MULTIPLE ORGAN FAILURE IN ELDERLY PATIENTS WITH CHRONIC DISEASES
老年慢性疾病患者的多器官衰竭

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Summary

*Multiple organ failure **(MOFE)** in elderly patients is a new clinical syndrome different from multiple organ failure **(MOF)** caused by surgical conditions in the young and middle-aged persons. One thousand and two cases of **MOFE** were analyzed retrospectively and their clinical features discussed. **MOFE** has a long insidious course. Its main predisposing factors are pulmonary infection, heart attack, etc. The mortality of **MOFE** increased with age and the number of organs involved. Nevertheless, those suffering from failure of 4 or more organs can still survive; but is mostly fatal if there is co-existing renal failure. **MOFE** has 3 different types: type **I**, **II** and **III**, with the last seen only in **MOFE** but not in MOF. We define **MOFE** as the sequential failure of 2 or more organs within a short period in elderly patients (≥ 60 years old) with multiple organ chronic disease on the basis of multiple organ dysfunction.*

摘要

發生在老年慢性疾病患者的“老年多器官衰竭（Multiple organ failure in elderly patients, MOFE）”是一個有別於多發生於中青年人而由外科情況（外傷、大手術、燒傷等）引起的多器官衰竭（Multiple organ failure, MOF）的新的臨床綜合症。本文回顧性地分析了在6個醫院中收治的1002例MOFE患者的臨床資料，並對它的臨床特症進行了討論。MOFE發病過程遷延漫長（而MOF發病急驟）。它的主要誘因是肺部感染、心臟病發作、腦血管意外等（而MOF的誘因主要是外傷、大手術等外科情況）。MOFE的死亡率隨年齡增加及侵及器官種類的增多而增高，多數國外文獻報導MOF中侵及4個和4個以上器官者，死亡率高達85-100%，但MOFE在侵及5-6個器官者部份仍可救治存活，但如累及腎臟，則死亡率增高。MOFE有單相型、雙相型和多相型三種臨床類型（而MOF僅有單相型和雙相型）。作者將MOFE定義為“在多器官功能不良的基礎上患有多種慢性疾病的老年人（≥60歲），於短時間內發生2個或2個以上器官序貫性衰竭”以供同道參考。作者體會，雖然MOFE在老年人多以感染特別是呼吸道感染為主要誘因，死亡率高，對老年人生命威脅大，但若對本綜合症的初期表現認識較早，及時發現各種器官衰竭的先兆，有預見性的及時治療將可大大降低死亡率，延長壽命。

Introduction

From 1977, we have published a series of articles[1-6] about multiple organ failure in elderly patients (MOFE) with chronic diseases, an entity with many clinical features different from ordinary multiple organ failure (MOF), which is mainly caused by surgical conditions and which often occurs in the young and middle-aged adults. In this paper, we retrospectively analyze 1002 cases of MOFE in 14 hospitals and further present the main clinical characteristics of MOFE.

Patients and Methods

MOFE is defined as the sequential failure of two or more organs within a short period in elderly patients (aged 60 years old or above) with multiple

organ chronic disease on the basis of multiple organ dysfunction. Cases of MOFE in 14 hospitals were retrospectively analyzed. All the cases met the diagnostic criteria we have mentioned in previous papers[1,5]. A total of 1002 cases were studied. The following clinical data were recorded: sex, age, underlying chronic diseases, predisposing factors, organs involved, clinical type of MOFE (according to the number of times organs failed), mortality.

Results

Sex and age distribution

In the 1002 patients studied, 746 were male and 256 female. Their age ranged from 60 to 94 years (mean 71.2 years), with 538 cases between 60 and 69 years; 348 between 70 and 79 years; 105 between 80 and 89 years; 11 were aged 90 years or above.

Underlying chronic diseases

Before multiple organ failure, most of the patients had more than 2 chronic diseases with the maximum number of 9 diseases (mean 2.4 diseases). The most common ones were cardiovascular and pulmonary diseases, followed by cerebrovascular disease and diabetes mellitus (Tables 1,2).

