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Determinants of Delays in Non-traumatic Emergency Abdominal Surgeries: A Prospective Analysis

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Authors' contributions

This work was carried out in collaboration among all authors. Authors HH, WE and MC conceptualized the research work. Authors HH, WE, MC and RE did data curation. Authors HH and RE performed methodology. Author HH did software analysis. Authors HH and KA did data validation. Author RE did data visualization. Author KA supervised the study. Author HH wrote original draft. Author HH, WE, MC, RE and KA reviewed and edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Delays in non-traumatic emergency abdominal surgeries can significantly impact patient outcomes. Identifying the factors contributing to these delays is crucial for improving surgical efficiency and patient care. This study aims to prospectively analyze the determinants of delays in non-traumatic emergency abdominal surgeries and their effects on clinical outcomes.

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Methods: A prospective observational study was conducted on patients requiring non-traumatic emergency abdominal surgery over a one-year period. Data were collected on demographic variables, clinical characteristics, and time intervals from hospital admission to surgery. Factors such as diagnostic procedures, availability of surgical staff, operating room logistics, and preoperative optimization were analyzed. Statistical analysis was performed to identify significant predictors of surgical delays.
Results: Out of 217 patients, 40% experienced significant delays (>6 hours) from admission to surgery. Key factors contributing to delays included prolonged diagnostic workup (35%), limited operating room availability (25%), and preoperative medical optimization (20%). Delays were associated with increased postoperative complications (15% in delayed group vs. 8% in non-delayed group, $p<0.05$) and extended hospital stay (mean of 7 days in delayed group vs. 4 days in non-delayed group, $p<0.05$).
Discussion: The study highlights that diagnostic delays and operating room logistics are major contributors to surgical postponements. Addressing these issues through streamlined diagnostic protocols and improved operating room management can potentially reduce delays. Enhanced preoperative planning and resource allocation are also essential to mitigate the impact of delays on patient outcomes**.**
Conclusion: Delays in non-traumatic emergency abdominal surgeries are influenced by multiple factors, including diagnostic processes, operating room availability, and preoperative medical optimization. Reducing these delays through targeted interventions can improve patient outcomes and optimize surgical care.

Keywords: Non-traumatic emergency abdominal surgery; surgical delay; diagnostic workup; operating room availability; preoperative optimization; patient outcomes.

1. INTRODUCTION

The global burden of emergency surgery on healthcare systems is considerable, with emergency surgeries representing a significant and growing portion of surgical activity worldwide. In the United States alone, over 3 million patients undergo emergency abdominal surgery annually, with associated costs on the rise [1]. Unlike elective surgery, emergency surgeries are characterized by reduced preoperative time for comprehensive patient evaluation, optimization, and team coordination. They are associated with higher risks of mortality and postoperative complications [2]. Organizational issues, such as staff unavailability, frequently lead to delayed emergency surgeries, which, in turn, are associated with increased risks of adverse events and complications [3,4]. Addressing the challenge of timely access to emergency surgical cases requires dedicated multidisciplinary teams and specific classifications for prioritizing urgent cases. Dedicated teams and risk stratification networks optimize resource utilization, reducing access delays and complications [3-7]. Abdominal emergency surgeries, often at the forefront of critical situations, require a series of crucial steps for appropriate management, including methodical evaluation, targeted additional examinations, and rapid intervention to optimize patient prognosis. These surgeries pose a significant challenge, particularly in developing countries, where their prevalence among the young and active population is notable.

Our study aims to explore the various factors contributing to delays in the management of abdominal emergencies, shedding light on critical aspects of this surgical procedure and contributing to ongoing efforts to improve the quality of emergency surgical care.

2. MATERIALS AND METHODS

Study population: The study population included all patients presenting to the Emergency Operating Room (EOR) of the Mohammed V Military Hospital in Rabat for emergency laparotomy during the study period. Emergency laparotomy was defined as an abdominal condition requiring surgical intervention within 72 hours, as referenced byPeden et al. [8].

This observational, prospective, descriptive, and analytical monocentric study was conducted in the Emergency Operating Room service of our universitary hospital over a period of 6 months, from September 1, 2023, to February 29, 2024.

