Journal of Health, Medicine and Nursing
ISSN 2422-8419 An International Peer-reviewed Journal
Vol.43, 2017 www.iiste.org

Enhanced Recovery After Surgery (ERAS) and the Role of Advanced Hemodynamic Monitoring

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Abstract
This study aimed at exploring the Enhanced Recovery After Surgery (ERAS) as a multi-modality, evidence-based approach to improving the quality of patient care after major surgery and to investigate the effectiveness of the implementation of the ERAS on the outcome measures. Therefore, the problem of this study lies in exploring the Enhanced Recovery After Surgery (ERAS) upon the role of advanced hemodynamic monitoring through examining a sample of (220) patients in two Jordanian hospitals (Jordan Hospital and the Specialty Hospital) undergoing major surgery. The study concluded that the patients had witnessed progressive outcome measures in the Improved Post-operative Morbidity Score (POMS), and the Reduced Length of Stay in Hospital, and the Reduced episodes of harm and surgical complications.

Acknowledgment
This research has been prepared through cooperation and concerted efforts of the researchers in collecting and compiling the necessary data; each researcher with a certain role. Hence, this research was conducted with the joint efforts of the researchers; Dr. Ahmad Enad Alenzi, Dr. Abdullah Abdulelah S Alanazi and Dr. Abdullatef Ahmad Alenzi as main authors, and Dr. Alruwaili, Wael Humaidi S, Dr. Attallah Mohammed Alonazi, Dr. Ibrahim Enad Alenazi and Dr. Fahad Zaidan Alanazi as co-authors.

The researchers thank everyone who contributed to providing the data and information that helped to accomplish this research.

1.1 Introduction

Although steady advances in the surgical techniques over the years, post - operative complications remain one of the major drawbacks of surgery, not only for the specific patient involved but also for their surgical care team and the health care system in general (Scott, Baldini, Fearon, Feldheiser, Feldman, Gan & Carli, 2015).

Enhanced Recovery After Surgery (ERAS) is a dynamic culmination of evidence based upon perioperative care elements. The strongest evidence for ERAS (*see figure 1*) implementation is in the care of patients undergoing open colonic resection. Many interventions previously shown to benefit outcomes in this population have now been successfully applied to laparoscopic colon resections, as well as to other surgical specialties such as urology, orthopedics, and gynecology (Kehlet & Wilmore, 2008).

Investigators studying the application of ERAS principles to colonic resections have acknowledged the difference between intra-abdominal large-bowel resections and pelvic surgery. Pelvic intestinal resections are fraught with higher complication rates, longer LOSH, and unique complications not seen in abdominal surgery. Because of this and a need to address the more common lower-bowel resections, the authors of ERAS studies have excluded patients undergoing rectal resection or treated pelvic resections as a subgroup. In several studies, rectal resections are included in the overall analysis of an ERAS protocol or component implementation, only to be excluded or discounted as a 'special consideration' group (Nygren, Thacker, Carli, Fearon, Norderval, Lobo & Ramirez, 2013).