Table 1. Underlying Chronic Diseases

Underlying Diseases	*No. of Patients*	*(% of Total Patients)*
Chronic bronchitis and obstructive emphysema	575	(57.4)
Coronary heart disease (including old myocardial infarction)	522	(52.1)
Cor pulmonale	289	(28.9)
Hypertension	259	(25.9)
Cerebrovascular disease	140	(14.0)
Diabetes mellitus	139	(13.9)
Chronic renal diseases	115	(11.5)
Chronic hepatitis and liver cirrhosis	112	(11.2)
Carcinoma	82	(8.2)
Pulmonary tuberculosis	49	(4.9)
Peptic ulcer and chronic gastritis	45	(4.5)
Bronchiectasis and pulmonary fibrosis	34	(3.4)
Rheumatic and congenital heart disease	12	(1.2)
Total	2408	

Table 2. The Relationship Between Age and Number of Underlying Chronic Diseases

	Number of Underlying Chronic Diseases						
Age	1	2	3	4	5	Undocumented	Total
(yrs)	No(%)	No(%)	No(%)	No(%)	No(%)	No(%)	
60-69	134(24.9)	198(36.8)	111(20.6)	58(10.8)	21(3.9)	16(3.0)	538
70-79	48(13.8)	108(31.3)	69(19.8)	68(19.5)	48(13.8)	- (2.6)	348
⩾80	17(14.8)	27(23.3)	28(24.1)	20(17.2)	19(16.4)	5(4.3)	116
Total	199(19.9)	333(33.2)	208(20.8)	146(14.6)	88(8.8)	28(2.8)	1002

Predisposing factors

The most common predisposing factors were infection, especially pulmonary infection, and acute attack of cardiovascular and cerebrovascular diseases (Table 3).

Table 3. Predisposing Factor of MOFE

*Predisposing Factors**	*No. of Patients (%)*
Infection	843(84.1)
Pulmonary	746(74.5)
Urological	23(2.3)
Biliary	20(2.0)
GI tract	19(1.9)
Septicemia	12(1.2)
Pancreatic	10(1.0)
Abdominal	10(1.0)
Skin	3(0.3)
Acute attack of CHD (AMI and arrhythmia)	61(6.1)
Stroke	32(3.2)
Toxic shock	30(3.0)
Late liver cirrhosis	29(2.9)
Haemorrhagic shock	28(2.8)
Surgery and trauma	27(2.7)
Malmedication	4(0.4)
Total	1054

**Some patients had 2 or more predisposing factors*
CHD = coronary heart disease, AMI = acute myocardial infarction

Organs involved

The frequency of organs involved in descending order was heart, lung, brain, kidney, gastrointestinal system, liver, blood system and pancreas; and that of the first failed organ was lung, heart, brain, kidney, liver, gastrointestinal system, blood system and pancreas (Table 4).

Table 4. The Frequency of Organs Involved and the First Failed Organ

	No. of Failed Organ	(% of Total Patients)	No. of First Failed Organ	(% of Total Patients)
Heart	891	(88.9)	348	(34.7)
Lung	92	(79.0)	956	(35.6)
Brain	610	(60.8)	113	(11.3)
Kidney	469	(46.8)	99	(9.9)
GI system	368	(36.7)	51	(5.1)
Liver	243	(24.3)	69	(6.9)
Blood system	59	(5.9)	10	(1.0)
Pancreas	28	(2.8)	6	(0.6)

Table 5.The Relationship Between the Patient's Age, Number of Failed Organ and Mortality