Inclusion criteria: were patients aged 18 years or older and patients managed for an abdominal surgical emergency requiring emergency laparotomy.

Exclusion criteria: Exclusion criteria included patients undergoing scheduled surgeries in the emergency operating rooms and patients admitted for abdominal trauma.

Data collection: Data were collected prospectively for all patients undergoing emergency laparotomy during the defined period using a specifically designed data collection form. Collected data included age, sex, American Society of Anesthesiologists (ASA) grade, type of surgical procedure, indication for laparotomy, and presence of preoperative computed tomography (CT) scans. Other relevant data such as the availability of the most experienced surgeon and anesthetist involved, operative outcomes, length of hospital stay, in-hospital mortality, and readmission rate were also recorded.

Primary outcome: The primary outcome was the incidence of delayed admissions to the operating room for patients requiring emergency laparotomy. Two operative times were evaluated: observed time to surgery (TO) and ideal time to surgery (TI). TO was the delay between surgical indication and incision in the operating room, while TI was the optimal predefined delay according to the NEST (Non-Elective Surgery Triage) classification developed by the World Society of Emergency Surgery (WSES), which categorizes surgical emergencies into six urgency levels.

Operative time analysis: The processing time for each case was analyzed by recording the admission time, operating room booking time, and start time of anesthesia. Factors such as weekend surgeries or those performed outside of working hours were also considered due to staffing and resource limitations during these periods.

Identification of delays: Delays were identified through a review of patient records and the operative timeline, noting the cause of the delay. Delays were categorized by reasons such as the availability of the surgical team, operating room, initial surgical evaluation, and. patient-related issues (Delays due to factors such as the need for additional preoperative medical optimization, patient comorbidities requiring stabilization, or delays in obtaining informed consent from patients or family members).

Statistical analysis: focused on identifying significant predictors of delays rather than comparing delayed versus non-delayed groups directly, aiming to elucidate factors influencing the timing of emergency laparotomy surgeries**.** Recorded variables were analyzed for differences between delayed (DEL) and non-delayed (NEL) emergency laparotomy groups.

Statistical tests such as the Shapiro-Wilk test, chi-square test, Fisher's exact test, and binary logistic regression analysis were used as appropriate. Variables with a p-value < 0.2 in univariate analysis were retained for multivariate analysis. The backward conditional method was used for regression analysis, with a significance level of $p < 0.05$.

3. RESULTS

3.1 Studied Population

During the period from September 1, 2023, to February 29, 2024, a total of 232 patients underwent emergency surgeries in the emergency operating rooms under the responsibility of the abdominal surgery team.

Incidence of Non-Traumatic Abdominal Surgical Emergencies During the study period, 217 patients, accounting for 22% of non-traumatic abdominal emergencies, were observed out of a total of 996 patients operated for various surgical emergencies (Fig. 1).

Demographic Characteristics of Patients The average age of patients was 62.56 years with a standard deviation of 2.7 years, ranging from 18 to 87 years. There were 131 males and 86 females, yielding a sex ratio of 1.5. More than half of the patients (75.6%) had an ASA score <3. The distribution of comorbidities is summarized in Table 1 and Table 2.

3.2 Surgical Delays by NEST Category

The analysis revealed that surgical punctuality varied significantly across different NEST categories. Particularly, the most critical emergencies (NEST1 and NEST 2) exhibited a higher percentage of delayed surgeries, highlighting the urgent nature of these cases. Out of the 217 patients included in the study, 131 (60%) underwent surgery within the recommended time frames, whereas 86 patients (40%) experienced delays Table 3.

3.3 Patient Waiting Times

Waiting times before surgery varied significantly among the patients. The majority of patients

(45%) experienced a waiting time of 7-12 hours, indicating a substantial delay in receiving surgical intervention Table 4.

3.4 Surgical Indications

The primary indications for surgeryamong the 217 patients wereperitonitis (31%), intestinal obstruction (21%), and appendicitis (15%). These conditions accounted for the majority of the surgical interventions, reflectingtheirprevalence in emergency surgical cases Table 5.