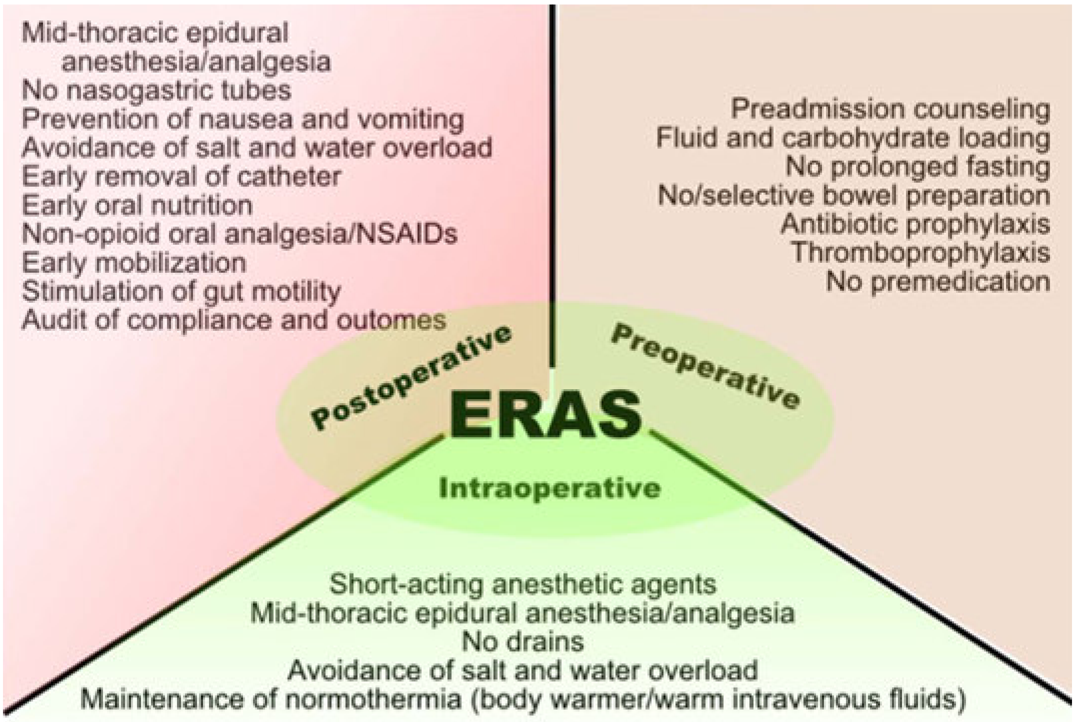


Figure (1): ERAS elements

Patients undergoing major surgery are faced with an inherent risk of morbidity and mortality (*see table 1*).These risks can increase depending on a patient's cardiovascular and hemodynamic condition and are known to contribute to a variety of postoperative complications and increased lengths of stay (LOS) in the hospital (Schilling, et al, 2008).

Specific factors that influence a patient's LOS during postoperative rehabilitation include the need for analgesia, intravenous fluids, and lack of mobility (Varadhan, Lobo & Ljungqvist, 2010).

To minimize recovery time and reduce postoperative complications for a variety of high- to moderate-risk surgical patients, hospitals and surgical teams around the world have adopted a comprehensive set of perioperative practice guidelines known as Enhanced Recovery After Surgery (ERAS).

Table (1): Postoperative complication rates

Surgery	Morbidity Rate
Esophagostomy	55%
Pelvic exenteration	45%
Pancreatectomy	35%
Colectomy	29%
Gastrectomy	29%
Liver resection	27%

Enhanced Recovery After Surgery (ERAS) programs incorporate multimodal optimization of patient care in the preoperative, perioperative, and postoperative states by following an evidence-based structured care pathway. The synergistic action of these mechanisms results in a reduction in the physiological and psychological effects of surgery on the patient (Donohoe, Nguyen, Cook, Geagan, Chen, Zaki, Mehigan, McCormick & Reynolds, 2011).

This achieves the aims of reducing morbidity, allowing earlier safe discharge after colorectal surgery, and reducing the amount of time to return to normal daily function (Gustafsson, Scott & Schwenk, 2013).

Enhanced Recovery After Surgery (ERAS) is a patient-centered method of optimizing surgical outcome by improving both patient experience and clinical outcomes. The ERAS programme was first described by Professor Henri Kehlet in 2000 (Kehlet & Morgensen, 1999).

ERAS aims to improve the quality of care provided to patients who undergo major surgery. By improving the quality in care, and reducing harm it is also assumed that hospital stay will become more efficient, thereby allowing hospital services to realize the benefits of the programme, through savings in bed days.

