

Does Arterial Hypotension Due to Cardiogenic Shock in Older Patients Lead to Functional Oliguria or to Acute Renal Failure?

Zijad Duraković, M.D.

*Department of Internal Medicine, Rebro University Hospital,
Medical Faculty University of Zagreb, Croatia*

Objectives: Reports indicate some differences in the outcome of prolonged arterial hypotension due to cardiogenic shock: acute renal failure in older and more often functional oliguria in younger patients. The aim of the study is to analyze prolonged hypotension due to acute myocardial infarction in older and younger patients and to answer the question: does prolonged hypotension, due to acute myocardial infarction, lead to acute renal failure or to functional oliguria in older patients.

Methods: During a 10-year observation, a study of 11 older (≥ 65 years) and 7 younger patients (< 65 years), suffering from acute myocardial infarction and cardiogenic shock, is presented: clinical data and laboratory: diuresis, sodium in urine, creatinine urine/plasma ratio, urine osmolality, osmolality urine/plasma ratio, renal failure index and fractional excretion of filtered sodium.

Results: In 7 older and 5 younger patients, natriuresis indicated acute renal failure. The ratio of creatinine in urine and plasma in 3 older and 5 younger indicated functional oliguria; in 3 older and 1 younger, acute renal failure; and in 5 older and 1 younger, borderline values. In 7 older and 2 younger, the values of urine osmolality were in the range of functional oliguria and, in 4 older and 5 younger, borderline values between those two parameters, as the osmolality quotient in urine and plasma. The values of the renal failure index in all older and younger patients was lower than 3.0 (in 6 older and 3 younger, lower than 1.0) indicated functional oliguria, as the fractional excretion of filtered sodium. Of 9 older patients who died, 5 were examined by autopsy, and 3 out of 4 younger who died. All had myocardial fibrosis and scars, apart from recent myocardial infarction and coronary atherosclerosis. In 2 older, acute tubular necrosis was found while in 2 no renal changes were found. In 2 younger, no renal changes were found and in 1 showed disseminated intravascular coagulation.

Conclusion: Acute renal failure due to cardiogenic shock in older patients is functional, or is rare renal.

Key Words: Older-younger patients, Cardiogenic shock, Acute renal failure.

INTRODUCTION

A contribution to the studies of variability in human populations which arises from the heterogeneity of age group, particularly assessed bio-

logically or physiologically, is often provided by clinicians. Physicians are often in a position to observe homogeneity in clinical parameters, changes in various pathological conditions due to age differences. There are still scarce data available on the phenomenon of aging.

Cardiogenic shock as a possible complication of acute myocardial infarction is twice as frequent in older than in younger patients. When cardiogenic

Address reprint requests to: Zijad Duraković, M.D.,
PHD, FACP, Professor and Head, Dept. of Internal
Medicine, Rebro Univ. Hospital, Kispaticeva str.12,
41000 Zagreb, Croatia, Europe

shock occurs during acute myocardial infarction, the coronary perfusional pressure decreases, which results in expansion of the myocardial necrosis and consequently circulus vitiosus is created. If the mass of the left ventricle is reduced by more than 40%, cardiogenic shock occurs¹⁾. Most clinicians report some differences in the outcome of prolonged arterial hypotension during cardiogenic shock in relation to different age groups: reporting acute renal failure more often than functional oliguria in older patients, and more often functional oliguria than acute renal failure in younger patients¹⁾.

The aim of this study was to analyze prolonged arterial hypotension during acute myocardial infarction, in relation to oliguria in a relatively large clinical sample of 11 patients during an 11-year period. The sample is very narrowly defined according to the diagnosis and age. The study was planned to try to answer the question: does prolonged arterial hypotension during acute myocardial infarction in older patients lead to acute renal failure or to functional oliguria and if the entities differ from those in middle-aged patients?

