Implementing a Protocol for Attenuating Spinal-Induced Hypotension with Prophylactic Phenylephrine Infusion

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Abstract

Problem: Spinal anesthetics are administered as an alternative to general anesthesia to reduce postoperative complications, improve pain management, and decrease consumption of narcotic medications. However, they are often associated with an increased risk of potentially deleterious hemodynamic disturbances. At a rural community-based hospital in the Mid-Atlantic region, up to 75% of patients receiving spinal anesthesia experience spinal-induced hypotension (SIH). **Purpose:** The primary goal of this quality improvement project was to achieve 100% compliance with a protocol for initiating a low-dose phenylephrine infusion concomitantly with the administration of a spinal anesthetic to decrease the incidence and severity of hypotensive episodes. **Methods:** Educational materials and evidence-based practice references were presented to the anesthesia providers prior to initiation of the implementation phase, achieving 100% attendance with anesthesia staff. A protocol for the attenuation of SIH was created and approved for use at the institution. Anesthesia providers initiated a low-dose phenylephrine infusion concomitantly with the administration of spinal anesthetics throughout a 15-week period. The REDCap database was used to confidentially track compliance with the protocol maintaining HIPPA compliance. Fifteen anesthesia providers participated in this project. **Results:** Protocol education and evidence-based practice materials were received by 100% of anesthesia providers. Ninety-two patients who received spinal anesthesia were included in the project data with six patients excluded. Providers were compliant with the protocol in 79 patients, and non-compliant in seven. In weeks one and 15, compliance was 100%. Median protocol compliance was 80%. **Conclusions:** Findings suggest the implementation of a SIH attenuation protocol is effective in eliciting practice change and adoption of evidence-based practice amongst anesthesia providers.

Keywords: spinal anesthesia, hypotension, phenylephrine

Implementing a Protocol for Attenuating Spinal-Induced Hypotension with Prophylactic Phenylephrine Infusion

Anesthesia providers administer spinal anesthetics, also known as subarachnoid blocks (SAB), to provide surgical anesthesia for procedures such as cesarean sections and lower extremity orthopedic operations. Spinal anesthetics are administered as an alternative to general anesthesia to decrease postoperative complications and consumption of narcotic medications, improve pain management, as well as numerous other advantages (Kranke et al., 2021). Despite widespread administration, one serious side effect of a SAB is spinal-induced hypotension (SIH), which is estimated to occur in over 75% of patients receiving a SAB (Sklebar et al., 2019).

Hypotension, a 20% or greater decrease in blood pressure from baseline, is a serious and highly prevalent complication of spinal anesthesia (Klohr et al., 2010). A sympathetic blockade is produced by the spinal anesthetic causing significant peripheral vasodilation refractory to interventions to restore normotension (Xu et al., 2018). There are multiple negative sequelae associated with profound incidences of hypotension including fetal and maternal complications in obstetrics, nausea and vomiting (potentially resulting in pulmonary aspiration), prolonged hospital stays, and increased healthcare costs to the patient and to the hospital (Kranke et al., 2021).

At a community-based hospital in the Mid-Atlantic region, numerous SABs are performed weekly. A root cause analysis (Figure 1) unveiled there was a lack of a standardized protocol for avoiding significant decreases in patient blood pressures during this procedure. Preliminary baseline data collection revealed hypotension occurred in 14/20 (70%) patients receiving a spinal anesthetic. With large volumes of cesarean sections and orthopedic procedures, complications associated with SIH increased time spent in the post anesthesia care unit (PACU) and delayed discharge which increases hospital costs and influences patient

satisfaction scores. These findings represented the significance of the problem and the opportunity for a quality improvement (QI) initiative. The purpose of this QI project was to create and implement a protocol for initiating a low-dose phenylephrine infusion concomitantly with the administration of a spinal anesthetic to decrease the incidence and severity of hypotensive episodes.

Available Knowledge

Current evidence shows SIH can be attenuated with the use of a prophylactic, low-dose phenylephrine infusion (Sklebar et al., 2019). A thorough evidence review was conducted, yielding seven Level IA research articles (based on the Johns Hopkins Nursing Evidence-Based Practice Rating Scale: Evidence and Quality Guide, [2022]). A synthesis of the research articles revealed strong, compelling, and consistent evidence concluding intravenous phenylephrine was effective in reducing the incidence and/or severity of hypotension in patients undergoing procedures with spinal anesthesia. See Appendix A and Appendix B for the evidence review and evidence synthesis, respectively.