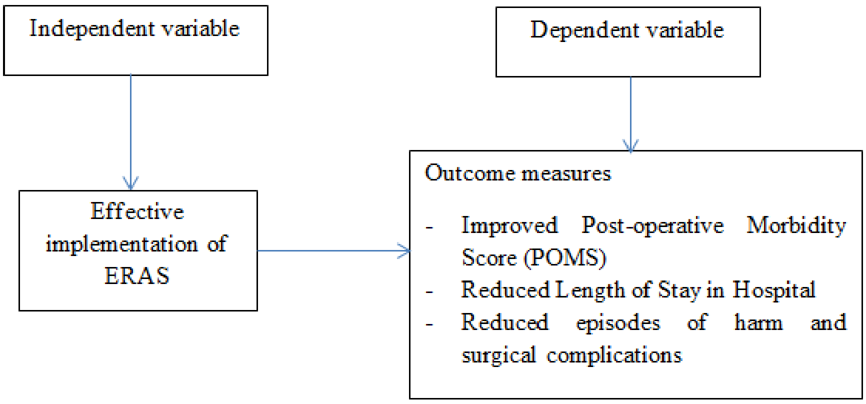
ERAS, sometimes referred to as 'fast track' or 'accelerated' surgery, is transforming elective surgical patient outcomes. Its efficacy is supported by a growing base of clinical and research evidence. Some of the principles of ERAS have already been implemented in sites across the world and it is hoped that the benefits to patients and hospital services associated with this programme can be introduced across all healthcare organisations. The effectiveness of ERAS to improve outcomes is dependent on the engagement, commitment and involvement of all members of the multi-disciplinary team at all stages of the patient's journey, starting from the General Practice surgery, continuing through the hospital stay and during recuperation in the patient's own home (Yoong, Sivashanmugarajan, Relph, Bell, Fajemirokun, Davies & Lodhi, 2014).

Hemodynamic monitoring comprises one of the cornerstones of intensive care medicine. Neurocritical care patients often require such monitoring, specifically to optimize cerebral blood flow (CBF) and brain tissue oxygen delivery in addition to managing conditions commonly seen in critically ill patients including shock states and acute lung injury. Manipulation of the cardiac output (CO), mean arterial pressure (MAP), systemic filling pressures, and volumes as well as dynamic markers of fluid responsiveness, requires continuous monitoring, thorough understanding of the modalities employed and proper interpretation of data acquired. Traditionally, invasive hemodynamic monitoring is equated to the use of a pulmonary artery catheter (PAC). Swan-Ganz catheter usage has more recently been tempered secondary to a lack of evidence on improving outcomes in randomized controlled trials and also due to the poor performance of filling pressures as indicators of fluid responsiveness; nevertheless PAC use may still be appropriate in selected patients and its use has been reviewed elsewhere (Lazaridis, 2012).

1.2 Problem Statement and questions of the study

The Enhanced Recovery After Surgery (ERAS) as a multi-modality, evidence-based approach to improving the quality of patient care after major surgery urges this research to investigate and explore the effectiveness of the implementation of the ERAS on the outcome measures. Therefore, the problem of this study lies in exploring the Enhanced Recovery After Surgery (ERAS) initiatives upon the role of advanced hemodynamic monitoring through examining a sample of (220) patients in two Jordanian hospitals (Jordan Hospital and the Specialty Hospital) undergoing major surgery. Thus the question of the study is: Does the effective implementation of the ERAS affect the outcome measures of the patients undergoing major surgery?

1.3 Study model



1.4 Study hypotheses

In light of the problem of the study, and through its questions, the researchers have adopted the following hypotheses:

1.4.1Major hypothesis

H0: There will be no statistically significant differences at the level of significance (α=0.05) of the Effective implementation of ERAS on the outcome measures in Jordan.

1.4.2 Sub- hypotheses:

The ramifications of the major hypothesis are the following sub-hypotheses:

H01: There will be no statistically significant differences at the level of significance (α=0.05) of the Effective implementation of ERAS on the Improved Post-operative Morbidity Score (POMS)in Jordan.

H02: There will be no statistically significant differences at the level of significance (α=0.05) of the Effective implementation of ERAS on the Reduced Length of Stay in Hospital in Jordan.

H03: There will be no statistically significant differences at the level of significance (α=0.05) of the Effective implementation of ERAS on the Reduced episodes of harm and surgical complications in Jordan.

1.5 What is Enhanced Recovery After Surgery?

Enhanced Recovery After Surgery (ERAS) is a multi-modality, evidence-based approach to improving the quality of patient care after major surgery, with a selected number of individual interventions which, when implemented as a group, demonstrate a greater impact on outcomes than when implemented as individual interventions. Success requires a multi-disciplinary approach.