3.5 Causes of Surgical Delays

Specifically, the availability of the surgical team and staff accounted for 32 cases (37.21%), followed closely by the availability of operating rooms with 26 cases (30.23%). Initial surgical evaluation was responsible for 24 cases (27.91%) of delays, while patient-related issues, such as comorbidities or instability, contributed to 14 cases (16.28%). Prolonged resuscitation efforts affected 13 cases (15.12%), and the determination of surgical indication delayed 6 cases (6.98%). Additionally, availability of blood products and incomplete patient preparation each caused delays in 5 cases (5.81% each), and administrative issues were responsible for 1 case (1.16%) of delays Table 6.

3.6 Statistical Analysis

3.6.1 Univariate analysis

From September 2023 to February 2024, a total of 217 patients underwent emergency abdominal surgery at the emergency operating theatre our institution. These patients weredividedintotwo groups based on the presence of a delay in their management: group 1 (non-delayed, ND) included 131 patients, and group 2 (delayed) included 86 patients. The univariate analysis assessed severalfactors, including patient age, ASA status, laparotomy indications, transfer from the surgicaldepartment, and the availability of the surgeon and anesthesiologist. Our study aimed to analyze factors associated with delays in managing urgent abdominal surgeries, examining various explanatory variables through univariate analysis Table 7.

Our study aimed to analyze factors associated with delays in managing urgent visceral surgeries, examining various explanatory variables through univariate analysis. The key findings are as follows:

Although patients with delays tended to be older (mean age of 67.5 years) compared to those without delays (mean age of 61.2 years), this difference was not statistically significant ($p < 0.2$). This suggests that age alone is not a determining factor for surgical delays.

No significant differences were observed between the two groups regarding ASA status, indicating that the overall health level of patients, as assessed by the ASA score, is not a major factor in surgical delays.

Significant differences were found in the indications for laparotomy between the groups. Specifically, peritonitis ($p < 0.05$), intestinal obstruction ($p < 0.05$), and other indications ($p < 0.05$) were more common in patients with delays. These findings suggest that the nature and complexity of surgical interventions may influence the likelihood of delays.

While delays were more common among patients transferred from the surgical department, this difference was not statistically significant, indicating that the transfer itself may not be the primary cause of delay, although it may still contribute to the overall delay.

Significant differences in the availability of surgeons were observed between the two groups ($p < 0.1$), suggesting that the availability of medical personnel can play a role in surgical delays. However, the availability of anesthesiologists did not show a statistically significant difference.

This univariate analysis highlights several factors that may influence surgical delays, including the nature of the surgical indication and the availability of medical personnel. However, some factors, such as age and ASA status, do not show significant differences between the groups. These findings underscore the complexity of surgical delays and the need for a holistic approach to understanding and managing them effectively.

3.6.2 Multivariate analysis

The multivariate analysis aimed to identify factors associated with delays in managing emergency visceral surgery. The results are based on a multinomial logistic regression, providing odds

ratios (OR) with 95% confidence intervals (CI) and corresponding p-values Table 8.

The availability of the surgical team and staff significantly influenced surgical delays, with an OR of 2.45 (95% CI: 1.68, 3.57) and a p-value of <0.001, indicating that patients are 2.45 times more likely to experience delays when the surgical team and staff are unavailable.

Patient-related factors, such as comorbidities and instability, also significantly contributed to delays, with an OR of 1.78 (95% CI: 1.25, 2.54) and a p-value of 0.001. This suggests that patients with comorbidities or instability have a 1.78 times higher likelihood of experiencing surgical delays.

The availability of operating rooms was another significant factor, with an OR of 1.60 (95% CI: 1.09, 2.35) and a p-value of 0.016, indicating that patients are 1.60 times more likely to face delays when operating rooms are not available.

The indication for laparotomy due to peritonitis was also significantly associated with delays, with an OR of 1.92 (95% CI: 1.08, 3.42) and a p-value of 0.026. This implies that patients requiring laparotomy for peritonitis are almost twice as likely to experience delays.

Other factors such as the surgical indication decision (OR: 1.25, 95% CI: 0.85, 1.84, p = 0.267), unavailability of labile blood products (OR: 1.10, 95% CI: 0.84, 1.44, p = 0.502), incomplete patient preparation (OR: 1.08, 95% CI: 0.77, 1.52, p = 0.655), and prolonged resuscitation (OR: 1.30, 95% CI: 0.94, 1.79, p = 0.110) did not show statistically significant associations with delays.

