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ORIGINAL PAPER

Perioperative Morbidity and Mortality Among Elderly and Octogenarian Patients Undergoing Major Abdominal Surgery

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ABSTRACT

Introduction: *The global population is aging and life expectancy is increasing rapidly. As a consequence, the need of major abdominal surgeries increases as well. However, due to the advanced age, such surgeries are characterized by high morbidity and mortality rates, which proportionately increase with age.*

Aim: *To investigate perioperative morbidity and mortality rates and identify their relative prognostic factors among elderly and octogenarian patients undergoing major abdominal surgery.*

Material and method: *A total of 321 patients who underwent major abdominal surgery in the Second Department of Propaedeutic Surgery of Laiko General Hospital in Athens, Greece, were prospectively reviewed. The sample was divided into two groups. Group A included 254 (79.1%) elderly patients aged 65 to 79 years and Group B, 67 (20.9%) patients aged 80 years and over. Data was collected between June 2021 and June 2024* via *patients' medical records using a recording form which included demographic and medical characteristics, morbidity factors such as duration of hospitalization, Dindo-Clavien classification, need of transfer to the intensive care unit (ICU) and survival outcome.*

Results: *There was no difference in baseline characteristics, including gender (p=0.094) and preoperative ASA (American Society of Anesthesiologists) classification (p=0.096), between the two groups. Absence of comorbidities was found only in Group A (p=0.010), while in Group B there were higher percentages of patients with more than two comorbidities, especially pathological ones (p=0.011), compared with Group A (p=0.006). Regarding the type of surgery (emergency or elective), there weas no difference between the two study groups (p>0.05), but colectomy and gastrectomy were more prevalent among patients in Group B, while hepatectomy and pancreatectomy were more prevalent in Group A (p=0.018). We found no difference in perioperative morbidity factors, including duration of hospitalization (p=0.841), the need for ICU transfer (p=0.166) and perioperative complications based on Dindo-Clavien classification (p=0.228). However, fatality rates were higher in Group B than Group A (10.4%* vs. *3.5%, p=0.030), with correlation analysis*

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showing a positive correlation between Group B and mortality (rs=0.129, p=0.021), indicating that age ≥80 years was directly affecting mortality. Morbidity factors were found to be independent risk factors of each other (p<0.05) for both study groups and ASA score was a direct predictor for morbidity among octogenarian patients, while the type of surgery was a direct predictor for ICU transfer among the elderly ones (p<0.05). Postoperative complications were a direct predictor of mortality for both groups (p<0.001), while ASA classification (p=0.011) and hospitalization duration (p<0.001) were direct mortality predictors for the elderly subjects and ICU transfer for octogenarian ones (p=0.005).

Conclusions: *Advanced age is associated with higher rates of mortality, which in turn is affected by both perioperative morbidity and preoperative ASA scores.*

Keywords: major abdominal surgery, elderly, octogenarians, morbidity, mortality.

INTRODUCTION

As life expectancy is increasing, the need for major abdominal surgeries, especially colectomies, hepatectomies, pancreatectomies and gastrectomies mainly due to cancer, is increasing as well. Estimations suggest that the population aged 80 years and over is expected to increase fourfold in the next four decades, and therefore it can be assumed that the number of major abdominal surgeries will proportionately increase (1). Although several perioperative measures (e.g., surgical and perioperative individualized management) are employed to decrease perioperative morbidity and mortality rates even below 2.5%, the elderly population experiences many risk factors such as comorbidities, which are still associated with high complication rates and mortality after major elective or emergency abdominal surgery (2-4). However, although age itself is considered to be a major factor associated with perioperative morbidity and mortality, results from studies have been conflictive; thus, some of them showed a clear relationship between age and higher postoperative complication rates and mortality, while others indicated that age was not a negative prognostic factor for postoperative outcomes (5-11).

It has been supported that, since more and more elderly patients are being diagnosed with various pathologies requiring major surgery, age is a factor that surgeons take into account before deciding if they are going to operate or not, along with multiple other factors, including comorbidity, long-term prognosis and expected perioperative morbidity and mortality (12). Risk stratification based on available tools, such as ASA physical status classification, which helps determine preoperative health status, and Dinco-Clavien classification, which assesses postoperative complications, has led to the early identification of patients who are at higher risk of postoperative complications and fatality (13, 14). However, age still poses one of the main controversies as to how safe it is to perform major abdominal surgeries in elderly patients who face both functional impairments and physiological problems, which are associated with perioperative morbidity and mortality rates, and how these rates can be reduced (15).