Large randomized-controlled trials including various populations (obstetrics, orthopedics, geriatrics, and bariatrics) were conducted to determine the effect of a phenylephrine infusion on hemodynamic stability during spinal anesthesia. The evidence reviewed consistently agreed phenylephrine, when given as a prophylactic infusion, is both safe and effective in the reduction of hypotension, nausea, vomiting, and other intraoperative side effects (Choudhary et al., 2018). In a randomized-controlled trial conducted by Shafeinia et al. (2020), intravenous phenylephrine administered prophylactically delayed the onset of hypotension and decreased the severity of hypotensive episodes compared with controls. The phenylephrine infusion was also compared to

other intravenous vasopressors (norepinephrine and ephedrine) with consistent results preferring the prophylactic phenylephrine infusion (Mostafa et al., 2021; Abbasivash et al., 2016).

The purpose of this Doctor of Nursing Practice (DNP) QI project was to implement a protocol for the prophylactic initiation of a phenylephrine infusion prior to the delivery of a SAB to maintain normotension. The first goal of the project was to provide education regarding the effectiveness of a prophylactic phenylephrine infusion in decreasing the incidence and severity of SIH to 100% of anesthesia providers at the hospital. The second goal was, following this education, 100% of the anesthesia providers would initiate a prophylactic phenylephrine infusion prior to the delivery of a SAB for eligible patients receiving a spinal anesthetic.

Rationale

Specific steps and phases in the implementation of this QI project were outlined using the Conceptual Framework of Complex Innovation Implementation (CFCI) framework. This framework played a pivotal role in ensuring the execution of the QI project resulting in the achievement of the implementation goals. The relationships between the key concepts of the framework can be visualized in Figure 2. These concepts include identifying change champions, gaining support from management, innovation aligning with institutional values, resource availability, implementation effectiveness, and policies and procedures (Helfrich et al., 2007). Change champions gave verbal commitment to facilitating the implementation of the QI project. Key stakeholders from the department were identified and approved the QI project. Management support, resource availability, and implementation climate were aligned. These factors along with the CFCI framework facilitated the smooth implementation of the QI project, resulting in achievement of the desired outcomes.

Methods

Context

Compared to research studies, QI projects are implemented in the real-world setting where it is difficult, if not impossible, to control the context of the implementation environment. It is crucial to present the context of the QI project, including the setting, participants, and team members, as well as the current structures and processes facilitating or impeding the implementation of the intervention. Reluctance to preparing a phenylephrine drip preoperatively and initiating the infusion concomitantly with the delivery of a SAB was an anticipated barrier to successful implementation of the QI project. Current evidence-based practice guidelines supporting the intervention were presented to the members of the anesthesia department. This evidence elicited a change in the climate of the department, resulting in adoption of the QI project intervention.

The previous climate of the anesthesia department in addressing SIH was not uniform. Treatment of SIH was at the professional discretion of the anesthesia provider, where each provider would utilize different variations of medications and interventions to restore normotension. See Figure 3 for the pre-implementation process map at the institution. Eliciting a change in practice and proposing a uniform protocol for the management of SIH presented numerous challenges. Protocols for the prophylactic administration of phenylephrine prior to delivery of a SAB existed within the administrative anesthesia agency employing the anesthesia providers at the institution. Adoption of these protocols by the institution helped guide the implementation and acceptance of the QI project by the anesthesia providers. Members of the QI project implementation team, including the key stakeholders and change champions, propelled

the initiation of the QI project, and facilitated the adoption of the intervention by other members of the anesthesia department.

Intervention

Implementation of the QI initiative involved creation and site approval of an evidence-based protocol for the prophylactic initiation of a phenylephrine infusion for eligible patients receiving spinal anesthesia. Evidence from the literature review and synthesis was used to facilitate the adoption of this protocol by the institution. The protocol advised anesthesia providers to initiate the phenylephrine infusion at or directly prior to the administration of spinal anesthesia. The protocol included contraindications to the use of phenylephrine such as patients with prior adverse reactions to phenylephrine as well as encouraging the providers to exercise expert opinion in initiating the infusion or not. Similar protocols have been adopted by large academic teaching facilities in the area, as well as by the administrative anesthesia agency staffing the anesthesia providers at the institution.

