	Fever	192	6.7	7	R96	Asthma	49	5.4	7	S87	Dermatitis/atopic eczema	41	11.9
8	R97	Allergic rhinitis	186	6.5	8	A03	Fever	44	4.8	8	S98	Urticaria	34	9.9
9	R05	Cough	180	6.2	9	S87	Dermatitis/atopic eczema	34	3.7	9	R72	Strep throat	33	9.6
10	D73	Gastroenteritis presumed infection	125	4.3	10	R21	Throat symptom/complaint	31	3.4	10	R78	Acute bronchitis/bronchiolitis	28	8.1
10	R07	Sneezing/nasal congestion	125	4.3										

		Children (0–14 y)					Children (0–14 y)					Children (0–14 y)		
		Fever+Abdominal pain localized other	860	301			Fever+Vomiting	1767	587			Fever+Diarrhea	1847	555
	ICPC-2	Diagnosis	N	Incidence (%)		ICPC-2	Diagnosis	n	Incidence (%)		ICPC-2	Diagnosis	n	Incidence (%)
1	R74	Upper respiratory infection acute	145	48.2	1	R74	Upper respiratory infection acute	307	52.3	1	R74	Upper respiratory infection acute	325	58.6
2	D06	Abdominal pain localized other	101	33.6	2	D73	Gastroenteritis presumed infection	236	40.2	2	D73	Gastroenteritis presumed infection	233	42.0
3	A03	Fever	71	23.6	3	A98	Health maintenance/preventive medicine	204	34.8	3	A98	Health maintenance/preventive medicine	204	36.8
3	D73	Gastroenteritis presumed infection	71	23.6	4	D10	Vomiting	131	22.3	4	D11	Diarrhea	181	32.6
5	A98	Health maintenance/preventive medicine	68	22.6	5	A03	Fever	84	14.3	5	H71	Acute otitis media/myringitis	86	15.5
6	R72	Strep throat	31	10.3	6	H71	Acute otitis media/myringitis	59	10.1	6	A03	Fever	70	12.6
6	R80	Influenza	31	10.3	7	R80	Influenza	57	9.7	7	R07	Sneezing/nasal congestion	51	9.2
8	R97	Allergic rhinitis	27	9.0	8	R96	Asthma	45	7.7	8	R05	Cough	43	7.7
9	R96	Asthma	19	6.3	9	R72	Strep throat	44	7.5	8	R96	Asthma	43	7.7
10	D12	Constipation	16	5.3	10	R97	Allergic rhinitis	41	7.0	10	S87	Dermatitis/atopic eczema	42	7.6

ICPC-2 = International Classification of Primary Care, 2nd Edition, NOS = not otherwise specified.

P06 Sleep disturbance were among the common codes that were not as common among children and adults.

Furthermore, regarding the final diagnosis, the conditional pretest probability coded A03 Fever (fevers of undetermined causation), was low in both children and adults at 14.7% and 9.5%, respectively, but was high in the elderly at 40.1%.

3.4. Other analyses

When considering the conditional pretest probability in children with fevers combined with other reason-for-encounter, we were able to determine how much the pretest probability changed based on the combined symptoms. For instance, compared with A03 Fever (6.0%) alone, R72 Strep throat combined with R21 Throat symptom/complaint (25.5%, LR+ 5.36) raised the conditional pretest probability. Moreover, compared with A03 Fever (15.4%) alone, when fever was accompanied by R80 Influenza combined with upper respiratory conditions such as R05 Cough (16.9%, LR+ 1.12) or R21 Throat symptom/complaint (16.8%, LR+ 1.11), the conditional pretest probability did not change; however, when A03 Fever was accompanied by codes related to the digestive system, such as D06 Abdominal pain localized other (10.3%, LR+ 0.63), D10 Vomiting (9.7%, LR+ 0.59), or D11 Diarrhea (7.0%, LR+ 0.41), the conditional pretest probability was decreased.

4. Discussion

4.1. Key results

This study is the first of its kind to report utilizing past accumulated diagnostic data in a clinic to calculate pretest probabilities in real time to assist in diagnosing patients. When we examined the new reasons-for-encounter, immunization, physical examination, and acute upper respiratory infections comprised the majority of reasons for seeing patients in all age groups. In the final diagnoses where the fever was a top new reason-for-encounter, influenza and other infectious diseases were the most common in children and adults. However, for the elderly, pneumonia, dementia, constipation, and sleep disturbances were found to accompany the fever; moreover, unlike other age groups, in 40% of cases, the fevers dissipated without ever determining the cause.