Based on the above, the aim of the present study was to investigate perioperative morbidity and mortality rates and identify their relative prognostic factors among elderly and octogenarian patients undergoing major abdominal surgery, which could help in developing strategies to optimize perioperative management in order to improve patients' outcomes. ❑

MATERIALS AND METHODS

Sample

A total number of 321 patients who underwent major abdominal surgery in the Second Department of Propaedeutic Surgery of Laiko General Hospital in Athens, Greece, were prospectively reviewed. The sample was divided into two groups. Group A included 254 (79.1%) elderly patients aged 65 to 79 years and Group B, 67 (20.9%) patients aged over 80 years. The study was approved by the Hospital's Science and Medical Ethics Board (registration number 603/8.9.2021). The General Data Protection Regulation (GDPR) requirements were met.

Inclusion criteria

The study population included patients ≥65 years of age undergoing major abdominal surgery, in-

cluding colectomy, hepatectomy, pancreatectomy and gastrectomy.

Data collection

Data were collected between June 2021 and June 2024. They were retrieved from patients' medical files using a recording form which included: 1) demographic and medical characteristics (except for age and gender, ASA classification and comorbidities, the surgery type – more specifically, whether patients underwent an emergency or elective surgical procedure and whether they were subjected to colectomy, hepatectomy pancreatectomy or gastrectomy); 2) morbidity (the assessment of perioperative morbidity was based on hospitalization duration, need for transfer in the ICU and Dindo-Clavien classification of surgical complications); and 3) mortality (more specifically, perioperative mortality).

Statistical analysis

The statistical software IBM SPSS, version 25, was used to analyze the data. To determine whether the distribution of variables was normal, the Kolmogorov-Smirnov test was used. Categorical variables are presented as frequencies and percentages and constant ones as means and standard deviations (SD) and medians and quarterlies. For the statistical analysis, Mann-Whitney (U), Kruskal Wallis (H), Chi-square (χ^2), Fisher's exact test, Spearman's rho correlation coefficient (rs) and multiple linear regression were applied. The statistical significance was set at $p<0.05$.

Table 1 summarizes the demographic data, the types of complications according to the Clavien-Dindo classification, ASA classification and case distribution.

RESULTS

When comparing the two study groups in terms of gender and preoperative ASA classification, no statistical difference was found (p=0.094 and 0.096, respectively) (Figures 1 and 2). However, there was statistical difference

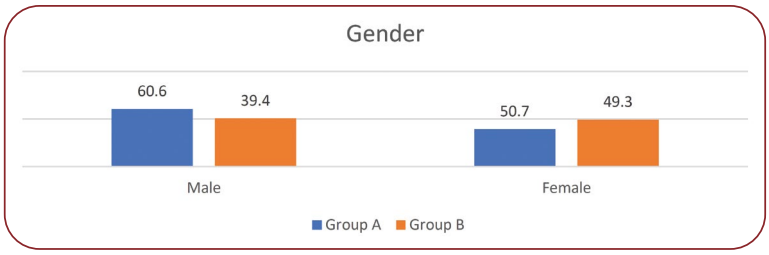

FIGURE 1. Comparison between the two study groups regarding gender (p=0.094)

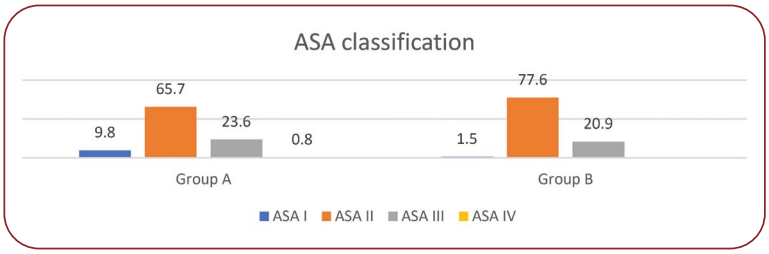

FIGURE 2. Comparison between the two study groups regarding ASA classification (p=0.096)