The "SIH Attenuation Protocol" was printed and posted in the anesthesia office, as well as within the operating rooms. Following approval of the protocol by the institution and anesthesia department, an education session occurred during a scheduled morning education meeting. Anesthesia staff were provided with evidence-based practice references as well as the approved protocol. The desired process goal was for anesthesia providers to consider the protocol when preparing to administer a spinal anesthetic and initiate a phenylephrine infusion in all eligible patients. See Figure 4 for the desired process map.

To achieve the project aims, a number of strategies and tactics were identified. To ensure accountability and collaboration, formal commitments were obtained by two change champions, who strived to facilitate department-wide adoption of the intervention. Tactics to elicit buy-in

from the department included providing education to convey the benefits of the intervention to both the patient and the provider. A local needs assessment was conducted to elicit data on the prevalence of SIH and the opportunity for a QI initiative. The protocol was developed and approved prior to the start of implementation on August 30, 2023, following the education session on the morning of August 30. Implementation of the prophylactic phenylephrine infusion occurred from August 30, 2023, to December 4, 2023. See Figure 5 for the protocol guideline.

Measures

Two process goals were measured to determine successful implementation of this QI initiative. Measurements were taken both prior to and following the implementation period to assess for achievement of project goals. See Table 1 for the implemented measurement plan.

Education delivery to the anesthesia providers was determined by comparing the number of providers receiving education to the total number of anesthesia providers in the department. A sign-in sheet was present during the in-person education session, and the session was recorded for providers not able to attend. The aim was for 100% of anesthesia providers to have received education following the implementation period. A survey tool created via the Research Electronic Data Capture (REDCap) software was used to track education reception status of the anesthesia department. See Appendix C for the education attendance audit tool.

Compliance with initiation of the prophylactic phenylephrine infusion was tracked using a REDCap audit tool as well as manual chart audits. The total number of phenylephrine infusions initiated prior to SAB administration was compared to the total number of spinal anesthetics administered, on a weekly basis. The aim was 100% of anesthesia providers would initiate a phenylephrine infusion for eligible patients receiving a spinal anesthetic. If a phenylephrine infusion was not initiated on a patient receiving a SAB, a section populated into the REDCap

audit tool to identify the reasoning for not using the phenylephrine infusion. See Appendix D for the protocol compliance audit tool.

Documentation required to determine successful implementation of the QI initiative existed in the anesthesia data record. Additional documentation did not need to be completed, but a REDCap survey was provided to streamline the data collection process. For instances where the survey was not completed, a manual chart audit was completed by the team lead. Continuous assessment of protocol compliance occurred weekly. The project lead continuously met with the key stakeholders as well as the change champions to determine successful implementation and required adjustments. A potential cost to the institution was the increased use of intravenous phenylephrine. The project lead provided the educational materials and printed protocol.

Ethical Considerations

Site ethics review procedures were completed as required. The site did not require Institutional Review Board (IRB) approval but required documentation of IRB approval from the University of Maryland School of Medicine (UMSOM). Documentation was provided prior to project initiation. Non-human Subject's Research determination from the Human Research Protections Office (HRPO) of the UMSOM IRB was obtained prior to project implementation. All data collected was password protected using two-factor authentication within a virtual private network (VPN). Prior to project dissemination, all patient information was deidentified. No actual or potential conflicts of interest were identified in the development of this QI project.

Results

In-person and virtual project education was conducted the morning of August 30, 2023, which was attended by 100% of anesthesia staff members. See Figure 6 for a pie chart depicting attendance of the education session.

Results through week 15 of the implementation period were recorded. Ninety-two patients were eligible for inclusion in the QI initiative, with six patients excluded due to presentation in a hypertensive state or emergency situations not allowing the provider enough time to initiate the infusion. See Table 2 for an illustration of patient characteristics. Seven eligible patients did not receive the prophylactic phenylephrine infusion due to provider reluctance to participate in the initiative.