PATIENTS AND METHODS

From the beginning of January 1983 to the end of December 1993, a total number of over 500 patients with acute myocardial infarction were treated in the Department of Internal Medicine, Rebro, University Hospital, Zagreb. 3.6% of patients showed a picture of cardiogenic shock, of which half were of the older age group (≥ 65 years). The total death rate of myocardial infarction amounted to 17.2%, of which 10.7% occurred within 6 hours, and 6.5% during hospitalization. The characteristics of shock during myocardial infarction are¹⁻³⁾ 1) electrocardiographic picture of acute myocardial infarction (not always present); 2) systolic pressure lower than 80mmHg; 3) cardiac index lower than 2.0 L/min/m²; 4) pulmonary wedge pressure higher than 18mmHg; 5) diuresis lower than 20 ml/hour; 6) signs of peripheral circulatory failure (sympathetic stimulation); 7) central venous pressure high (>12 cmH₂O). The blood pressure was mea-

sured continuously by using a mercury manometer (indirect method). The term-blood pressure in shock means the mean systolic pressure during shock state. The definition of hypotension was: systolic blood pressure less than 80mmHg (in one hypertonic less than 90mmHg- patient no.7, 54.y.). All findings of the cardiogenic shock should be present for including a patient in this study (but pulmonary wedge pressure, because of potential complications in using the method on the elderly). The patients were oliguric at the moment of development of cardiogenic shock (less than 20ml/h). Clinical and laboratory parameters were followed in all patients: diuresis, sodium in urine, creatinine urine/plasma quotient, urine osmolality, urine/plasma osmolality quotient, the renal failure index and the fractional excretion of filtered sodium. These parameters were analyzed the day after establishment of diuresis i.e. 16 to 24 hours after the onset of the cardiogenic shock, from 7a.m. in the morning to 7 a.m. the following morning (in all patients a urethral catheter was used). It is not done in the oliguric phase, because this phase lasted a short time in most of those patients and, in most of them, the cardiogenic shock was a cause of admittance to the hospital and there were no data about renal function prior to cardiogenic shock. The therapy for cardiogenic shock was applied in accordance with the rational principles of clinical pharmacology in the treatment of this condition.

RESULTS

In all of the 11 patients of older age with cardiogenic shock due to acute myocardial infarction, the central venous pressure was higher than 19.5cm H₂O (other hemodynamic parameters: pulmonary wedge pressure and cardiac index were measured in 2 patients) and all other parameters indicated cardiogenic shock also. In 7 of the 11 older and in 5 younger patients, natriuresis indicated a value of more than 25mmol/L in the range of acute renal failure, while the ratio of creatinine in urine and plasma in 3 older and 5 younger patients indicated functional oliguria, in three older and one younger in the range of acute renal failure and in five older and one younger between

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Table 1. Parameters for the Differentiation of the Type of Acute Renal Failure^{4,5)}

Acute renal failure		Diuresis ml/dU	Sodium in urine mmol/L	Creatinine urine/plasma mmol/L	Urine osmolality mosm/kg	Osmolality urine/plasma	RFI	FE _{Na} %
functional	oliguria	≤ 500	< 20	> 40	> 500	> 1.5	< 1	< 1
acute	oliguric	< 400	> 25(40)	< 20	< 350	≤ 1.1(1.5)	> 2(3)	> 2(3)
renal failure	nonoliguric	> 600	> 25(40)	< 20	< 350	≤ 1.1(1.5)	> 2(3)	> 2(3)

$$\text{RFI (the renal failure index)} = \frac{\text{sodium in urine}}{\text{creatinine urine/plasma}}$$

$$\text{FE}_{\text{Na}}\% \text{ (the fractional excretion of filtered sodium)} = \frac{\text{sodium urine/plasma}}{\text{creatinine urine/plasma}} \times 100$$

Table 2. Some Hemodynamic Parameters in Older Patients with Cardiogenic Shock and Acute Renal Failure

No	Sex	Age (years)	Blood pressure in shock (mmHg) and duration of hypotension	Duration of oliguria (hours)	Blood pressure at the time of analysis mmHg	Central venous pressure cmH ₂ O	Main diagnosis
1	F	74	80/60(18h)	19	105/70	28	myocardial infarction of the anterior wall
2	M	80	80/60(16h)	?	100/60	22	myocardial infarction of the posterior with LBBB
3	M	71	70/40 (8h)	few	110/70	26	myocardial infarction of the anterior wall
4	M	66	75/50(22h)	22	80/60	21.5	myocardial infarction of the anterior wall
5	M	79	85/55(14h)	14	100/70	20	myocardial infarction anteroseptalis+fibrillatio atriorum
6	M	68	80/55(19h)	8	105/75	20	reinfarction of the anterior wall
7	M	72	65/45(11h)	?	95/70	22	myocardial inf.anterior+ bifascicular block
8	F	75	60/40(16h)	24	85/65	26	myoc.inf.anterior+basalis
9	M	69	80/60 (6h)	3	125/80	19	myoc.inf.of the posterior wall
10	F	76	70/55 (8h)	9	100/60	20	myoc.inf.,anterior wall
11	M	67	65/45 (9h)	10	95/65	21	myoc.inf.,posterior wall

those two parameters. In 7 older and 2 younger patients the values of urine osmolality were in the range of functional oliguria and in four older and 5 younger in borderline range between functional oliguria and acute renal failure, as the osmolality quotient in urine and plasma: in 7 older and one younger indicated functional oliguria and in four older and 3 younger acute renal failure. The value of the renal failure index in all patients was lower

than 3.0, but in 6 older and 3 younger patients lower than 1.0 indicated functional oliguria, and the values of the fractional excretion of filtered sodium were similar (Table 2, 2a, 3, 3a).