Age (yrs)		No. of Failed Organs						Total
		2	3	4	5	6	7	
60-69	No. of patients	97	225	145	54	14	9	538
	No. of deaths	42	155	127	50	12	2	388
	(Mortality %)	(43.3)	(68.4)	(87.6)	(92.6)	(85.7)	(66.7)	(72.1)
70-79	No. of patients	57	142	88	49	10	2	348
	No. of deaths	34	118	79	48	9	2	290
	(Mortality %)	(59.0)	(80.2)	(89.9)	(97.9)	(90.0)	(100)	(83.3)
80-89	No. of patients	26	34	36	6	2	1	105
	No. of deaths	18	25	36	6	2	1	88
	(Mortality %)	(69.0)	(73.0)	(100)	(100)	(100)	(100)	(83.8)
≥90	No. of patients	0	4	4	3	0	0	11
	No. of deaths	0	3	4	3	0	0	10
	(Mortality %)		(75.0)	(100)	(100)			(90.9)
Total	No. of patients	180	405	273	112	26	6	1002
	No. of deaths	94	301	246	107	23	5	776
	(Mortality %)	(52.3)	(74.3)	(90.1)	(95.5)	(88.5)	(83.3)	(77.4)

Mortality in different age groups and in different number of involved organs

The overall mortality was 77.4%, but the mortality increased with increasing age and with increasing number of organs involved. Whenever the kidney was involved, the mortality was significantly high (Tables 5, 6).

Table 6. Mortality of Patients with Renal Failure

No. of Organs Involved	No. of Patients	No. of Deaths	Mortality (%)
2	35	23	65.7
3	137	112	81.7
4	151	147	97.3
5	111	109	98.2
6	26	25	96.2
7	4	4	100.0
Total	464	420	90.5

The clinical types of MOFE and their mortality.

According to our observation, MOFE may be classified into 3 types: Type I, failure of organs occurred once; Type II, failure of organs occurred twice; Type III, failure of organs occurred several times (Table 7).

Table 7. The Clinical Types and Mortality of MOFE

Type	No. of Patients (%)	No. of Death	Mortality (%)
I	415(41.4)	320	77.1
II	452(45.1)	329	72.8
III	135(13.5)	127	94.1
Total	1002(100.0)	776	77.4

Discussion

The underlying conditions and clinical course of MOFE

MOF due to surgical conditions frequently occurs in the young and middle-aged adults (aged 16 to 45 years). Most patients in this age group have normal organ function and MOF is often precipitated by massive bleeding or serious infection of the wound, so that the clinical course often occurs abruptly. MOFE usually takes a rather long course to evolve because of age-related systemic deterioration and various long-standing chronic diseases, which damage the function of involved organs. Under these circumstances, some less serious stress may result in damage to a certain organ and thus may induce sequential failure of two or more organs. In our patients with a mean age of 71.2 years, the function of various organs is often decreased to 2/3 or even 1/2 of the original level [7], and they suffered from 2 to 9 chronic diseases (2.4 on average). The number of chronic diseases increased with increasing age (Table 2). In most patients, the vital organs such as heart, lungs, brain and liver, etc. were badly hampered by protracted illnesses which made them incapable of maintaining normal functions and subsequently evolved into multiple organ system failure when stressed by some predisposing factors. Thus the course of MOFE may be described as a cascade of events: age-related multiple organ hypo-function, multiple organ chronic diseases, single organ failure or dysfunction, and multiple organ failure which takes a rather long and insidious course.

Predisposing factors of MOFE

In the young and middle-aged adults, MOF is mostly precipitated by severe stress such as trauma, burn, septicemia or major operation. For example, Fry[8] reported that in a group of MOF, emergency operation, rupture of spleen, bacilloid septicemia