Throughout the implementation period, providers were compliant with 91.8% of eligible patients having a prophylactic phenylephrine infusion initiated concomitantly with the administration of a spinal anesthetic (n=79). There were five runs, data points crossing the median compliance line, which is expected for the number of data points. Compliance increased following interventions in weeks three and seven, suggesting frequent re-education is needed for successful implementation. There were no trends or shifts noted. The astronomical data points of 100% compliance seen in weeks one and 15 were due to only one SAB being administered those weeks due to the project education occurring mid-week and the implementation phase ending early in week 15. The median compliance rate was 80%, despite two weeks of absent data input from anesthesia providers (week five and week six). It was discovered the project intervention protocols had been removed from the operating rooms by cleaning staff. The project lead worked with the housekeeping department to determine a safe and sanitary location for the intervention protocol, and the project lead conducted manual chart audits to obtain the project data from those two weeks. Figure 7 contains a run chart depicting compliance with the project intervention protocol.

Discussion

Project implementation and data collection was initiated on August 30, 2023, and continued until December 4, 2023. The use of quantitative statistics to analyze run charts and interpret data allowed for determination of achievement of project goals. Analysis of the run chart on a weekly basis allowed for interpretation of variability patterns to determine if the variability was common-cause (random) or special-cause (due to the QI project or a situational contextual factor). The type of variability was determined by analyzing run chart variations and trends and examining situational and interventional factors. Any suspicion of special cause variation was investigated, such as the decreased compliance seen when the protocols were removed.

Interventions occurred during weeks three and seven as compliance with the project audit tool was poor, but providers were participating in the QI project. Providers were re-educated on the utility of the QR code on the project audit tool in tracking project compliance rates, and the project lead was able to conduct manual chart audits to obtain compliance rates for cases where the provider exercised the project intervention but did not enter their data into REDCap.

The key finding of this QI project was an increase in the initiation of a prophylactic phenylephrine infusion concomitant with the administration of a spinal anesthetic. A protocol tailored to site-specific characteristics proved to be effective in changing practice techniques amongst anesthesia providers and facilitating the adoption of evidence-based practice. Frequent project updates, reminders, and compliance reports were paramount to maintain and increasing provider compliance. This QI project did not have a financial component and included an intervention that staff are familiar and comfortable with, which also added to compliance and buy-in from staff members. Positive patient outcomes and decreased requirements of providers

needing to treat hypotensive episodes also contributed to project success and will play a role in sustainability and spread. Findings align with current literature stating that facilitation, sustainment, and adoption of evidence-based practice techniques through implementation of a process-based protocol, is effective when tailored to institution-specific characteristics.

Conclusion

The completion of this QI initiative demonstrates that implementing a protocol for the attenuation of SIH using a prophylactic phenylephrine infusion is an evidence-based, feasible, and practical solution in this practice environment. This work is of high value to the anesthesia profession, as well as to the quality of health care delivery, safety, and outcomes. As a result of this initiative, the incidence and severity of SIH may be reduced or completely avoided.

Due to the positive clinical results and staff buy-in related to this project, sustainability is likely. To maintain sustainability with current staff, and achieve buy-in from future anesthesia staff, change champions have committed to providing protocol reminders at future staff meetings. The SIH attenuation protocols will remain posted in the operative suites and in the anesthesia lounge, as well as a binder with all project details and information to serve as a reference. Looking forward, the addition of other methods to attenuate SIH, and the creation of a SIH attenuation bundle including multiple interventions, may be a point of focus for future initiatives. Future projects may also be concerned with tracking outcome goals such as the percent reduction in hypotensive episodes in patients receiving prophylactic phenylephrine after spinal anesthesia compared to a control group.

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Table 1

Measurement Plan

Project Goals	Data Collection Procedures (who, how, when)	Name of Data Collection Tool
At the beginning of project implementation (August 28, 2023), educational materials and evidence-based practice references will be presented to anesthesia providers regarding the use of phenylephrine for attenuating spinal-induced hypotension.	Who: Project Lead How: Attendance at in-person education session and/or recording of session When: August 30, 2023	No data collection required
At the beginning of implementation of the quality improvement initiative (August 28, 2023), a protocol for the prophylactic initiation of a phenylephrine infusion for patients receiving spinal anesthesia will be created and approved by the facility.	Who: Project Lead How: Facility approval (yes/no) When: August 28, 2023	No data collection required
Following education on SIH prevention techniques (August 28 – September 11, 2023), 100% of anesthesia providers will have received education regarding the effectiveness of a prophylactic phenylephrine infusion in decreasing the incidence and severity of spinal-induced hypotension.	Who: Project Lead How: Staff interview (attended in-person education session or viewed recorded session) (yes/no) using REDCap Survey Tool When: September 11, 2023	REDCap Survey Tool