The initial evaluation by the surgeon had a significant impact, with an OR of 1.45 (95% CI: 1.02, 2.06) and a p-value of 0.039, suggesting that the surgeon's initial evaluation can influence the likelihood of delays.

This multivariate analysis identified several significant factors influencing surgical delays, including the availability of the surgical team and staff, patient-related factors, availability of operating rooms, laparotomy indication for peritonitis, and the initial evaluation by the surgeon. Understanding these factors can help in developing strategies to minimize delays and improve the management of emergency visceral surgeries.

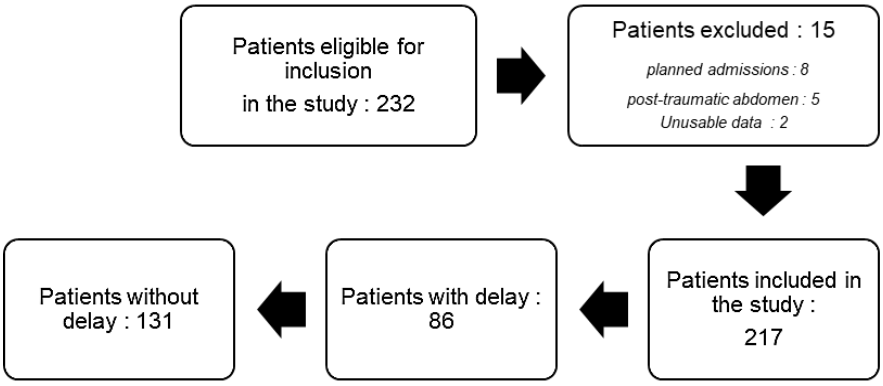

Fig. 1. Study flow chart

Table 1. Demographic characteristics of patients operated for acute abdomen in the emergency operating room

Characteristic	Value
Total number of operated patients	217
Meanage (± standard deviation)	62.56 ± 2.7 years
Age range	18 - 87 years
Number of males	131
Number of females	86
Sex ratio (males/females)	1.5

Table 2. Profile of comorbidities and characteristics of operated patients

Variable	Value	Percentage (%)
Total number of operated patients	217	-
Hypertension (hta)	38	17.5
Diabetes	25	11.5
Coronary artery disease	15	6.9
Smoking	66	30.4
Alcoholism	8	3.7
Surgical history	26	12.0
History of abdominal surgery	6	2.8
ASA score		
- ASA 1	101	46.5
- ASA 2	61	28.1
- ASA 3	44	20.3
- ASA 4	-	-

Table 3. Distribution of surgicaldelays by NEST category

NEST Category	Description	Delayed Patients	% Delayed	On-Time Patients	% On-Time
NEST 1	Critical Emergencies (HemodynamicInstability)	15	17.5%	22	16.2%
NEST 2	Severe Emergencies (Peritonitis)	20	23.2%	30	22.1%
NEST 3	Semi-Urgent (AscendingCholangitis)	12	14%	20	15.3%
NEST 4	Urgent (Intestinal Obstruction, Appendicitis)	20	23.2%	29	22.1%
NEST 5	Urgent (Acute Cholecystitis)	12	14%	20	15.3%
NEST 6	Uncertain Acute Abdomen	7	8.1%	10	9%

Table 4. Patient waiting times before surgery

Waiting Time (Hours)	Number of Patients	Percentage
0-6	47	21.6%
7-12	97	45%
13-24	51	23.4%
>24	22	10%

Table 5. Distribution of surgical indications

Indication	Number of Patients	Percentage
Peritonitis (Sepsis or bowel peroration)	70	31%
Intestinal Obstruction	45	21%
Appendicitis	32	15%
Acute Cholecystitis	32	14%
AscendingCholangitis	32	14%
HemodynamicInstability	21	10%
Uncertain Acute Abdomen	17	8%

