

About the Evaluation of Liver Disease by the Monitoring of Mahalanobis Distance: Examination for Acute Hepatic Failure

Hisato Nakajima^{1*}, Kouya Yano², Shinichirou Uetake³ and Ichirou Takagi³

¹Department of Medical Insurance Guidance Room, The Jikei University Hospital, Japan

²Department of Industrial Engineering and Management, College of Industrial Technology, Nihon University, Japan

³Department of Gastroenterology and Hepatology, The Jikei University School of Medicine, Japan

Abstract

It is Mahalanobis-Taguchi (MT) system to give the standard to evaluate a process of diagnosis of the doctor commonly. When Mahalanobis distance (MD) is calculated using MT system, it can be grasped as a unitary statistic. MD was calculated using data of fulminant hepatitis and acute on chronic hepatic failure, and a change of MD was compared with the outcome of patients. As a result, it was expressed for the numerical unified value that the data which changed complicatedly. When MD increase, the condition of a patient turns worse. When MD decreases, the condition of a patient is improved. This judgment was enabled easily and was useful as information in the medical treatment.

Keywords: Mahalanobis distance; Mahalanobis-taguchi system; Acute hepatic failure

Introduction

It may be said that the process of thinking that a doctor unifies majority items such as physical views, clinical examination, image diagnosis, and medical care is pattern recognition. It is Mahalanobis-Taguchi (MT) system [1] to give the standard to evaluate that is common to this pattern recognition. Kanetaka [2] used MT system for the judgment of medical examination for the first time. We also reported judgment and cost reduction [3-5] of the medical examination, future prediction of the health condition [6], pathologic grasp and diagnosis of liver disease [7,8]. Particularly, we pointed out that it was the index of liver transplant when a value of Mahalanobis distance (MD) by MT system continued over 1,000 for hepatic failure or hepatocellular carcinoma [9]. Furthermore, for autoimmune liver disease, we reported that the diagnosis of border line of autoimmune liver disease was possible by the reversion of the pattern of figure of factor effect made in MT system [10].

When this MT system is used, and MD is calculated by clinical data, the grasp as the unitary statistic of clinical data becomes possible [8-10]. We calculated MD using clinical data of fulminant hepatitis and acute on chronic hepatic failure this time, and we compared the change of value of MD with the outcome of patient. It was expressed for the numerical unified value that clinical data to change complicatedly. And a pathologic evaluation and a judgment of the curative effect were enabled easily. Because such system was useful as information in the medical treatment, we report it.

Methods

Nineteen acute hepatic failure used for this examination was 15 fulminant hepatitises and four acute on chronic hepatic failure. The details of 19 cases were shown in Table 1. The survivors were four fulminant hepatitises and were one acute type, three subacute type. The death was 15 cases and was three fulminant hepatitises acute type, eight subacute type and four acute on chronic hepatic failure.

The data of following 18 items were used for this examination. There was the item in hepatic coma grade (coma), ammonia (NH₃) microgram/dl, number of platelets (PLT) 10⁹/L, prothrombin time (PT) %, hepaplastin test (HPT)%, aspartate aminotransferase (AST)/IU/L, alanine aminotransferase (ALT) IU/L, lactate dehydrogenase (LDH) IU/L, cholinesterase (ChE) IU/L, total bilirubin (T.B) mg/dl, alkaline phosphatase (ALP) IU/L, leucineaminopeptidase (LAP) IU/L,

gamma-glutamyltranspeptidase (rGT) IU/L, Urea nitrogen(UN) mg/dL, creatinine (Cr) mg/dL, total cholesterol (T.C) mg/dL, total protein (T.P) g/dL, albumin (ALB) g/dL.

The unit space of MT system is defined individually. In addition, it is evaluated how much an object is away from the unit space by a level of MD. MT system is divided into MT method, MT Ajoint method, Taguchi-Schmidt method and Taguchi method. The MT method used this time is a method using an inverse matrix using MD, and it's precision is higher than other methods. It is the characteristic of this method that the target average by unit space becomes "MD=1". The data of 18 items of 30 physically normal people were shown in Table 2, and these data were used for making of the unit space. In addition, the data of each case used for examination were shown in Tables 3-5. The data of 18 items of these 19 cases were used, and MD was calculated by MT method. Hepatic coma grade assumed it a five level from zero, and numerical value data were just used for other 17 items.

This unit space was made by the data of physically normal person. "MD=1" is the center in unit space. When MD increases, it is meant that an object leaves from the physically normal person who is unit space. Therefore, change of MD was compared with a change of clinical data every case and was considered. By MD which was a unitary statistic, pathologic aggravation and grasp of the improvement were considered. In addition, the data of 30 physically normal people and 19 patients were collected in anonymous form. The patient privacy is protected. In addition, *t*-test was used for significant difference examination. "The MT system 1, MT method" of the software made in oken company was used for a calculation of MD.

Results

The data of 19 cases at the time of hospital discharges or death were shown in Figure 1-5. The change of the data of 18 items was shown in

*Corresponding author: Hisato Nakajima, Department of Medical Insurance Guidance Room, The Jikei University Hospital, Japan, E-mail: drhisato@icloud.com

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Case	Sex	Age	Diagnosis and type		Cause	Prognosis	
1	Male	24	Fluminant hepatitis	acute	HBV	alive	
2	Female	22	Fluminant hepatitis	subacute	HBV	alive	
3	Male	50	Fluminant hepatitis	subacute	drug	alive	
4	Male	51	Fluminant hepatitis	subacute	unknown	alive	
5	Male	48	Fluminant hepatitis	acute	HBV	dead	renal failure
6	Male	54	Fluminant hepatitis	acute	unknown	dead	hepatic failure
7	Female	45	Fluminant hepatitis	acute	unknown	dead	hepatic failure
8	Male	32	Fluminant hepatitis	subacute	HBV	dead	hepatic failure
9	Male	73	Fluminant hepatitis	subacute	HBV	dead	hepatic failure
10	Male	73	Fluminant hepatitis	subacute	HBV	dead	renal failure
11	Male	28	Fluminant hepatitis	subacute	HBV	dead	GI bleeding
12	Female	71	Fluminant hepatitis	subacute	drug	dead	hepatic failure
13	Male	34	Fluminant hepatitis	subacute	unknown	dead	hepatic failure
14	Male	40	Fluminant hepatitis	subacute	unknown	dead	hepatic failure
15	Male	57	Fluminant hepatitis	subacute	unknown	dead	GI bleeding
16	Male	50	Acute on chronic		Budd Chiari	dead	renal failure
17	Male	51	Acute on chronic		cirrhosis	dead	GI bleeding
18	Female	71	Acute on chronic		HBV	dead	renal failure
19	Female	62	Acute on chronic		alcohol	dead	renal failure

Table 1: The details of 15 cases of fluminant hepatitis and 4 cases of acuto on chronic.