Following education on SIH prevention techniques (August 28 – September 11, 2023), 100% of anesthesia providers will initiate a prophylactic phenylephrine infusion for patients receiving a spinal anesthetic.	Who: Project Lead How: Chart review, REDCap Audit Tool When: Weekly, September 11, 2023 – December 4, 2023	REDCap Audit Tool

Note. Table describing the plan for measurement of achievement of project goals.

Table 2

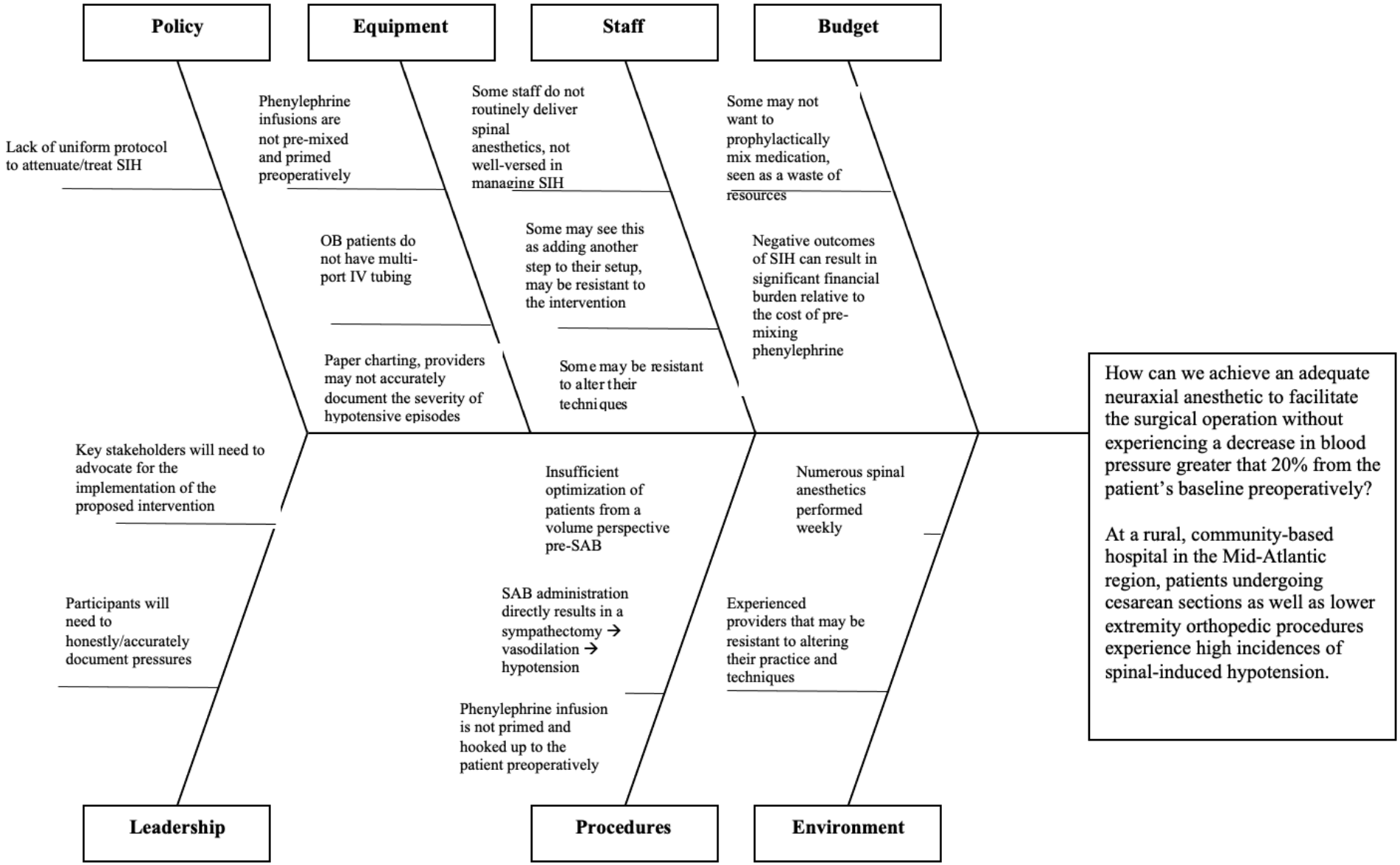
Patient Characteristics Table

Patient Characteristics (n=92)	n	%
Total Eligible Patients	92	100
Included	86	93.4
Excluded	6	6.6

Note. Depiction of patients included and excluded from quality improvement initiative.