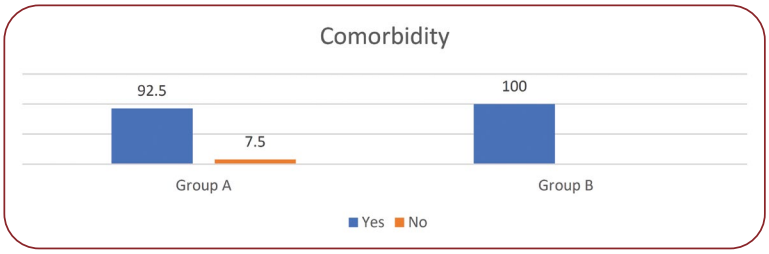

FIGURE 3. Comparison between the two study groups regarding comorbidity (p=0.010)

Category	Group A (65-79 years)	Group B (≥80 years)
Age (mean ± SD)	73.4 ± 4.2	82.9 ± 2.7
Gender (male/female)	148 / 106	41 / 26
ASA classification (I-II/III-IV)	156 / 98	36 / 31
Number of comorbidities (≥2)	131 (51.6%)	48 (71.6%)
Type of surgery (colectomy/hepatectomy/pancreatectomy/gastrectomy)	112 / 59/ 45/ 38	29/15 / 12 /11
Dindo-Clavien classification (0-5)	87/29/95/20/10/1/3/9	21/9/26/4/0/0/0/7
ICU transfer (yes/no)	45 / 209	16 / 51
Mortality (yes/no)	9 / 245	7 / 60

TABLE 1. Demographic data, types of complications according to the Clavien-Dindo classification, ASA classification and case distribution

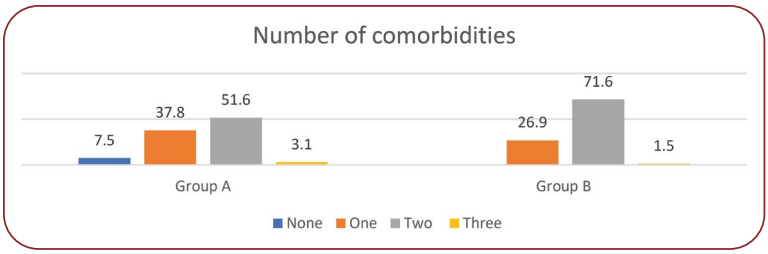

FIGURE 4. Comparison between the two study groups regarding the number of comorbidities (p=0.011)

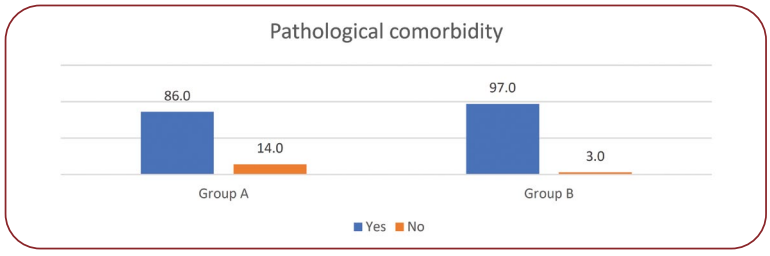

FIGURE 5. Comparison between the two study groups regarding pathological comorbidity (p=0.006)

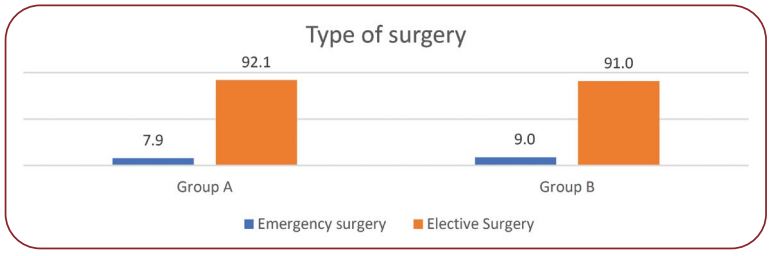

FIGURE 6. Comparison between the two study groups regarding surgery type (p=0.469)