The basic principles include:

- Ensuring the patient is in the best possible condition for surgery
- Ensuring the patient has the best possible management during and after his/her operation
- Ensuring the patient experiences the best possible rehabilitation, enabling early recovery and discharge from hospital allowing them to return to their normal activities quicker.

The Enhanced Recovery After Surgery (ERAS) pathway promotes and incorporates best practice recommendation and can instill a greater confidence in patients of their healthcare organisations. By improving the quality in care, and reducing harm it is assumed that hospital stay will become more efficient, and hospital services can realize the benefits, such as saving bed days (Shao & Zhou, 2012).

1.6 Enhanced Recovery After Surgery Driver's Diagram

1.7 Methods and producers
A sample of (220) patients in the two Jordanian hospitals (Jordan Hospital and the Specialty Hospital) undergoing major surgery as the distribution in figure 2 show.

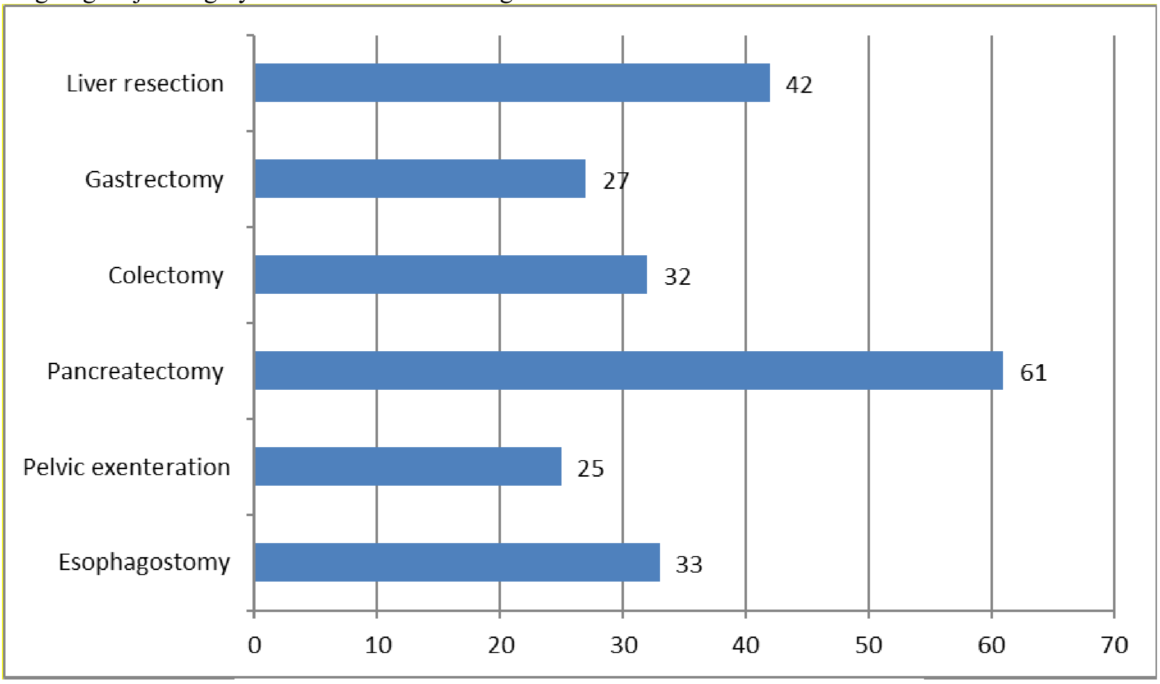


Figure (2): distribution of the study sample upon kind of surgery

1.7.1 Demographic characteristics of the Study Sample

1.7.1.1 Gender

The study sample consisted of (101) males and (119) females as shown in figure 3.