4.2. Interpretation and generalizability

There are prior studies on outpatients' reasons-for-encounter,[4–12] and we have found the same tendencies for the most frequent reasons-for-encounter or diagnoses. However, in these prior studies, the frequency of the reasons-for-encounter and the frequency of the final diagnosis were expressed independently and were not stratified based on age. The reason for this is that these prior studies were conducted to examine the range of health issues with which family practitioners deal in their daily practices.

Of these prior studies, only the study by Waza et al[4] reported a comparison of the frequencies of the main reasons-for-encounter in a hospital's outpatient facility over a year as well as comparison by age. In that study, in 142 cases, including those in children aged 0 to 14 years, with A03 Fever as the reason-for-encounter, the diagnosis (ICD-10) in 58.5% of the cases was acute upper respiratory infection, acute gastroenteritis in 12.0%, and acute tonsillitis in 7.7%; influenza was not in the 10 most common diagnoses. In 16 cases where the patients were more than 65 years old, 31.3% were diagnosed as acute upper respiratory infection, while 18.8% had arthritis and 18.8% had fever of undetermined cause. The current results are similar to these prior results in that acute upper respiratory infection was more common in children and adults and having a fever of undetermined cause was common in the elderly. It is possible that in many cases of elderly in-home care patients developing fevers, management (experimental treatment) is prioritized without a definite diagnosis. However, there is room for further consideration regarding the phenomenon that the fever of such patients is often alleviated naturally. Regardless, the environment for outpatient care has changed since the prior study, and it is no longer as simple to compare cases such as influenza, as it has been underdiagnosed in Japan.

Although we only partially considered the final diagnosis (conditional pretest probability) of patients with fever, it became evident that the pretest probability fluctuates greatly based on age and reason-for-encounter. For example, children with gastrointestinal symptoms have been shown to have lower conditional pretest probability for influenza. This finding is consistent with that of a prior study[15] suggesting that the probability of an influenza diagnosis decreases (odds ratio: 0.84) when gastrointestinal symptoms are observed. By using the accumulated medical data to correct the subjective diagnostic judgments of the physicians, we can expect to improve each individual diagnostic process.

Furthermore, to provide a more precise diagnosis and decisions regarding treatment plans, it is first necessary to further study the various factors influencing the diagnosis. CDSS can provide the foundational medical data for such a study.

For example, in the case of infectious diseases and other epidemic diseases, CDSS would likely be useful for epidemic forecasting and activities that could raise awareness. Moreover, in cases where there are vast differences among various medical care settings or among physicians, such as in the field of family medicine, comparing diagnostic characteristics could improve the quality of care as well as be helpful for further clinical studies. To assist with further clinical studies, we will continue to collect further data and conduct further analyses.

4.3. Limitations

This study has some structural limitations. First, all diagnoses depended on clinical diagnosis, so it was not possible to determine the accuracy of the diagnosis. When the patients revisited the clinic, we learned the outcomes after the fact; however, in the absence of such revisits, we would have been unable to obtain accurate information regarding the outcomes and may not have been able to accurately reflect the diagnoses of other hospitals and medical facilities that were also visited. Therefore, though the diagnostic accuracy increases with diseases with a higher rate of occurrence, in the case of rare diseases, diagnostic accuracy decreases due to lack of data. Accordingly, it is a challenge to improve the system to more accurately determine outcomes in clinical settings; nonetheless, it is important that, based on the characteristics of the system, it is not suitable for assisting in diagnosing rare diseases.

Furthermore, bias cannot be excluded during coding. Fever tends to be identified by caregivers and coded by the attending physician, thus creating detection bias. Biases such as gastroenteritis-presumed infection with respect to cases of diarrhea tend to be coded based on specific symptoms. Thus, it is possible that such biases may influence the data. The diagnostic tendencies of the attending physician can become a major source of bias because of the relatively short time

allotted for coding within the total care time, and we would like to consider this type of bias in future studies.

Additionally, there is an instability issue with ICPC-2. For example, there are diseases, such as Kawasaki disease, that do not have corresponding reason-for-encounter or diagnostic codes (or the inability to enter detailed names of the diagnosis into the codes). Moreover, as in the case of P17 Tobacco abuse, some codes may or may not be coded depending on the attending physicians. Technological improvements of the interface to overcome and minimize such instabilities in the codes are challenges that lay ahead.

5. Conclusion

We reported the details of diagnoses, which utilized CDSS for the diagnostic process over a 4-year period for all 11,688 individuals who used the services of an urban clinic in Japan. This study illustrates it is possible to use CDSS to obtain epidemiological data such as the reasons-for-encounter and final diagnoses, as well as enabling calculation of the pretest probability based on age or reason-for-encounter. CDSS could be a useful tool in understanding and improving the reality and quality of the diagnoses.

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