None of these patients was dialyzed. We have not seen any significant change in their urine sodium or osmolality as time progressed (especially in the patients who died). In most of them, we did not measure a serum creatinine level just before

Table 2a. Some Hemodynamic Parameters in Younger Patients with Cardiogenic Shock and Acute Renal Failure

No	Sex	Age (years)	Blood pressure in shock(mmHg) and duration of hypotension	Duration of oliguria	Blood pressure at the time of analysis (mmHg)	Central venous pressure cmH ₂ O	Main diagnosis
1	F	47	60/40 (1 day)	1 day	140/90	21.0	acute myocardial infarction of the anterior wall
2	M	41	75/50 (5 hours)	1 day	150/90	20.5	stenosis valvulae mitralis, congestive heart failure
3	F	17	0 (10-12 hours)	10 hours	100/70	21.0	acute myocarditis
4	M	60	50/ 0 (10 hours)	1 day	95/70	28.0	acute myocardial infarction of the posterior wall
5	M	59	60/35 (1 day)	1 day	100/60	24.0	stenosis valvulae aortae, congestive heart failure
6	M	61	70/40 (12 hours)	18 hours	105/70	23.0	pulmonary embolism(massive)
7	M	54	85/55 (16 hours)	1 day	125/85	21.0	acute myocardial infarction of the anteroseptal location

Table 3. The Laboratory Parameters in Older Patients with Cardiogenic Shock and Acute Renal Failure

No	Diuresis at the time of analysis ml/24h	Sodium in urine mmol/L	Creatinine urine/ plasma mmol/L	corrected creat.clear. ml/min.	Urine osmolality mosm/kg	Urine/ plasma osmolality mosm/kg	The renal failure index(REI)	The fractional excretion filtered sodium (FE _{Na} %)	The outcome	Hospitalization in days in intensive care unit
1	1700	73	25.6	31.8	570	1.8	2.8	2.1	lethal	4
2	950	38	36.3	21.9	560	1.9	1.0	0.8	lethal	9
3	2320	47	32.2	59.0	560	1.8	1.5	1.1	well	4
4	1750	18	61.3	20.6	600	1.9	0.3	0.2	lethal	15
5	1220	29	23.1	28.1	590	1.9	0.9	0.8	lethal	7
6	1900	21	31.9	34.1	500	1.6	0.7	0.6	lethal	11
7	1100	34	16.4	19.3	440	1.4	2.1	1.8	lethal	5
8	1420	29	42.4	18.1	460	1.4	0.7	0.6	lethal	2
9	1910	19	52.2	29.4	480	1.5	0.4	0.3	well	6
10	740	39	17.0	19.1	390	1.3	2.3	2.0	lethal	4
11	920	22	19.4	24.3	530	1.7	1.1	1.0	lethal	11

death. Of the older patients with a picture of cardiogenic shock, nine died and 4 died in the younger age group. Autopsy was done in 5 older (no.1, 2, 4, 10, 11) and 3 younger (no. 1, 4, 6) and the pathological finding of the heart and blood vessels was in correlation with the clinical and ECG changes. Finding of the kidneys in two older patients was normal (no. 1, 11) in one showed bilateral chronic pyelonephritis (no. 2) and in two patients acute tubular necrosis was the finding (no. 4 with previous finding of the renal failure index of

0.3 and the fractional excretion of filtered sodium of 0.2 and in no. 10, with previous finding of the renal failure index of 2.3 and the fractional excretion of filtered sodium of 2, 0). Finding of the kidneys in two younger patients was normal (no. 1, and no. 6) and in one showed disseminated intravascular coagulation (no. 4).