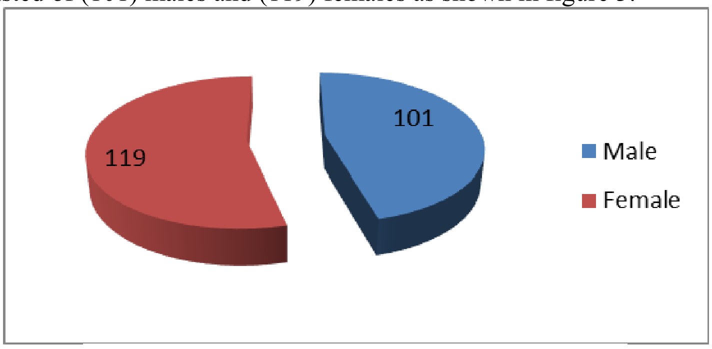


Figure (3): Gender distribution of the study sample

1.7.1.2 Age groups

The study sample consisted of different age groups as shown in figure 4.

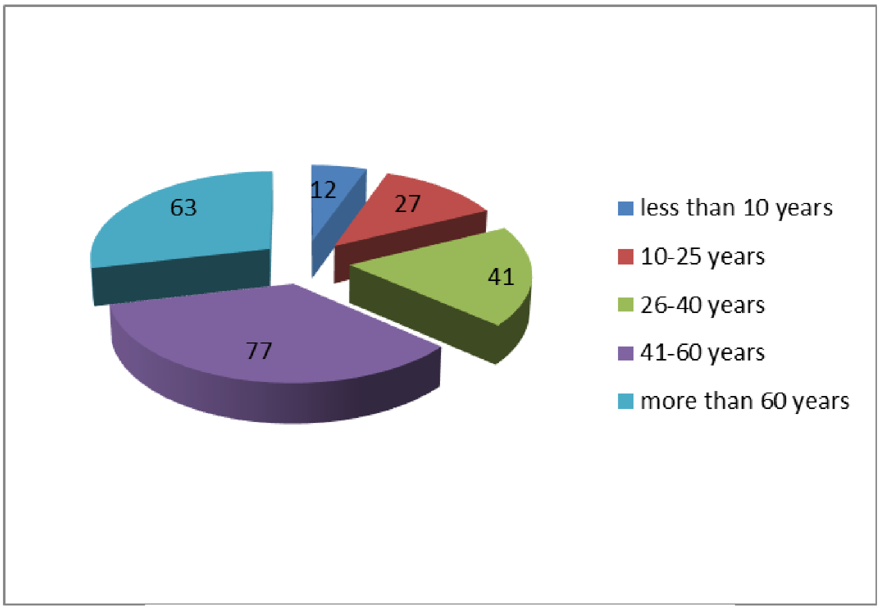


Figure (4): Age groups distribution of the study sample

1.7.2 The study tool

After each surgery for each patient, accumulative data is collected by the corresponding author (s) by filling the form of the study tool as shown in table 2.

Table (2): Form of the study tool

Patient gender	Patient age	Kind of surgery	POMS	Length of Stay	Surgical complications

1.8 Testing the Study Hypotheses

In order to test the hypotheses of the study, of statistical methods were used with the appropriate tests to the nature of the variables and assumptions, using the simple linear regression and the multiple linear regression analysis so as to put the base of acceptances or rejections the hypothesis as follows:

1. If the calculated value of (T) is higher than the tabulated (T) value at the level of (α = 0.05), the result will be rejection for the null or the zero hypothesis (H0) and the alternative hypothesis (H1) will be accepted, which indicates the statistically significant relationship effect.
2. If the calculated value of (T) is less than the tabulated (T) value at the level of (α = 0.05), the result will be accepted for the null or the zero hypothesis (H0) and the alternative hypothesis (H1) will be rejected, which indicates no statistically significant relationship effect.
3. If the calculated value of (F) is higher than the tabulated (F) value at the level of (α = 0.05), the result will be rejection for the null or the zero hypothesis (H0) and the alternative hypothesis (H1) will be accepted, which indicates the statistically significant relationship effect.
4. If the calculated value of (F) is less than the tabulated (F) value at the level of (α = 0.05), the result will be accepted for the null or the zero hypothesis (H0) and the alternative hypothesis (H1) will be rejected, which indicates no statistically significant relationship effect.