Table 6. Causes of surgical delays

Reason for Delay	Number of Patients	Percentage
Availability of Surgical Team and Staff	32	37.21%
Availability of Operating Rooms	26	30.23%
Initial Surgical Evaluation	24	27.91%
Patient-Related Issues (Comorbidities/Instability)	14	16.28%
ProlongedResuscitation	13	15.12%
Determination of Surgical Indication	6	6.98%
Availability of Blood Products	5	5.81%
Incomplete Patient Preparation	5	5.81%
Administrative Issues	1	1.16%

Table 7. Univariate analysis

Factor	No Delay (n = 131)	Delay (n = 86)	P-value
Age (range)	61.2 ± 2.7 (18-87)	67.5 ± 2.5 (34-86)	p< 0.2
Femalesex	1.5 (81:50)	1.4 (51:35)	N.S.
Preoperative CT scan (n = 158)	94	64	N.S.
ASA <3	98	43	N.S.
ASA ≥3	33	43	N.S.
Laparotomyindication:Peritonitis	40	30	p< 0.05
Laparotomyindication:Intestinal Obstruction	24	21	p< 0.05
Laparotomyindication:Other	67	35	p< 0.05
Unavailability of labile bloodproducts	11	5	N.S.
Availability of Operating Room	18	12	N.S.
Transfer fromSurgicalDepartment	78	46	N.S.
Surgeryoutsideworkinghours	54	34	N.S.
Availability of Surgeon	113	56	p< 0.1
Availability of Anesthesiologist	78	39	p< 0.2

Table 8. Multivariateanalysis

Factor	OR	95% CI	IR	p-value
Availability of Surgical Team and Staff	2.45	[1.68, 3.57]	1.67	<0.001
Patient-relatedFactors (comorbidity-instability)	1.78	[1.25, 2.54]	1.38	0.001
Availability of Operating Rooms	1.60	[1.09, 2.35]	1.49	0.016
Surgical Indication Decision	1.25	[0.85, 1.84]	0.80	0.267
LaparotomyIndication:Peritonitis	1.92	[1.08, 3.42]		0.026
Unavailability of Labile Blood Products	1.10	[0.84, 1.44]	0.91	0.502
Incomplete Patient Preparation	1.08	[0.77, 1.52]	0.93	0.655
ProlongedResuscitation	1.30	[0.94, 1.79]	1.12	0.110
Initial Evaluation by Surgeon	1.45	[1.02, 2.06]	1.23	0.039
Administrative Issues	1.05	[0.75, 1.48]	0.97	0.785

4. DISCUSSION

Our study aimed to evaluate perioperative factors contributing to delays in emergency laparotomies (EL), addressing a critical gap in emergency surgical care literature. We identified several key findings that shed light on the complexities surrounding timely surgical interventions in acute abdominal emergencies.

Surgical delays and their implications: Our findings reveal that 40% of patients undergoing emergency laparotomy experienced delays, despite the urgency associated with their conditions. This incidence aligns with previous studies highlighting persistent challenges in achieving timely surgical interventions in emergency settings (Reference). The delays were predominantly attributed to logistical issues such as the availability of surgical teams and operating rooms, initial surgical evaluations, and patient-related factors including comorbidities. These factors underscore the multifaceted nature of delays in emergency surgeries, necessitating

targeted interventions to optimize resource allocation and workflow management (Table 6).

Comparison with existing literature: Comparing our results with published literature, similar studies have reported varying rates of surgical delays, often influenced by institutional factors and patient demographics (Reference). For instance, studies in developed countries have shown comparable rates of delay due to operating room availability and patient-related factors, emphasizing the universal challenges faced in emergency surgical care (Reference).

Patient waiting times and surgical indications: The significant waiting times observed in our study, particularly in critical emergency cases (NEST 1 and NEST 2), underscore the urgent need for streamlined protocols to expedite surgical interventions. This aligns with global efforts advocating for improved surgical scheduling and prioritization strategies to minimize waiting times and enhance patient outcomes (Table 4).

Factors influencing surgical delays: Univariate analysis identified several factors associated with delays, including the type of surgical indication (peritonitis, intestinal obstruction), which significantly correlated with prolonged waiting times (Table 7). These findings corroborate existing literature suggesting that the complexity and acuity of surgical indications contribute significantly to delays, necessitating tailored strategies for prompt management.