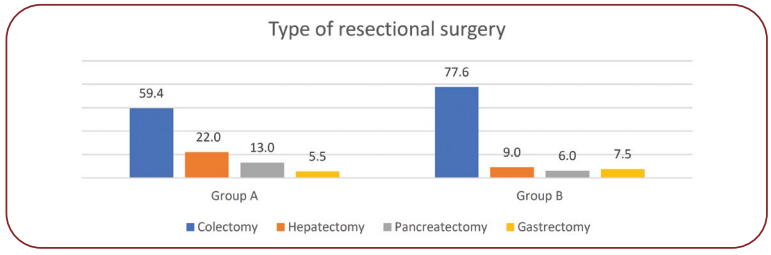

FIGURE 7. Comparison between the two groups regarding the type of resectional surgery (p=0.018)

between groups regarding comorbidity (p=0.010); more specifically, absence of comorbidity was found only in Group A, while in Group B there were higher percentages of patients with more than two comorbidities (71.6% *vs* 51.6%, p=0.011) (Figures 3 and 4). Regarding the type of comorbidity, pathological comorbidities were significantly more prevalent in Group B than Group A (p=0.006) (Figure 5).

There was no intergroup difference in the type of surgery (emergency or elective surgical procedure) (p>0.05). However, it was observed that colectomy and gastrectomy were more frequently performed among patients in Group B, while hepatectomy and pancreatectomy were more often done in Group A (p=0.018) (Figures 6 and 7).

When comparing the two groups in terms of morbidity factors, we found no difference in duration of hospitalization [$U(1_{GroupA}=254, 2_{GroupB}=67)=8374,5$, p=0,841] and need for ICU transfer (p=0.166) and perioperative complications (p=0.228) based on the Dindo-Clavien classification (Table 2).

However, the correlation analysis showed a positive correlation between the three morbidity factors, with hospitalization time being positively correlated with ICU transfer (rs=0.307, p<0.001) and Dindo-Clavien (rs=0.482, p<0.001), which were positively correlated with each other (rs=0.336, p<0.001). However, there was a significant difference in mortality, which was higher in Group B than Group A (10.4% *vs* 3.5%, p=0.030). Correlation analysis indeed showed that Group B was positively correlated with mortality (rs=0.129, p=0.021), indicating that age over 80 years was directly affecting survival outcomes.

Regarding the prediction of morbidity, the regression model can predict the duration of hospitalization for the elderly and octogenarian patients by 28% and 37.2%, respectively, if ASA classification, the number of comorbidities, Dindo-Clavien classification and the need of ICU transfer are known, with Dindo-Clavien being direct predictors for both groups, ASA for octogenarian subjects and ICU transfer for the elderly ones (p<0.05). Complication severity can be predicted for the two groups by 32.9% and 45.5%, respectively, if the same variables are known, with the duration of hospitalization and need for ICU transfer being direct predictors for both groups (p<0.05). The need for ICU transfer can be predicted by 20.4% and 31.7%, respectively, with the type of surgery (pancreatectomy and gastrectomy) being direct predictors for the elderly patients, which increases the risk of ICU transfer (p=0.006), the duration of hospitalization (p=0.041) and the gravity of complications based on Dindo-Clavien classification for both groups (p=0.000 and 0.002, respectively).

TABLE 2. Comparison between groups regarding perioperative morbidity and mortality

	Group A	Group B	p
	mean ± SD and median (percentiles)		
Duration of hospitalization	11.4 ± 6.3 and 10.0 (8.0-12.0)	11.9 ± 7.3 and 10.0 (8.0-13.0)	0.841
	n (%)		
ICU transfer			
Yes	45 (17.7)	16 (23.9)	0.166
No	209 (82.3)	51 (76.1)	
Dindo-Clavien classification			
0	87 (34.3)	21 (31.3)	0.228
1	29 (11.4)	9 (13.4)	
2	95 (37.4)	26 (38.8)	
3a	20 (7.9)	4 (6.0)	
3b	10 (3.9)	0 (0.0)	
4a	1 (0.4)	0 (0.0)	
4b	3 (1.2)	0 (0.0)	
5	9 (3.5)	7 (10.4)	
Mortality			
Yes	9 (3.5)	7 (10.4)	0.030
No	245 (96.5)	60 (89.6)	