1.8.1 Testing the major hypothesis

H0: There will be no statistically significant differences at the level of significance (α=0.05) of the Effective implementation of ERAS on the outcome measures in Jordan.

In order to test the major hypothesis, the sub-hypotheses must be tested first.

1.8.2 Testing the first sub-hypothesis

H01: There will be no statistically significant differences at the level of significance (α=0.05) of the Effective implementation of ERAS on the Improved Post-operative Morbidity Score (POMS)in Jordan.

It is noted from simple regression analysis results described in table (3) that there is a statistically significant differences at the level of significance (α=0.05) of the Effective implementation of ERAS on the Improved Post-operative Morbidity Score (POMS)in Jordan.

This statistically significant differences at the statistically significant level (α=0.05), as the calculated (T) value is (7.552), which is higher than tabulated (T) value, is in line with the simple regression analysis results that explain the (0.167%) variance.

According to that the null hypothesis (H01) will be rejected and the alternative hypothesis will be accepted, that means there is a statistically significant differences at the level of significance (α=0.05) of Effective implementation of ERAS on the Improved Post-operative Morbidity Score (POMS)**in Jordan.**

Table (3): Testing results of the first sub hypothesis

Significant (T)	Calculated (T)	Tabulated (T)	(R) Square	(R)
0.000	7.552	1.670	0.167	0.334

1.8.2 Testing the second sub hypothesis

H02: There will be no statistically significant differences at the level of significance (α=0.05) of the Effective implementation of ERAS on the Reduced Length of Stay in Hospital in Jordan.

It is noted from simple regression analysis results described in table (4) that there is a statistically significant differences at the level of significance (α=0.05) of the satisfaction of the Effective implementation of ERAS on the Reduced Length of Stay in Hospital in Jordan.

This statistically significant effect at the statistically significant level (α=0.05)**,** as the calculated (T) value is (9.851), which is higher than tabulated (T) value, is in line with the simple regression analysis results that explain the (34.0%) variance.

According to that the null hypothesis (H02) will be rejected and the alternative hypothesis will be accepted, that means there is a statistically significant differences at the level of significance (α=0.05) of the Effective implementation of ERAS on the Reduced Length of Stay in Hospital **in Jordan.**

Table (4): Testing results of the second sub hypothesis

Significant (T)	Calculated (T)	Tabulated (T)	(R) Square	(R)
0.002	9.851	1.960	0.340	0.467

1.8.3 Testing the third sub hypothesis

H03: There will be no statistically significant differences at the level of significance (α=0.05) of the Effective implementation of ERAS on the Reduced episodes of harm and surgical complications in Jordan.

It is noted from simple regression analysis results described in table (5) that there is a statistically significant differences at the level of significance (α=0.05) of the Effective implementation of ERAS on the Reduced episodes of harm and surgical complications in Jordan.

This statistically significant effect at the statistically significant level (α=0.05)**,** as the calculated (T) value is (9.113), which is higher than tabulated (T) value, is in line with the simple regression analysis results that explain the (21.0%) variance.

According to that the null hypothesis (H03) will be rejected and the alternative hypothesis will be accepted, that means there is a statistically significant differences at the level of significance (α=0.05) of the Effective implementation of ERAS on the Reduced episodes of harm and surgical complications in **Jordan.**

Table (5): Testing results of the third sub hypothesis

Significant (T)	Calculated (T)	Tabulated (T)	(R) Square	(R)
0.002	9.113	1.960	0.210	0.771

1.9 Conclusion

Upon testing results of the sub hypotheses, the major null hypothesis (H0) will be rejected and the alternative hypothesis will be accepted, that means there will be a statistically significant differences at the level of significance (α=0.05) of the Effective implementation of ERAS on the outcome measures in Jordan.

Therefore, the effective implementation of the Enhanced Recovery After Surgery (ERAS) as a dynamic culmination of evidence based upon perioperative care elements show that the strongest evidence for ERAS implementation is in the care of patients undergoing open surgery. These patients had witnessed progressive outcome measures in the Improved Post-operative Morbidity Score (POMS), and the Reduced Length of Stay in Hospital, and the Reduced episodes of harm and surgical complications.

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