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
0	38	20.4	97	74	14	6	219	580	0.2	299	187	18	9	0.6	187	6.7	3.8
0	35	33.3	87	88	17	21	217	334	0.6	332	225	44	19	0.4	200	6.9	4.1
0	29	24.9	87	100	12	10	216	385	0.4	306	195	17	15	0.5	198	6.7	3.5
0	21	24.8	93	100	23	26	206	598	0.5	287	210	25	8	1	214	8.2	4.3
0	35	20.5	100	94	19	15	215	378	0.4	386	207	26	14	0.9	202	7.1	3.7
0	24	31.2	94	96	28	21	226	505	0.7	312	227	23	9	0.3	216	6.7	3.9
0	39	25.4	70	90	17	13	226	361	0.7	178	186	10	14	0.4	149	6.8	4.1
0	20	22.8	84	81	16	14	223	427	0.4	261	240	48	15	0.6	208	7.1	4.1
0	40	26.1	100	100	13	12	205	568	0.3	300	267	8	10	0.8	213	7.8	4.7
0	31	22.1	89	93	12	14	144	336	0.8	136	143	38	17	0.7	147	6.9	4.5
0	39	27.4	87	81	11	9	145	280	0.2	140	137	2	18	0.8	139	6.9	3.9
0	29	20.9	97	100	18	16	194	623	0.8	201	208	23	15	0.7	183	7.2	4.1
0	38	24.4	100	100	24	23	242	556	0.8	194	182	10	17	0.4	218	7.2	4.4
0	47	29.1	94	94	21	21	176	700	0.4	267	161	11	18	0.5	189	6.8	4.2
0	20	28.4	86	93	13	11	199	486	0.5	400	229	8	14	0.6	133	7.1	4.1
0	38	31.3	87	100	10	6	170	614	0.2	315	169	13	11	0.3	199	7.2	4.1
0	47	33.6	93	93	12	12	236	518	1.1	246	179	19	19	0.4	193	7.2	4.4
0	44	18.2	81	100	21	19	240	700	0.5	204	202	17	17	0.5	195	7.9	4.4
0	36	33.6	90	100	12	22	169	433	0.7	305	171	28	18	0.8	160	7.2	4.2
0	50	21.2	87	100	13	17	194	671	0.6	273	204	41	8	0.6	200	7.5	4.4
0	34	30.9	96	100	10	4	230	546	0.8	346	213	41	16	1	213	6.7	4.2
0	21	35.5	100	100	18	21	210	658	0.5	171	194	17	12	0.9	193	7.8	5.1
0	27	18.9	96	100	27	27	205	483	1.1	336	189	51	11	0.8	174	7.1	4.2
0	32	19.6	86	84	15	17	182	524	0.7	258	165	4	12	0.7	138	7.1	4.2
0	45	19.3	100	100	12	9	183	593	0.7	192	155	13	11	0.8	202	7.1	4.2
0	26	17.9	100	95	17	14	224	644	0.4	252	178	34	20	0.6	202	6.9	4.5
0	45	25.7	90	90	16	17	237	463	0.6	162	225	21	17	0.5	216	7.4	4.3
0	26	27.3	89	100	21	19	196	549	8	221	170	26	16	0.7	213	7.7	5.1
0	41	31.7	97	100	6	2	141	314	0.3	185	172	5	14	0.8	141	7.1	3.8
0	30	28.1	100	100	14	7	215	290	0.7	214	158	6	10	0.7	175	7.5	3.7

Table 2: The data of 18 items of 30 physically normal people who underwent a medical examination.

the figure left side. The logarithmic change of MD was shown in the figure right side.

As shown in Figure 1, MD of the early period of onset of four fulminant hepatitis survivors was more than several thousand. With case 1 and 4, the data level of 18 items decreased generally. Data fluctuated with case 2 and 3 complicatedly up and down, but MD

decreased smoothly. And MD approached to the unit space according to improvement of hepatic failure of the patient.

Three death cases of fulminant hepatitis acute type were shown in Figure 2. With case 5, the data of 18 items improved by treatment, and MD reflected this improvement and as a result MD decreased. Just before the death, MD level was 1,318 and this MD meant a terminal

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
1	8	6.4	23	13	1292	3004	509	243	8.7	639	408	46	12	1.1	70	5.8	3.6
1	84	8.6	36	20	400	1770	270	258	8.2	623	284	47	9	1	68	6	3.3
1	92	9.4	62	23	194	1393	239	312	8	623	3.6	47	10	1	99	7	3.9
2	54	9.9	84	61	89	429	235	400	5.7	479	236	36	11	0.8	120	6.1	3.8
3	82	13.4	96	80	60	388	218	443	7.1	479	275	57	12	1	120	7.4	3.9
2	36	17.6	97	83	46	323	220	474	5.4	479	294	88	11	1	128	7.1	4.3
1	36	18.6	100	93	37	205	200	450	5.2	463	300	100	12	1.1	130	7	4
0	40	20.7	100	93	36	198	197	479	4.1	447	320	107	13	0.6	125	7.1	4.3
0	34	21.3	100	93	40	159	236	513	3.4	431	320	122	13	0.6	130	7.1	4.3
0	34	31.1	96	88	39	122	207	511	2.8	479	345	131	16	0.7	128	7.1	4.3
0	46	34	97	80	36	104	195	495	2.9	431	321	127	12	0.8	140	7	4
0	46	34.3	100	102	33	65	146	533	2.1	415	316	107	13	0.9	153	6.7	4.1
0	34	30.4	96	100	33	58	197	461	1.6	431	325	70	13	0.8	150	7.1	4.5

Case 1: acute type

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
4	150	1.2	13	10	290	1350	1234	6.5	29.4	670	322	44	9.2	1.1	135	7	4.2
4	160	1.6	20	10	134	245	955	5.3	18.4	399	157	11	18	1.2	151	6.9	4
4	173	1.3	15	10	91	88	652	7.3	14.2	351	172	22	20	1.2	124	6.2	3.9
4	140	1.6	20	15	100	143	620	7.1	15.6	335	283	71	29	1	124	6.7	3.9
4	150	1.2	25	18	120	209	715	7.5	19.4	447	400	116	23	0.9	145	6.9	3.8
4	127	1	43	25	122	256	864	7.2	22.4	463	436	138	23	0.9	140	7.1	4.3
3	110	1.7	50	35	58	121	589	7.5	12.4	319	296	97	15.8	0.8	135	7	4
1	80	1.6	55	40	98	246	694	7.6	27	590	454	213	18	1	151	7.1	4.3
1	75	3.1	65	50	90	188	486	6.6	17.8	638	357	264	25	0.8	124	7	4
0	60	2.4	100	80	86	168	389	6.5	9.6	702	486	349	21.4	0.9	124	7.1	4.3
0	55	1.8	90	80	107	236	375	6	7.1	862	681	442	18	0.7	130	7.2	4.2
0	61	1.6	80	70	119	252	455	5	8.1	926	742	475	19.9	0.7	140	7.1	4.3
0	60	1.9	93	85	57	172	460	5.2	6.4	1069	822	529	19	0.7	135	7	4
0	60	1.8	72	65	39	91	537	7.1	6.1	1117	868	554	19.5	0.6	151	7.1	4.3
0	78	2.2	70	65	36	68	466	6.9	4.1	1054	747	527	18	0.7	124	7.2	4.2