and abdominal abscess were the main causes. But in MOFE, the predisposing factors are quite different. In our group, the predisposing factors were multiple (Table 3). The most important one was a pulmonary infection which accounted for 74.5% of all patients. Elderly patients often suffered from chronic pulmonary diseases (in our group, 65.8% of all patients suffered from chronic bronchitis, emphysema, tuberculosis, bronchiectasis and pulmonary fibrosis) which, in addition to the low immunity of elderly patients, made them very sensitive to pulmonary infection; and once pulmonary infection occurred, it often terminated in respiratory failure, precipitating the onset of multiple organ system failure. Acute attack of chronic cardiovascular disease was another important factor which accounted for 6.1% of all patients. This was related to the high incidence of elderly patients with coronary heart disease (57.5% in our series), which reduced their cardiac function and predisposed them to cardiac arrhythmia, angina pectoris or acute myocardial infarction, resulting in cardiac failure and hypo-perfusion of other vital organs and subsequently their failure. These predisposing factors were very rare in the young and middle-aged patients suffering from ordinary MOF.

The mortality and efficacy of resuscitation of MOFE

As reported by other authors[9-11], the mortality of MOF after serious injuries was 70 -100%. The more the organs were involved, the higher the mortality. When 4 or more organs were involved, the mortality was 100%. Knous[12] analyzed 2719 cases of organ system failure (OSF) and came to the conclusion that advanced age (≥65 years old) increased both the probability of developing OSF and the probability of death once OSF occurred. For patients aged 65 years or above with one or two OSFs, the mortality rate was frequently twice that of younger patients and recovery was unlikely if only two OSFs persisted for 24 hours. In our patients, the overall mortality was 77.6%, and the mortality increased with increasing age and the number of organs involved (Table 5). However, it is noteworthy that, of 417 cases with failure of 4 or more organs, 36 cases were successfully resuscitated (27 with 4 organs involved, 5 with 5 organs involved, 3 with 6 organs involved and 1 with 7 organs involved). For example, a 65-year-old man with coronary heart disease and chronic bronchitis developed haemorrhagic shock, acute renal failure, stress gastrointestinal bleeding, pulmonary infection and respiratory failure, acute left ventricular failure, hepatic failure, and disseminated intravascular coagulation after resection of giant cell carcinoma and was successfully resuscitated. This suggested that even in elderly patients with failure of 4 or more organs, resuscitation is likely to be successful if systemic evaluation of various organ function have been carried out to predict the probability of the onset of organ failure, the rescue techniques of medical staff and facilities are well trained and prepared, and multiple resuscitative measures are provided timely and effectively. Another point is that although less frequent than heart and pulmonary failure, renal failure carried great prognostic significance to the patient. In our patients, 420 of 464 cases (90.5%) with renal failure died. When renal failure occurred in the presence of failure of 4 or more organs, the mortality was as high as 97.3 to 100% (Table 6). This is probably attributed to the fact that age-related decline in renal function is often clinically insidious, and low renal perfusion due to any precipitating factor is apt to induce renal failure and terminate in MOFE.

The clinical types of MOFE

Faist, *et al*, [13] classified MOF into two types: single phase (rapid pattern) and two phase (delayed pattern) accounting for 44.1% and 55.9% respectively. Referring to Faist's typing, the authors divide MOFE into three categories: (1) Type I : single phase, rapid pattern, generally precipitated by infection (mainly pulmonary) or acute attack of underlying chronic disease, with one single organ failure (mainly pulmonary or heart) at first and consequentially two or more organs being involved with recovery or death as the result. (2) Type II : two phase, delayed pattern, generally evolved on the basis of type I with rapid recovery. After a short lucid period, failure of two or more organs occurs once more with recovery or death as the result. (3) Type III : multiphase, recurrent pattern, based on type II, numerous recurrences of multiple organ failure occur with recovery or death as the result.

Comparing our classification with that of Faist's, we would like to emphasize that our type III, the recurrent type, is the unique one only seen in multiple organ failure of elderly chronic patients, but not in the ordinary MOF. It may recur several times and even as many as 9 times which was never being seen in ordinary MOF. Its occurrence may be related to the following factors: (1) In the previous attacks the number of organs involved was usually small or only heart and lungs involved and thus, patients were easily saved. (2) Sparing of the critical organs like kidneys and haemopoietic system. (3) The age of the patient was comparatively

younger. (4) Increase of experience in treatment and improvement of therapeutic facilities. Thus we may conclude that the presentation of MOFE is the result of success in treating single organ failure of chronic elderly patients, and type III of MOFE implies further advancement of emergency care for elderly patients and is the very result of successful treatment of type I and II of MOFE. It can be anticipated that with the further improvement of emergency care of elderly patients and additional experience in treatment of MOFE, the proportion of type III might be increasing in the future.