Mortality can be predicted by 89.8% for the elderly and by 80.6% for octogenarians if ASA classification, the number of comorbidities, the type of surgery, the need for ICU transfer, the duration of hospitalization and Dindo-Clavien classification are known, with the last variable being the common direct predictor ($p<0.001$). ASA classification and the duration of hospitalization were also found to be direct predictors of mortality for the elderly patients ($p=0.011$ and 0.000, respectively), and the need for ICU transfer was found to be an additional direct predictor of mortality for octogenarian ones ($p=0.005$) (Table 3). ❑

DISCUSSION

The aim of the present study was to highlight the differences between elderly and octogenarian patients undergoing major abdominal surgery regarding perioperative morbidity, which was determined by the hospitalization duration, need of ICU transfer and gravity of postoperative complications based on the Dindo-Clavien classification, and mortality. We found no difference between the two study groups regarding perioperative morbidity ($p>0.05$), which was in agreement with the study of Andreou *et al* (12) who reported no difference in either postoperative morbidity ($p=0.664$) or length of hospitalization ($p=0.372$) between octogenarian patients and younger ones. Komori *et al* (15) also found no significant difference between patients <80 years of age and those aged 80 and over in terms of complications after gastrectomy (29.4% *vs*. 32.4%, $p=0.699$).

ASA classification was found to be a predictor for hospitalization duration for octogenarian patients ($p<0.05$), while the type of surgery, especially pancreatectomy and gastrectomy, was an independent factor for ICU transfer among the elderly subjects ($p<0.001$). This can be explained by the fact that the percentages of more than two comorbidities, particularly pathological ones, were significantly higher in octogenarian patients ($p=0.011$) than subjects in Group A ($p=0.006$). These findings indicate that preoperative health status among octogenarians is worse than the elderly's, with frailty and poor health status being often suggested to be one of the major predictors of postoperative complication rates. More specifically, both functional impairments and physiological problems increase with age and they are associated with higher rates of perioperative morbidity after major abdominal surgery, such as gastrectomy (15); this could explain the fact that, in the present study, all morbidity factors were positively correlated with each other ($p<0.001$).

In our study, octogenarian patients had higher rates of mortality, indicating that the age over 80 years was directly affecting mortality ($p<0.01$), with all morbidity factors being mortality predictors ($p<0.01$) along with ASA classification. These findings are in agreement with another study which investigated age as a prognostic factor of mortality and found that patients ≥80 years of age had higher mortality rates than younger ones (15.4% *vs*. 2%, $p<0.0001$) after pancreatectomy (12). Tzeng *et al* (16) also found that major complications were associated with a mortality rate of 20.1% in elderly patients compared with 10.8% in younger ones ($p<0.001$), indicating that advanced age was indeed a factor of fatality due to severe complications after hepatectomy. Kent *et al* (17) also report that mortality rates after colectomy increase with age by 29.3% in patients aged 70-79 years and by 37.8% in those aged over 80, with ASA score being an independent factor only for the elderly subjects and not for the octogenarian ones.

In the present study, emergency surgery was not correlated with either morbidity or mortality, while Cooper *et al* (18) reported that older pa-