Case 2: subacute type

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
2	94	13.6	44	29	374	605	333	259	20.4	702	484	257	14	1.3	130	6.2	3
2	80	15.5	40	27	232	433	288	263	23.3	718	489	263	10	1.1	131	6.5	3
2	100	15.6	44	27	168	348	262	253	23.8	750	455	229	16	1.4	120	6.3	3
2	82	18	49	28	118	268	239	254	21.6	654	459	209	18	1	117	6	2.8
2	102	12.7	46	33	83	197	269	318	23.6	702	476	175	17	1	135	6.8	3.3
1	60	16.5	47	31	58	88	231	350	12	622	619	120	18	1	160	6	3.1
1	80	11.1	46	30	64	78	280	301	8.1	574	367	122	16	1.1	141	5.8	2.9
0	70	11	53	30	50	52	211	269	8.2	686	375	140	23	1	139	5.8	2.9
0	74	6.5	58	35	43	41	194	255	7	622	345	125	25	1	140	5.8	2.6
0	80	8.5	72	45	45	37	253	223	3.7	782	366	94	16	1	129	5.4	2.5

Case 3: subacute type

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
2	150	8	30	20	670	845	242	179	0.3	559	237	171	48	1.1	63	6.4	2.9
2	87	6.6	35	29	255	391	306	148	23.2	512	193	148	37	0.7	59	5.7	2.3
2	80	5.7	35	28	212	233	286	143	26.2	522	162	106	28	0.7	56	5.9	2.2
1	62	5.5	35	30	159	144	244	110	28.9	506	142	61	44	1.3	56	5.7	2.1
0	39	3.3	40	34	108	72	224	143	26.6	461	156	52	43	1.5	60	6	2.6
0	40	1.5	35	32	99	56	230	148	27.9	500	170	60	45	1.4	69	6	2.5
0	50	3.4	40	35	92	50	200	201	22.2	450	160	50	39	1.3	80	6.3	2.7
0	55	7.7	45	40	73	40	210	254	22.4	460	170	50	45	1.5	95	6.3	2.8
0	60	10.6	40	29	63	33	196	380	26	398	152	37	40	1.3	146	7.3	3.1
0	60	10.5	55	50	36	19	203	349	13.7	256	150	23	45	1.4	121	6	3.4
0	62	11.8	75	70	68	31	169	370	13.5	315	193	41	40	1.4	120	6.9	3.5
0	55	15.4	60	52	59	27	183	349	10.2	334	201	45	35	1.3	110	7.6	3.6
0	50	13.5	80	74	141	53	206	444	9.6	449	276	86	45	1.2	162	6.8	4.7
0	50	14.2	90	86	144	62	201	491	9.5	471	322	80	58	1.6	202	9.5	4.6
0	45	10	65	50	89	47	167	333	10	390	257	76	23	1	154	7.9	3.5

0	40	27.3	75	62	50	24	169	233	6.1	299	230	63	12	0.9	140	7.3	3.2
0	45	24.5	70	60	45	20	156	190	4.5	260	205	58	11	0.9	137	6.4	2.8
0	50	11.8	70	62	40	16	136	190	2.8	271	219	65	14	1	176	6.7	2.9
0	41	12.3	75	65	37	19	149	201	1.8	301	243	74	14	1	204	7.5	3.3

Case 4: subacute type

Table 3: The data of 4 survival cases of fluminant hepatitis used for examination.

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
2	140	9.3	10	10	7611	4665	7006	431	5.6	1070	1133	108	25	1.2	75	6.7	3.6
3	152	5.2	10	10	5470	3060	5620	368	6.9	894	525	81	19	2.1	61	5.3	3.7
3	146	5.5	10	10	3249	2620	1844	228	8.2	639	638	56	17	2.8	57	5.5	3.1
5	508	6.8	10	10	1000	1330	632	198	10.5	575	415	41	14	4.8	116	5.3	3.3
5	214	8	17	18	325	281	1404	288	7	149	245	18	12	7.7	88	4.7	2.6

Case 5: acute type

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
2	117	13.5	18	10	296	247	400	107	17.3	471	304	28	5	0.4	87	5.4	2.5
2	138	13.2	22	12	197	182	354	175	15.1	412	275	26	16	0.8	89	5	2.2
3	107	8.3	24	17	44	54	306	474	12.3	303	182	23	14	0.5	187	5.4	3
3	180	8.6	24	14	45	50	325	437	11.3	255	169	18	10	0.6	155	5.3	3
4	138	8.2	23	16	184	128	417	472	10.2	245	163	21	16	0.8	153	5.1	2.7
5	107	5.7	22	15	274	196	547	481	10.9	258	182	29	14	0.5	161	5.3	3
5	180	6.5	24	14	256	184	540	438	11.4	287	215	32	10	0.6	169	5.8	2.3

Case 6: acute type

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
2	100	28.1	10	10	1440	1455	1748	274	10	814	267	43	25	0.5	103	5.9	3
2	110	15.7	12	5	299	341	516	374	5.7	415	157	21	30	0.7	110	5.8	3.1
4	201	13	14	4	226	240	349	342	9.3	463	184	17	27	0.6	140	5.8	2.9
4	209	5	10	6	160	250	451	360	9.2	463	190	16	28	0.6	150	5.7	3
4	133	6	10	4	64	116	448	432	12.8	447	449	250	32	0.7	140	5.5	2.8
4	150	7	12	5	31	41	400	456	8	527	170	502	31	0.7	130	5.6	2.8
5	210	5	14	10	43	55	398	420	13.2	511	210	676	29	0.6	140	5.4	2.7
5	230	6	10	10	231	96	420	498	11.2	571	190	1638	35	0.8	135	5.5	2.6

Case 7: acute type

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
2	170	22.1	19.9	10	342	353	533	158	35.2	2603	431	22	8	1.2	89	5.1	3.3
2	185	16.7	44.1	30	277	177	676	155	26.4	1517	299	12	9	1.1	107	5.5	3.6
3	148	16.1	54.2	45	343	210	699	160	26	1781	265	8	9	1	149	6.7	4.2
5	120	18.4	34.4	30	382	217	699	145	25.5	1533	261	9	23	1.8	132	5.9	3.3
5	150	8.9	44.1	35	129	254	844	150	18.9	1628	252	4	33	2.1	181	6.3	3.8
5	43	6.5	24	15	210	99	580	120	23.2	1837	286	11	51	3.5	137	5.6	3.5
5	85	6.9	28.3	25	437	165	1478	135	19.6	1438	256	6	49	2.5	135	5.6	3.5
5	63	6.6	26.7	25	284	312	1725	145	22.2	1724	284	11	43	1.9	176	5.6	3.3
5	57	4.7	24	20	144	209	2024	130	26.8	2178	327	14	55	2.4	193	6.2	3.7