DISCUSSION

Clinical and laboratory parameters of acute

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Table 3a. The Laboratory Parameters in Younger Patients with Cardiogenic Shock and Acute Renal Failure

No	Diuresis at the time of analysis ml/24h	Sodium in urine mmol/L	Creatinine urine/plasma mmol/L	corrected creat.clear. ml/min.	Urine osmolality mosm/kg	Urine/plasma osmolality mosm/kg	The renal failure index(REI)	The fractional excretion filtered sodium (FE _{Na} %)	The outcome	Hospitalization in days in intensive care unit
1	3600	43.0	53.2	85.0	375	1.1	0.8	0.6	lethal	3days
2	1320	44.0	19.4	31.8	355	1.1	2.3	1.7	well	16days
3	1550	58.0	93.4	129.0	195	0.7	0.6	0.4	well	4days
4	1450	6.0	71.7	62.2	440	1.6	0.08	0.06	lethal	8days
5	720	19.0	62.3	19.1	375	0.9	0.3	0.2	lethal	4days
6	650	24.0	44.7	19.2	220	0.7	0.5	0.4	lethal	5days
7	1100	17.0	29.1	31.8	430	1.3	0.6	0.5	well	8days

renal failure were presented in 11 older and in 7 younger patients with cardiogenic shock. This is, therefore, a higher frequency than reported in the literature: in some data, this amounts to approximately 1% of 500 patients⁶). However, this difference depends on numerous factors such as the time of arrival in hospital at the beginning of the clinical signs. However, in older patients it should be borne in mind that the clinical signs of infarction is more serious, and that lung edema is more frequent⁷, and even more frequent than cardiogenic shock⁸. A fatal outcome during cardiogenic shock is very frequent: of four patients reported in one paper, all four died⁹. According to some authors, it is possible to find that, during myocardial infarction acute renal failure is infrequent because the patients do not live long enough to develop acute renal failure: the lethality rate reached 75-90% in cardiogenic shock in the elderly¹⁰. Data exist on renal blood flow: in healthy persons this is 1130ml/min, while in patients with myocardial infarction in cardiogenic shock this is 420ml/min¹⁰. The cardiogenic shock is a main causal factor of acute renal failure. Our data show that all older and younger patients had creatinine quotient in urine and plasma, the renal failure index and the fractional excretion of filtered sodium in the range of functional oliguria or at the borderline values indicating that those parameters did not separate who has prerenal failure and who has established acute renal failure¹¹⁻²⁰. In cases of cardiogenic shock with heart failure, urinary sodium excretion may not be a good clinical indicator

of acute renal failure, since acute cardiac dilatation with stimulated ANP could lead to an erroneous natriuresis even in a state of prerenal oliguria. Even more, urinary sodium excretion could be low in cases of frank acute tubular necrosis in severe congestive heart failure. The distinction between functional oliguria (prerenal failure) and acute renal failure in this situation may be meaningless and should be judged from the clinical outcome of the patients.

The urine osmolality and the urine/plasma osmolality ratio were too high for the diagnosis of acute tubular necrosis. All the patients presented were (at the time of U/P osmolality tests) suffering from prerenal failure (functional oliguria) with quite a good renal reserve. This was corroborated by the value of creatinine clearance which amounted to over 18.1ml/min. in all older and to over 17.0ml/min. in younger patients the day after the phase of oliguria. This does not agree with data from the literature which suggests that hypotension, due to acute myocardial infarction which lasts for one hour or longer, leads to acute renal failure in all older patients²¹.

Although, in the literature, the values of RFI and FE_{Na}% indicating of functional oliguria are reported as values less than 1.0 when acute renal failure is considered, when this amounts to over 1.0⁵, in our earlier work¹¹⁻¹⁵, we have demonstrated that the renal failure index in cases of functional oliguria amount to 0.9 or less, while in acute renal failure it amounts to more than 3.0. In contrast to the data of other authors¹⁹, the sodium

in urine is not sufficiently discriminative: there were only two older and three younger patients with urine sodium more than 40mmol/L and they got furosemide. All others did not lose sodium. The creatinine quotient is not discriminative, also. Two of five patients died and had been examined by autopsy. They had findings of acute tubular necrosis, and both had laboratory signs of functional oliguria. There is no good correlation between structural and functional changes in human ischemic renal failure.

CONCLUSION

Acute renal failure due to cardiogenic shock in older and younger patients is pre-renal or is rare acute tubular necrosis in the elderly. Acute renal failure develops in fatal cardiogenic shock only. All the older and younger patients had adequate urine concentration at the onset of the shock. Out of nine older patients who died. Acute tubular necrosis was present in two only.

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