TABLE 3. Regression analysis of perioperative morbidity and mortality

	Correlation coefficient (r)		**Determination coefficient (r square)**		**Adjusted determination coefficient (adjusted r square)**						
Dependent variable	A	B	A	B	A	B					
Duration of hospitalization	0.529	0.610	0.280	0.372	0268	0.332					
Dindo-Clavien	0.573	0.675	0.329	0.455	0.318	0.420					
ICU transfer	0.452	0.563	0.204	0.317	0.188	0.261					
Mortality	0.691	0.898	0.478	0.806	0.465	0.787					
	ANOVA										
Dependent variable		**Sum of squares**		**Df**		**Mean square**		**F**		**P**	
Duration of hospitalization		A	B	A	B	A	B	A	B	A	B
	Regression	2813.108	1323.085	4	4	703.277	330.771	24.202	9.188	0.000	0.000
	Residual	7235.620	2231.900	249	62	29.059	35.998				
	Total	10048.728	3554.985	253	66						
Dindo-Clavien	Regression	222.671	122.896	4	4	55.668	30.724	30.494	12.962	0.000	0.000
	Residual	454.564	146.955	249	62	1.826	2.370				
	Total	677.232	269.851	253	66						
ICU transfer	Regression	7.554	3.862	5	5	1.511	0.772	12.713	5.666	0.000	0.000
	Residual	29.473	8.317	248	61	0.119	0.136				
	Total	37.028	12.179	253	66						
Mortality	Regression	4.149	5.054	6	6	0.691	0.842	37.684	41.597	0.000	0.000
	Residual	4.532	1.215	247	60	0.018	0.020				
	Total	8.681	6.269	253	66						
		Beta		**t**		**P**					
Dependent variable	**Independent variables**	**A**	**B**	**A**	**B**	**A**	**B**				
Duration of hospitalization	ASA	.016	-0.258	0.261	-2.445	0.795	0.017				
	Number of comorbidities	-0.021	-0.025	-0.353	-0.237	0.724	0.814				
	Dindo-Clavien	0.461	0.501	7.840	4.155	0.000*	0.000*				
	ICU transfer	0.135	0.158	2.298	1.312	0.022*	0.194				
Dindo-Clavien											
	ASA	0.090	0.202	1.566	2.020	0.119	0.048				
	Number of comorbidities	0.002	-0.044	0.032	-0.456	0.974	0.650				
	ICU transfer	0.238	0.343	4.296	3.280	0.000*	0.002*				
	Duration of hospitalization	0.430	0.435	7.840	4.155	0.000*	0.000*				
ICU transfer											
	ASA	0.055	0.086	0.869	0.739	0.386	0.463				
	Number of comorbidities	0.055	0.069	0.873	0.620	0.384	0.538				
	Type of surgery	0.163	0.018	2.778	0.170	0.006*	0.866				
	Duration of hospitalization	0.136	0.169	2.051	1.273	0.041*	0.208				
	Dindo-Clavien	0.266	0.431	3.960	3.255	0.000*	0.002*				
Mortality											
	ASA	0.132	0.018	2.568	0.291	0.011*	0.772				
	Number of comorbidities	-0.014	-0.0146	-0.276	-0.763	0.783	0.448				
	Type of surgery	0.054	-0.005	1.119	-0.088	0.264	0.930				
	ICU transfer	0.079	0.200	1.535	2.910	0.126	0.005*				
	Duration of hospitalization	-0.276	-0.043	-5.086	-0.596	0.000*	0.554				
	Dindo-Clavien	0.712	0.794	12.645	10.308	0.000*	0.000*				

A=Group A; B=Group B; ASA=American Society of Anaesthesiologists physical status classification; ICU=intensive care unit; *statistical significance

tients undergoing major abdominal surgery of an emergency nature had higher mortality rates exceeding 14% and concluded that age was an independent predictor of lethality, which was supported by the current study based on the fact that octogenarians had higher mortality rates.

What can be supported, though, is that whether elderly and octogenarian patients undergo emergency or elective major abdominal surgery, perioperative morbidity is affected by the preoperative health status, both of which affect mortality rates. Knowing the predictive factors of mortality, as the ones identified in the present study, individualized perioperative strategies should be implemented to reduce the morbidity and mortality risk factors as far as possible. This is of a high importance since the elderly population is rapidly increasing worldwide, especially in the Western world, so the need for major abdominal surgeries – elective or emergency ones – in this population is expected to increase proportionately (17).

Study limitations

The present study has two main limitations: the absence of detailed postoperative complications and the fact that it did not include intraoperative characteristics, which could have affected postoperative morbidity and mortality rates. ❑

CONCLUSIONS

As this study states, advanced age, specifically over 80 years old, tends to correlate with elevated levels of postoperative complications and death. In fact, the existence of comorbidities has a considerable effect on the outcome of surgery, thereby necessitating careful planning of the perioperative risk. During intensive care and many other complications that adversely affect a patient's life, these different contributors are all intimately related, adding another layer of complexity to a patient's chance of survival.

In order to implement a change in the life of elderly patients who require major surgeries, especially on the abdomen, it is wise to incorporate a specific strategy. Through early identification of these patients and baseline preoperative procedures, overarching management can be tailored to specific need. By taking a more proactive approach, doctors can lessen the extent to which a patient will have to recover from the surgery, ultimately improving the patient's quality of life after surgery and enhancing his/her survival. Given the increasing trend of the aging population, it will be important for all surgical strategies to be adjusted in order to provide safer and more effective intervention in the future. ❑

Conflicts of interest: none declared.
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