Case 8: subacute type

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
2	40	18.2	40	33	183	197	346	190	23.3	527	283	47	32	1.7	72	5.6	2.5
2	38	21.3	46	46	140	142	332	266	26.5	606	296	47	17	1.7	84	6	2.7
1	36	17.2	38	37	131	134	322	272	27.2	590	281	46	14	1.5	83	5.9	2.7
2	36	16.8	39	32	110	98	301	277	27.6	606	281	44	11	1.4	85	5.8	2.5
2	36	17.5	45	37	123	112	365	326	35	782	326	52	11	1.3	95	6.7	3
2	28	11.2	72	67	63	48	250	384	23	415	218	30	9	1.6	113	5.6	3
2	28	13	51	65	72	51	279	393	24.5	511	248	37	9	1.5	128	6.3	3.3
1	18	12.7	41	52	66	48	250	394	24.7	590	269	42	10	1.5	116	6.4	3.3
1	24	8.9	34	39	43	27	207	328	17.7	367	168	25	9	1.6	102	5.3	3
2	28	10.3	41	57	44	29	228	326	19.4	415	208	30	9	1.4	106	5.5	3
2	30	11.7	38	54	46	27	241	360	19.7	479	238	37	8	1.4	116	5.6	3.1
2	40	9.7	52	67	34	19	219	375	16.2	351	184	32	7	1.4	128	5.5	3.2
2	36	10.1	41	40	35	21	246	407	19	447	226	38	8	1.4	142	6.1	3.3
2	40	10.4	32	29	31	19	260	411	22.4	479	267	43	8	1.4	136	6.2	3.3
2	40	9.9	37	42	47	19	315	423	22.8	588	267	40	11	1.3	126	6.5	3.5
1	44	8.2	48	37	26	13	248	372	19.4	415	199	30	12	1.3	145	5.9	3.3

1	28	7.1	38	31	30	11	287	377	21.6	479	220	42	9	1.4	129	6	3.2
1	42	6.8	42	29	31	15	307	397	23	511	237	40	13	1.1	131	6.2	3.4
2	32	7.8	42	50	30	12	307	397	23	511	251	52	22	1.2	126	6.6	3.5
2	42	9.3	32	40	33	13	319	432	23.5	542	294	71	29	1.3	111	7.3	3.6
2	56	10.7	37	29	28	9	284	403	22.3	558	276	72	30	1.4	103	6.9	3.6
2	48	10.8	48	42	21	10	291	430	19.8	479	249	47	33	1.2	120	7.1	4
2	52	12.4	38	37	21	5	278	434	20.8	542	267	59	33	1.2	116	6.8	3.9
2	70	12.1	42	31	21	7	276	450	23.6	606	274	54	29	1.2	111	7.4	3.7
2	48	14.7	42	29	60	13	953	369	28	702	316	51	44	1.9	62	7.1	3.5
3	68	18.5	20	30	58	13	507	326	15.9	383	193	25	41	1.8	97	5.7	3.1

Case 9: subacute type

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
1	126	8.3	10	10	3611	2596	4338	406	9	782	516	117	28	1.6	145	6.2	2.7
1	70	8.4	17	11.5	3061	2040	4846	444	11	766	511	101	26	1.7	145	7	4.1
3	64	6.4	15	12	845	665	1960	460	8.6	782	490	352	16	2.1	160	5.3	3
4	122	6.3	10	10	644	746	1599	422	14.3	574	277	45	10	1.6	181	5.9	3.1
5	122	7.3	14	19.5	109	172	759	357	12.7	351	179	20	10	1.8	156	5.5	3.1
5	160	9.6	21	33	81	73	803	368	11.4	351	164	17	9	2.9	148	6.7	3.7

Case 10: subacute type

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
2	136	11.6	22.5	19.8	126	141	476	3.5	22.6	590	323	51	8	0.8	88	5	2.5
2	145	5	17	10	135	133	483	2.7	21	590	301	42	7.6	0.8	73	3.9	2
2	157	4.7	31	21.5	80	80	435	4.6	17.8	399	213	43	8	1	89	4.6	2.8
1	185	5	34	26	115	107	369	4.1	15.4	351	170	45	8.9	0.9	110	5	3.2
2	208	4.2	35	29	50	51	346	8.3	10.4	335	190	40	10.7	0.7	153	5.2	3.5
3	211	4.6	25	21	52	58	364	8.3	10.8	351	205	43	13.4	0.8	130	5.3	3.4
3	256	6	23	13	54	72	383	7.9	12.3	383	213	45	15	0.7	175	5.6	3.5
3	199	7.2	22.5	21	63	79	390	8.7	14.4	383	170	55	12.2	0.7	154	5.3	2.9
4	157	8.8	22	11.5	79	94	467	9	15.8	415	250	70	13.8	0.6	145	5.2	3
3	228		21	20.5	67	86	445	8.7	16.4	367	358	95	15	0.7	140	5	3.1
5	238	10.2	23	26.5	56	64	480	8.5	13.1	271	221	42	12.7	0.6	134	4.9	2.8

Case 11: subacute type

Table 4: The data of 7 dead cases of fluminant hepatitis used for examination.

Coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
2	70	6	61	40	742	537	652	177	13.9	443	387	65	5	0.4	109	5.5	2.8
3	90	6.5	46	31	647	540	644	167	18.7	391	375	63	16	0.8	117	5.4	2.9
4	107	6.6	40	30	334	321	592	184	21.4	326	332	59	14	0.5	125	5.1	2.4
5	180	5.2	35	25	214	204	548	143	25	367	401	120	10	0.6	100	4.9	2.1

Case 12: subacute type

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	ON	Cr	T.C.	T.P.	Alb
2	160	22.9	21	10	682	666	701	2.5	30.2	718	261	12	8	0.8	82	5	2.9
2	153	20.9	20	14.5	583	648	635	2.4	32	783	322	14	7.2	0.8	88	5	2.9
1	179	18.8	38	17.5	353	302	604	2.4	25	495	255	5	5.8	0.7	88	5	3.3
2	190	14.8	21	17	296	241	476	6	23.8	495	253	32	8.1	0.7	119	5	3.3
2	160	10.2	25	21	264	193	563	8.3	22	479	268	31	10	0.6	136	5	3.2
2	257	15.2	22	16.5	345	192	598	8.3	20.7	415	224	30	10.8	0.8	135	5.2	3.4
2	287	11.8	28	21.5	319	174	646	7.9	18.9	399	222	16	10	0.7	151	4.6	2.99
2	104	3.4	10	13.5	340	177	730	6.4	21	447	214	16	12.4	0.9	124	4.7	2.99
3	93	3.4	11	18	244	156	637	6.4	22.4	447	259	16	14.4	0.3	124	4.8	2.9
5	87	8.8	17.5	18.2	221	147	798	5.2	26.6	527	262	20	17.4	1	116	5.2	2.8
5	135	9.1	18	17	180	107	942	5.1	23.8	574	247	15	17.1	1.1	109	4.7	2.6
5	150	5.5	10	10	943	285	3924	4	18	1453	243	5	22.1	4.1	81	3.8	2.4

Case 13: subacute type

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
3	90	8	29	20	670	845	242	179	0.3	559	237	171	5	0.4	63	6.4	2.9
3	110	6.6	17	29	255	391	306	148	15.7	512	193	148	16	0.8	59	5.7	2.3
4	107	5.7	16	28	212	233	286	142	26.2	522	162	106	14	0.5	56	5.9	2.2
5	180	5.5	15	30	159	140	244	111	28.9	687	298	189	10	0.6	56	5.4	2.1