Table 8. Main Clinical Differences Between MOFE and MOF

	MOFE	*MOF*
Age	⩾ 60 years	Most are young or middle-aged
Precipitating factors	Pulmonary infection, acute attacks of underlying chronic diseases, etc.	Trauma,major surgery, sepsis, etc.
Organ function	Decreased to 1/2 - 1/3 of original value	Normal
Underlying chronic diseases	Multiple (2 - 11)	Rare
Clinical course	Onset insidious, with prolonged clinical course, and sometimes recurrent attacks	Onset abrupt, with short clinical course, rapid recovery or death
No. of failed organs	3 - 4 organs usually, 7 at most	2 - 3 organs usually, 5 at most
Clinical types	3 types	2 types
Sequence of organ failure	Heart>lungs>kidneys>brain	Lungs>liver>brain> heart
Prognosis	very poor	better than MOFE

The clinical difference between MOF and MOFE and the definition of MOFE

From the above discussion and the following table (Table 8), it is clear that the differences between MOFE and MOF are remarkable. These differences are mainly attributed to the fact that MOFE occurs on the background of senile deterioration of multiple organ function with multiple organ chronic diseases. Some of these vital organs were in a critical state of dysfunction so that a stress of even slight degree may trigger the failure of one organ which might result in the evolution of numerous organ failure as a domino phenomenon. Thus the definition of MOFE might be defined as : sequential failure of 2 or more organs within a short period in elderly patients (aged 60 years old or above) with multiple organ chronic diseases on the basis of multiple organ dysfunction.

References

1. Wang SW, Ye P, Fan L. Severe multiple organ failure in the elderly. *Med J Chin PLA* 1987;**12**:340-342.
2. Wang SW. Multiple organ failure in the elderly. *Modern Medicine (Jpn)* 1989;**44**:2560-2565.
3. Wang SW, Fan L. Clinical features of multiple organ failure in the elderly. *Chin Med J (Engl)* 1990;**103**:763-767.
4. Wang SW, Mu SC. Preliminary approach to the clinical types and stages of multiple organ failure in the elderly. *Natl Med J China* 1990;**70**:241-243.
5. Wang SW, Mu SC. On the definition, diagnostic criteria, and clinical types and stages of multiple organ failure in the elderly. *Bull Postgrad Med Coll Chin PLA* 1990;**11**:193-197.
6. Wang SW. Multiple organ failure in the elderly: A new clinical syndrome in geriatrics. *J Am Geriatr Soc* 1992;**40**:1289.
7. Wang SW. Physiology of aging. In: Zei Sinhua (ed). *Clinical Geriatrics*. Tianjin: Science and Technology Publishing House, 1988:1-6.
8. Fry DE. Multiple organ system failure. *Abd Surg* 1982;**24(3)**:35.
9. Shu HF. Multiple organ failure after serious trauma, infection and major operation. *Clin J Crit Med* 1984;**4**:7.
10. Fry DE, Pearlseein L, Fulton RL, Polr HC. Multiple system organ failure: the role of uncontrolled infection. *Arch Surg* 1980;**115**:136-140.
11. Amdo N. Multiple organ failure following shock. *Jap J Clin Surg* 1981;**36**:779.
12. Knous WA, Draper EA, Wagner OP, Zimmerman JE. Prognosis in acute organ system failure. *Ann Surg* 1985;**202**:685-693.
13. Faist E, Baue AE. Multiple organ failure in polytrauma patients. *J trauma* 1983;**25**:775-781.