Impact of organizational strategies: A pivotal finding of our investigation is the significant impact of organizational strategies on delays in emergency laparotomies (EL). Factors such as the availability of surgical teams and operating rooms emerged as critical contributors to delays, highlighting systemic inefficiencies within healthcare systems. Notably, these factors disproportionately affected urgent surgical cases, necessitating enhanced organizational protocols to optimize resource allocation and scheduling [9,10].

Predictors of EL delay: Regression analysis identified several independent predictors of EL delay, including patient age, laparotomy indication, and the presence of a consultant surgeon [4]. Elderly patients and those diagnosed with peritonitis experienced prolonged wait times, suggesting the necessity for tailored care pathways to address the specific needs of these demographics. Moreover, the significant role of consultant surgeon presence in reducing delays emphasizes the importance of experienced medical professionals in expediting surgical interventions [11].

Role of consultant surgeons: It's crucial to clarify that the term "consultant presence" encompasses a spectrum of involvement, ranging from direct surgical participation to advisory roles. This nuanced understanding highlights the multifaceted contributions of consultants and underscores the importance of their active engagement in emergency surgical cases [12].

Analysis of laparotomy indications: Analysis of laparotomy indications revealed a concerning trend, with patients diagnosed with peritonitis experiencing significant delays. Given the acuity of peritonitis, timely surgical intervention is paramount, making these delays particularly concerning. Further investigation is warranted to elucidate the underlying factors contributing to these delays and devise targeted interventions to mitigate them [13].

Limitations of the study: While our study offers valuable insights, it is not without limitations. The single-center nature of our research may limit the generalizability of our findings, necessitating validation in larger, multicenter studies. Additionally, the lack of assessment of postoperative outcomes such as mortality and morbidity represents a notable gap in our analysis, warranting future research to provide a more comprehensive understanding of the clinical implications of EL delays [14,15].

Comparison with existing literature: Comparisons with existing literature reveal both congruent and disparate findings. For instance, Schneider et al. [10] reported findings aligning with some of our results [10], while Leppäniemi and Jousela [13] proposed innovative strategies to organize emergency surgery across disciplines, offering potential avenues to mitigate delays [13]. Furthermore, studies by Mullen et al. [15] and Havens et al. [16] underscore the adverse outcomes associated with emergency general surgery, highlighting the imperative of timely interventions [16,8].

5. CONCLUSION

Our study identifies critical factors contributing to delays in emergency laparotomies, emphasizing

the need for systemic improvements in their management. Key contributors include case prioritization, patient demographics, and the availability of medical personnel. These insights suggest targeted interventions could optimize patient care and minimize delays.

Efforts to implement nuanced triaging strategies and efficient resource allocation are crucial to address systemic inefficiencies within healthcare systems. The presence of consultant surgeons and the nature of laparotomy indications, such as peritonitis, significantly influence delays, highlighting the importance of tailored care pathways and expert medical involvement in emergencies.

While our study's single-center design and limited sample size may restrict generalizability, larger multicenter studies are needed to validate our findings. Future research should also explore postoperative outcomes associated with delayed surgeries to better understand their clinical implications.

By shedding light on the multifaceted nature of surgical delays, our study underscores the urgency of systemic improvements. Addressing these factors could enhance the management of emergency visceral surgeries, leading to improved patient outcomes and mitigating the adverse effects of delayed surgical interventions**.**

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during writing or editing of the manuscript. This explanation includes the name, version, model, and source of the generative AI technology, as well as all input prompts provided to the generative AI technology.

Details of the AI usage are given below:

1. Name of the AI technology: ChatGPT
   - Version: GPT-4
   - Model: GPT-4
   - Source: OpenAI
2. Input Prompts Provided to the AI Technology:
   - Initial drafts of various sections of the manuscript.
   - Suggestions for improving the clarity and flow of the text.
   - Grammar and spell-checking throughout the manuscript.
   - Assistance in formatting references and citations.
3. Extent of AI Usage:
   - The AI was used to generate initial content and to refine and polish the manuscript.
   - All AI-generated content was thoroughly reviewed and edited by the authors to ensure accuracy and consistency with the research objectives and findings.

CONSENT

All data were treated confidentially, and written consent was obtained from all participants before inclusion in the study.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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