Case 14: subacute type

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
2	66	10.5	30	38	102	94	351	200	36.1	638	340	81	25	2.1	79	6.6	2.8
2	50	10.9	29	27	77	86	366	216	30.1	591	342	82	19	1.8	79	5.7	2.6
2	40	10.5	60	66	59	63	346	204	27.4	453	338	72	18	1.5	85	5.2	2.4
2	30	11.6	63	31	37	40	360	322	22.8	390	282	52	25	1.7	85	5	2.3
2	74	11	50	40	53	57	571	319	25.2	431	328	91	21	1.6	100	5.1	2.4
2	42	9.2	60	65	37	29	348	260	21	367	251	60	22	2	112	5	2.7
2	54	8.9	50	39	36	29	303	316	22.6	335	237	40	22	1.9	100	5.5	2.9
2	55	9	50	40	43	28	361	336	31.3	448	209	54	21	1.8	102	6.1	3.4
2	64	9	35	30	28	22	283	337	16.5	255	199	31	20	1.7	95	5.6	3.4
2	65	9	40	30	26	21	309	319	15.4	303	231	36	21	1.6	100	6.2	3.5
2	65	9.9	33	25	28	22	267	347	15.8	479	278	47	23	1.3	131	5.9	3.6
2	66	7.7	55	54	31	18	262	262	19.9	287	214	43	20	1.2	99	5	2.9
2	54	9	26	25	35	34	246	332	22.5	149	246	50	17.8	1.2	100	5.7	3.3
2	76	8.7	30	24	40	34	234	300	24.4	367	243	40	18	1.3	95	6.1	3.8
2	66	9.1	23	25	38	17	213	310	26.9	367	249	46	19	1.3	100	6.2	3.7
4	54	9.2	30	34	29	7	238	326	22.6	335	225	35	20	1.2	129	6.5	3.9
5	88	8.9	19	15	31	12	183	204	23.3	271	196	40	20	1.4	110	5.2	3.1

Case 15: subacute type

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
4	202	0.8	53	48	21	10	334	103	23.5	1357	248	11	102	4.5	55	5.4	2.3
2	85	1.3	45	40	28	7	510	110	27.9	1581	263	10	111	5.5	47	5.6	2.1
2	64	1.3	48	45	33	10	331	113	33.7	1357	277	15	131	3.7	38	5.7	2.2
2	70	1	40	35	33	15	236	65	37	1038	277	10	133	4.2	40	6	2.3
2	84	1.8	45	40	40	16	250	124	38.5	1117	281	4	106	4.2	39	5.9	2.2
2	56	1.9	45	40	38	10	280	133	44	1197	295	3	127	3.7	41	6.3	2.5
2	26	3.5	68	50	33	16	264	270	35.6	1117	270	5	111	2.6	60	6.6	2.6
3	30	3.8	40	35	29	12	298	207	31.9	862	262	3	119	3.5	80	6	2.5
5	214	2.6	30	25	279	89	1425	240	28.5	1038	249	6	112	4.3	70	5.9	2.2

Case 16: Acute on chronic

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
2	117	5.6	12.5	10	1644	765	1079	32	35.7	1676	268	18	5	0.4	44	7.7	3.1
2	138	6.4	12	10	1105	575	674	48	37.3	1309	296	17	16	0.8	54	8	3.2
2	107	9.3	9.9	8	488	367	668	44	36.1	1373	230	16	14	0.5	41	6.2	3.1
5	180	8.4	16.5	15	415	219	1182	48	26.5	942	164	7	10	0.6	80	5.3	3

Case 17: Acute on chronic

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
0	30	6.5	46	31	647	540	644	167	18.7	479	375	63	15	1.1	117	5.4	2.9
2	60	6.6	40	30	334	321	592	184	21.4	399	332	59	23	1.3	125	5.1	2.6
2	46	5.2	43	30	214	204	548	154	21	335	299	50	30	1.4	100	4.9	2.6
2	48	5.5	51	31	338	218	633	250	21.3	383	324	46	30	1.3	123	5.5	2.9
2	66	5.4	53	40	370	225	650	254	20.4	351	289	41	29	1.3	110	5.3	2.7
2	67	7.8	50	41	238	174	606	274	19.6	367	297	42	29	1.3	136	5.2	2.7
2	30	6	64	62	98	77	456	426	11.6	415	239	32	32	1.3	160	5.6	3.2
2	72	9.5	68	50	111	82	432	471	12.6	447	258	45	36	1.2	170	5.9	3.3
2	48	6.7	51	54	201	128	513	412	14.4	447	299	54	21	1.2	202	5.7	3
2	46	5.2	61	57	172	124	542	374	16.9	447	283	48	28	1.2	174	5.2	2.7
2	40	5.3	61	49	150	88	537	360	17.2	335	221	29	29	1.2	148	5.2	2.7
2	48	5.9	65	50	102	76	469	378	23	399	287	40	39	1.1	213	5.7	3.1
2	50	5.5	55	54	199	121	451	363	30	479	303	47	34	1.1	210	5.7	3
2	48	4.7	55	58	123	73	386	378	24.4	351	233	31	34	1.1	144	5.5	3.1
2	50	6.2	50	45	141	94	427	407	30.1	431	267	38	31	1.1	170	5.9	3.1
2	52	4.6	56	53	99	77	386	397	26.9	463	277	39	25	1.1	169	5.6	3.1
2	34	5.1	60	51	164	105	634	370	37.6	495	318	53	39	1.1	168	5.7	2.8
3	70	6.2	58	46	140	81	580	349	34.4	511	326	48	50	1.3	151	5.3	2.8
3	58	4.9	57	46	137	88	607	344	37.4	511	334	47	66	1.4	157	5.2	2.6
3	70	6	48	41	121	87	678	353	35.3	671	369	51	67	1.3	156	5.4	2.6
3	75	3.8	36	31	367	132	1344	324	32.4	703	382	61	99	2.3	119	5.1	2.6

Case 18: Acute on chronic

coma	NH3	PLT	PT	HPT	AST	ALT	LDH	ChE	T.B.	ALP	LAP	rGT	UN	Cr	T.C.	T.P.	Alb
2	108	7.6	37	38	104	19	438	101	32.2	1277	460	503	73.6	3.1	160	4.5	2.1
2	90	14.2	35	35	89	22	531	95	30.4	1357	470	407	103	4.3	152	5.2	2.7
1	68	10	36	35	71	26	508	113	38.4	1245	450	461	106	3.4	150	5	2.5
2	62	6	36	32	40	25	495	128	34	1293	479	378	110	4.1	149	5.4	3.1
3	48	7	35	40	31	24	336	132	33.9	1197	420	320	113	2.6	145	5	2.6
3	130	6.2	43	50	40	35	350	150	34.8	1117	359	258	137	4	160	5.8	3.9
3	124	9.5	40	45	42	30	345	220	33.3	894	320	223	165	3.4	150	5.9	3
3	72	9.1	27	35	42	20	343	294	20.8	686	279	159	194	4	160	5.8	3.5
3	60	10.9	40	50	33	25	479	260	14.8	878	334	199	260	4.9	155	7	4.8
4	96	4.9	37	41	22	22	363	251	15	798	320	200	294	5.1	163	7.4	5.1
5	100	2.9	34	38	26	28	592	494	16	766	309	199	324	6	160	7	4.5
5	138	2.3	30	28	36	40	550	450	17	846	320	220	378	7.8	150	6.5	4.1

Case 19: Acute on chronic

Table 5: The data of 7 dead cases of fulminant hepatitis used for examination.

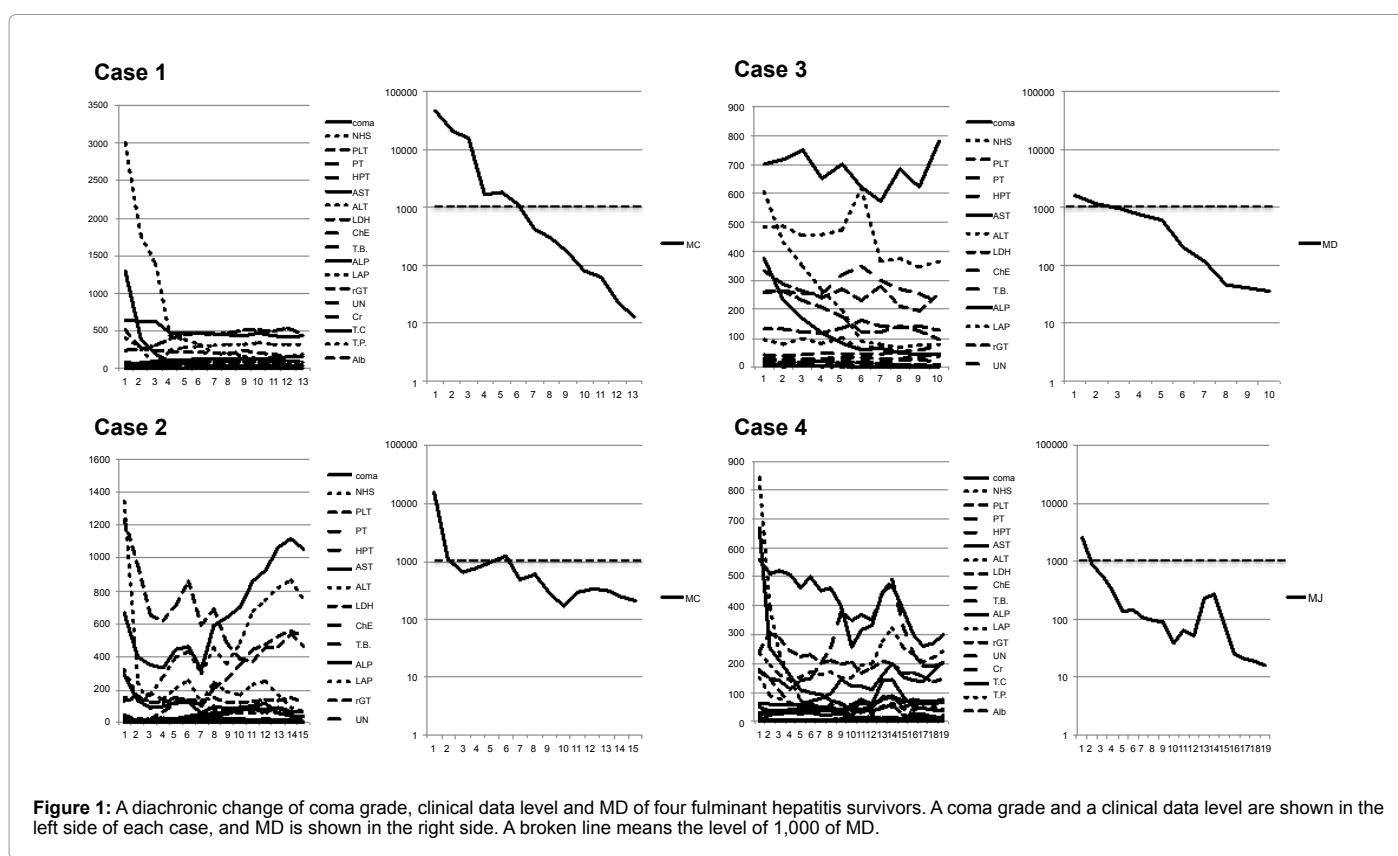


Figure 1: A diachronic change of coma grade, clinical data level and MD of four fulminant hepatitis survivors. A coma grade and a clinical data level are shown in the left side of each case, and MD is shown in the right side. A broken line means the level of 1,000 of MD.

liver disease and the patient died by renal failure. Case 6 and 7 improved the data of 18 items by an effect of treatment once. However, the data turned worse with progress of hepatic failure and, as a result, MD level showed more than 1,000 again, and the patients died by hepatic failure.

Eight death cases of fulminant hepatitis subacute type were shown in Figure 3 and 4. Case 10, 12 and 14 reflected curative effect, and the data of 18 items were improved. However, MD level of case 10 decreased to 906 just before the death, but the patient died by renal failure not hepatic failure. In addition, MD level of case 12 was 1,571, and MD level of case 14 was 1,385. Their MD showed terminal level of 1,000 or more and died by hepatic failure. Data of other five cases turned worse according as pathologic aggravation. It was reflected on increase of MD, and the patient died.

Four death cases of acute on chronic hepatic failure were shown in Figure 5. In these four cases, 18 items accept a complicated change. On the other hand, MD decreased by treatment slightly once. However, the disease turned worse, and MD level increased about 2,000 and the patient died.

The MD level was divided into survival case and death case, and a logarithm of MD was shown in Figure 6. MD level of four survivors decreases to an average of 68, standard deviation of 94 at the time of hospital discharge and was normalized afterwards. On the other hand, MD level in 15 death was an average of 2,227, standard deviation of 2,274. This MD level was significantly higher than survivors by t-test ($p=0.003$), and MD level of 12 cases were more than 1,000. Three MD decreased with progress, but in the death of three cases, MD level of case 9 increased to 390, MD level of case 15 to 922. The change of these

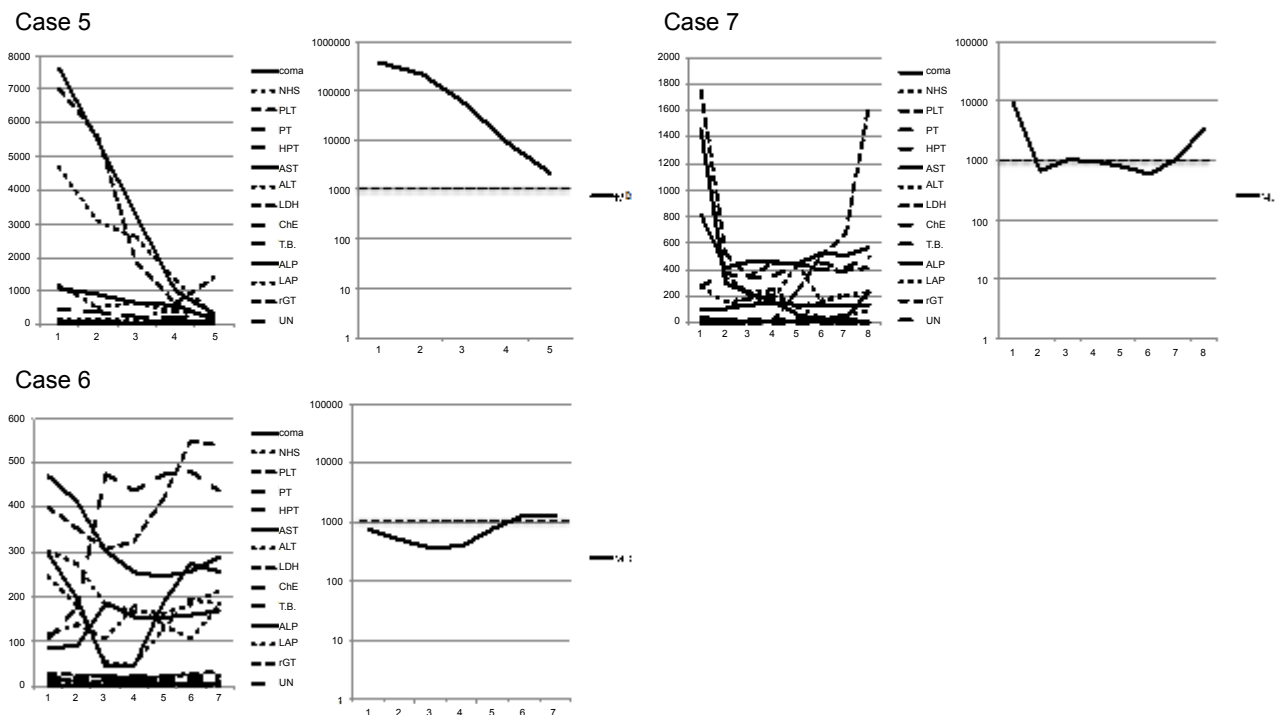


Figure 2: A diachronic change of coma grade, clinical data level and MD of three fulminant hepatitis acute type death cases. A coma grade and a clinical data level are shown in the left side of each case, and MD is shown in the right side. A broken line means the level of 1,000 of MD.

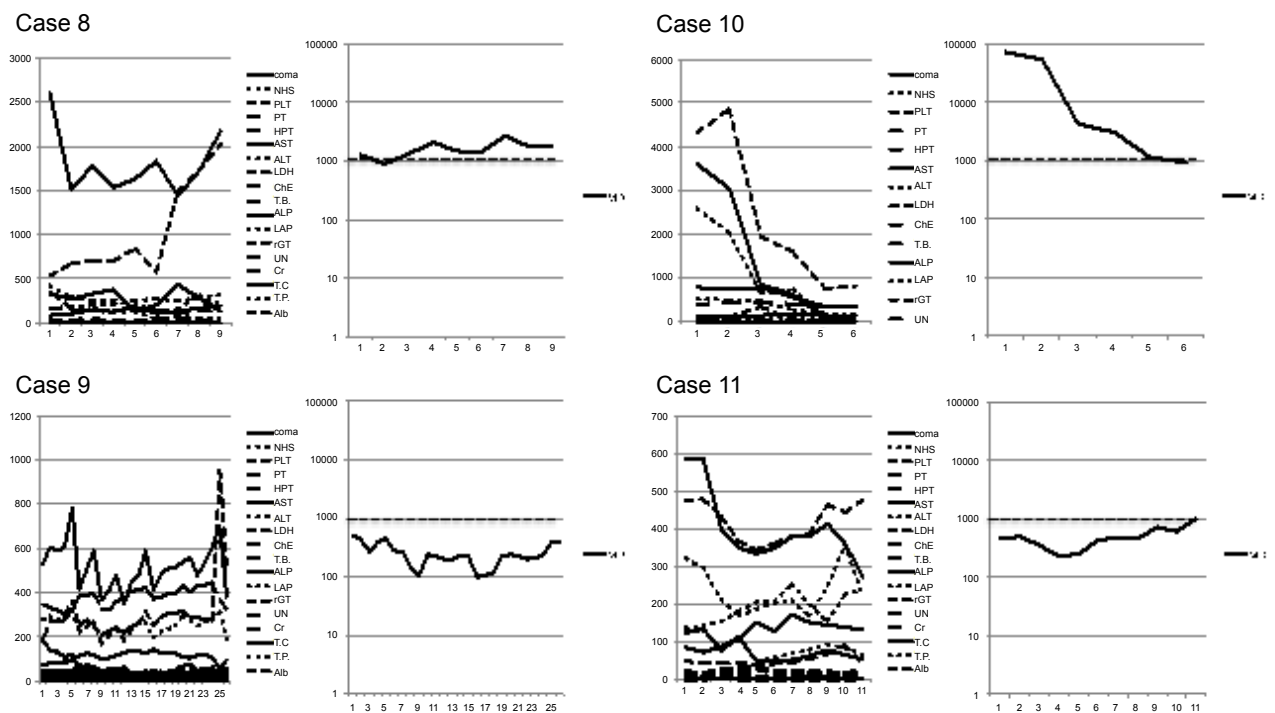


Figure 3: A diachronic change of coma grade, clinical data level and MD of four fulminant hepatitis subacute type death cases. A coma grade and a clinical data level are shown in the left side of each case, and MD is shown in the right side. A broken line means the level of 1,000 of MD.

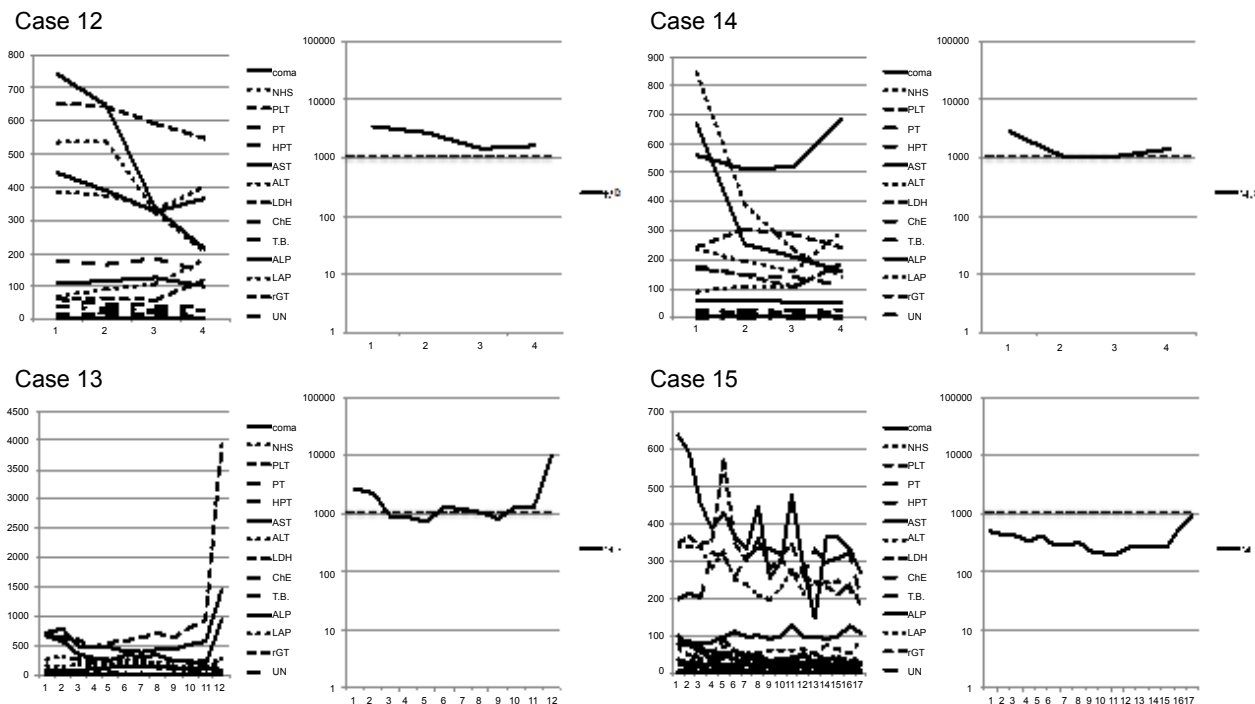


Figure 4: A diachronic change of coma grade, clinical data level and MD of four fulminant hepatitis subacute type death cases. A coma grade and a clinical data level are shown in the left side of each case, and MD is shown in the right side. A broken line means the level of 1,000 of MD.

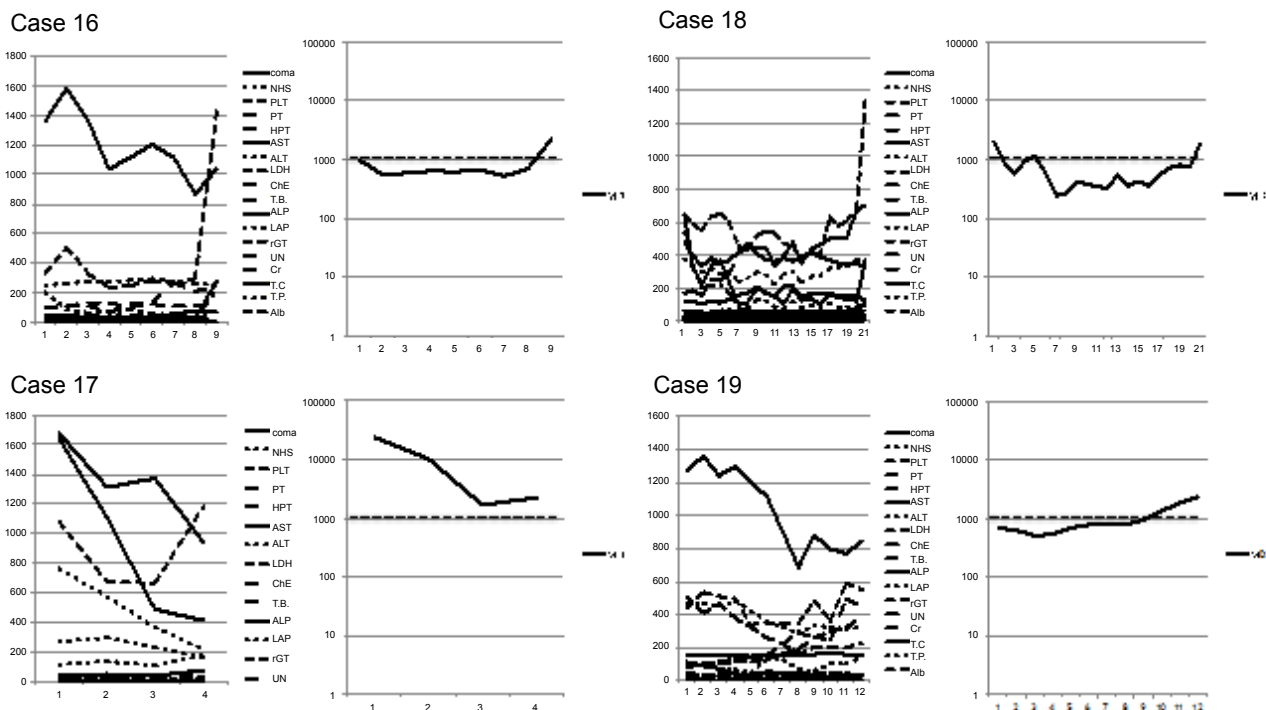
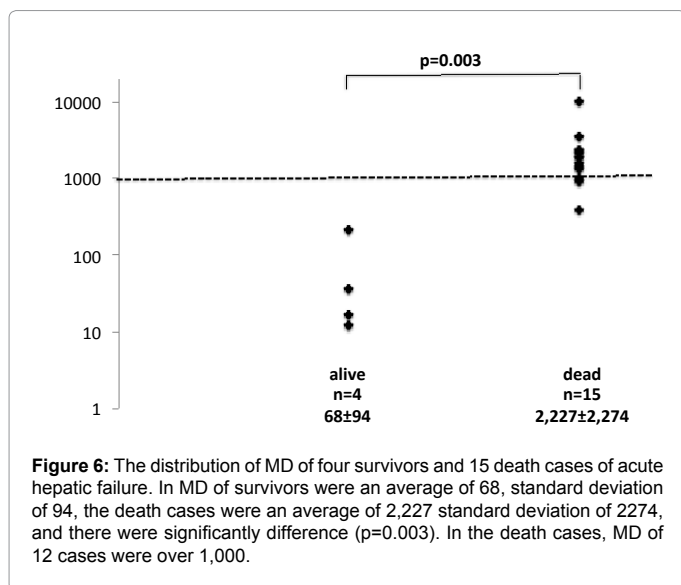


Figure 5: A diachronic change of coma grade, clinical data level and MD of four acute on chronic hepatic failure death cases. A coma grade and a clinical data level are shown in the left side of each case, and MD is shown in the right side. A broken line means the level of 1,000 of MD.



MD reflected pathologic aggravation. In the death, MD level of case 10 decreased to 906 from 7,173, but the patient died by renal failure not hepatic failure.

Consideration

As for the characteristic of MT system, the unit space is made using the data of physically normal person. MD for this unit space is calculated by the data of patient “individual”, not statistical “group”, and is evaluated, and as a results, “individual changes” of patient are judged as a unitary statistic. In addition, the correlation of data of patient individual is examined in MT system. We examined change of MD in the liver disease until now. And we reported about increase of MD showed pathologic aggravation, and decrease of MD showed pathologic improvement [7,8]. In addition, MD level more than 1,000 means terminal liver diseases. And MD level more than 1,000 became the index of liver transplantation [9].

In this study, clinical data fluctuated complicatedly by clinical course, and a judgment of improvement or aggravation of these diseases are difficult. Each clinical data are unified into MD, and evaluate MD. As a result, pathologic grasp becomes easy using a common evaluation standard for doctor. MD decreased with this four survivors immediately, and the condition of a patient was improved. In the case of 5, 10, 17, MD level decreased, but it was still more than 1,000 at death time. In addition, case 5 and 10 died by renal failure, and case 17 died by gastrointestinal bleeding, not hepatic failure.

The unit space of MT system was defined each time. This 18 items were for the evaluations of hepatic failure. The hepatic failure of case 5,10,17 was improved, however, these cause of death was renal failure and gastrointestinal bleeding, not hepatic failure. Renal failure and gastrointestinal bleeding were hard to evaluate in these 18 items, as a results, the evaluation of MD was low grade. For the renal failure, only two items of UN and Cr are insufficient. The datas such as quantity of glomerulus filtration, volume of urine or edema increase may becomes a more accurate index. For the gastrointestinal bleeding, the much

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frequent endoscopy is difficult, so datas such as blood UN level, an occult bleeding reaction or melena will be necessary in future.

The clinical datas of 13 death cases was complicated, and pathologic grasp was difficult. However, pathologic grasp became easy with one numerical value by unifying those clinical datas into MD. By treatment, MD decreased 13 cases temporarily, however MD gradually increased with pathologic aggravation and the patients died.

When MD unifying clinical datas as above is calculated, pathologic grasp to change complicatedly becomes easy. And the evaluation standard that is common to the diagnosis of the doctor is given.

Conclusion

“Individual changes” are evaluated as a unitary statistic in MD. Using MD from the unit space of physically normal person, complicated pathologic grasp of acute hepatic failure becomes much easy.

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