Figure 1

Fishbone Diagram



Note. Root cause analysis depicting the factors contributing to SIH following administration of a spinal anesthetic.

Figure 2

Theoretical Framework

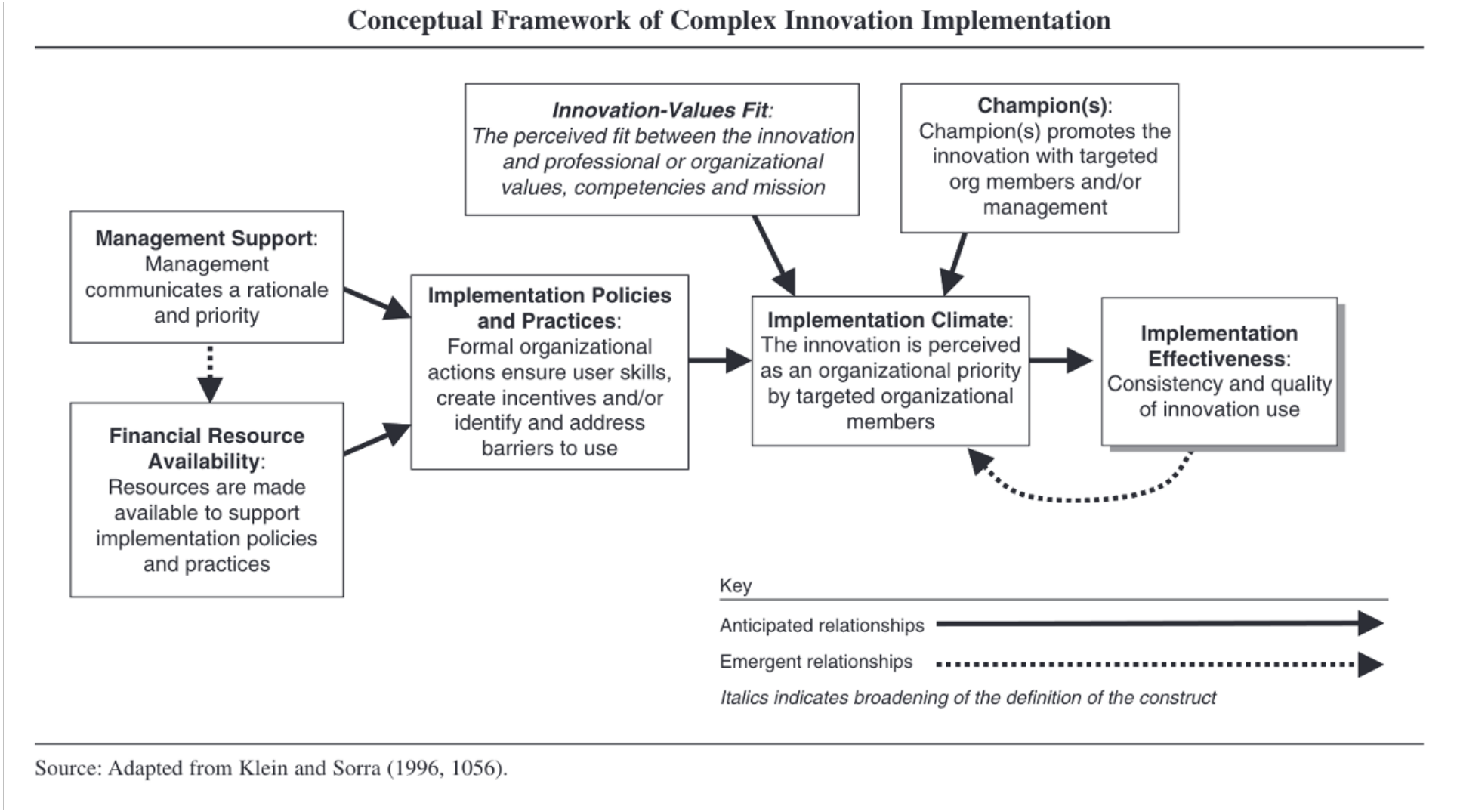
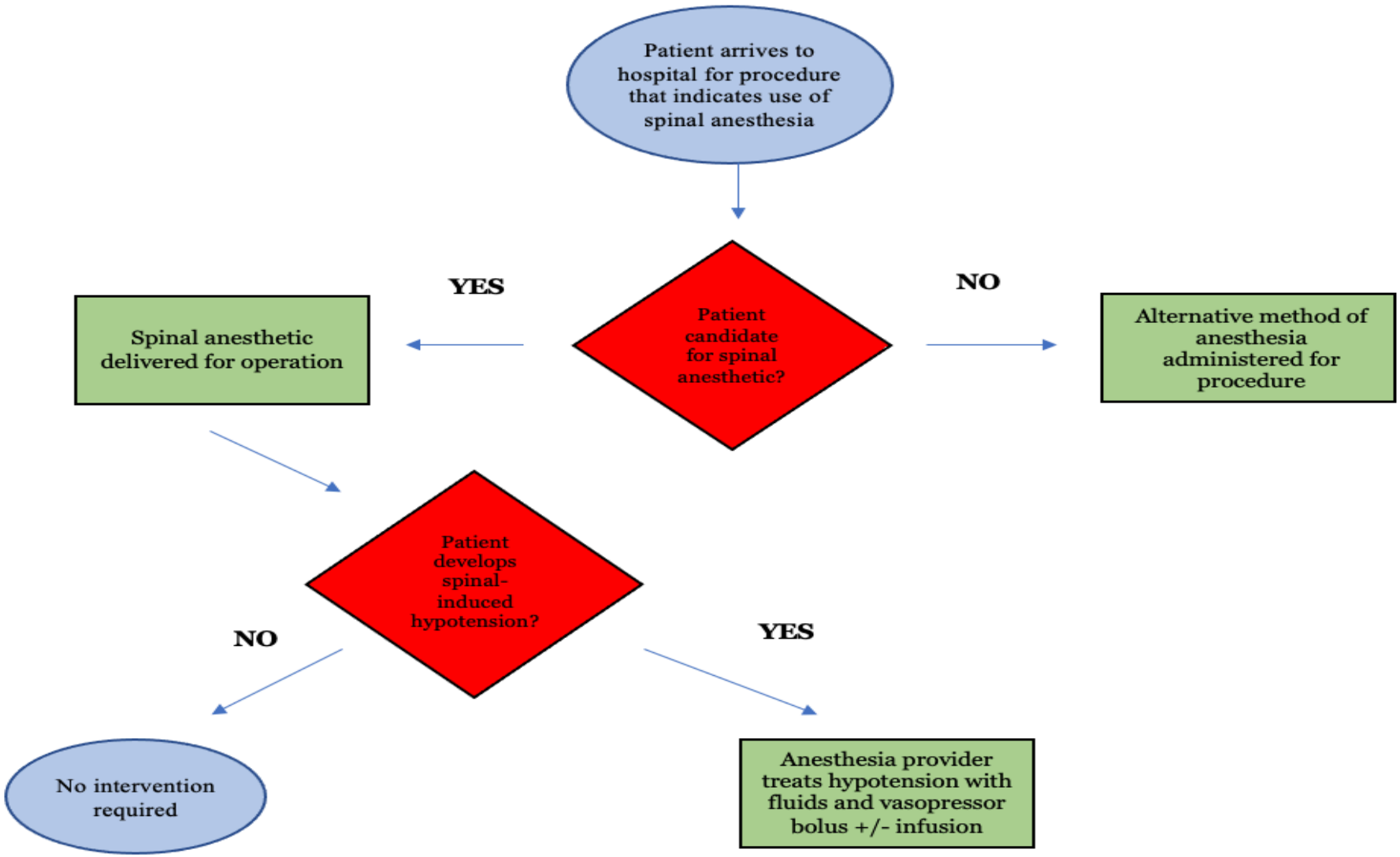


Figure 3

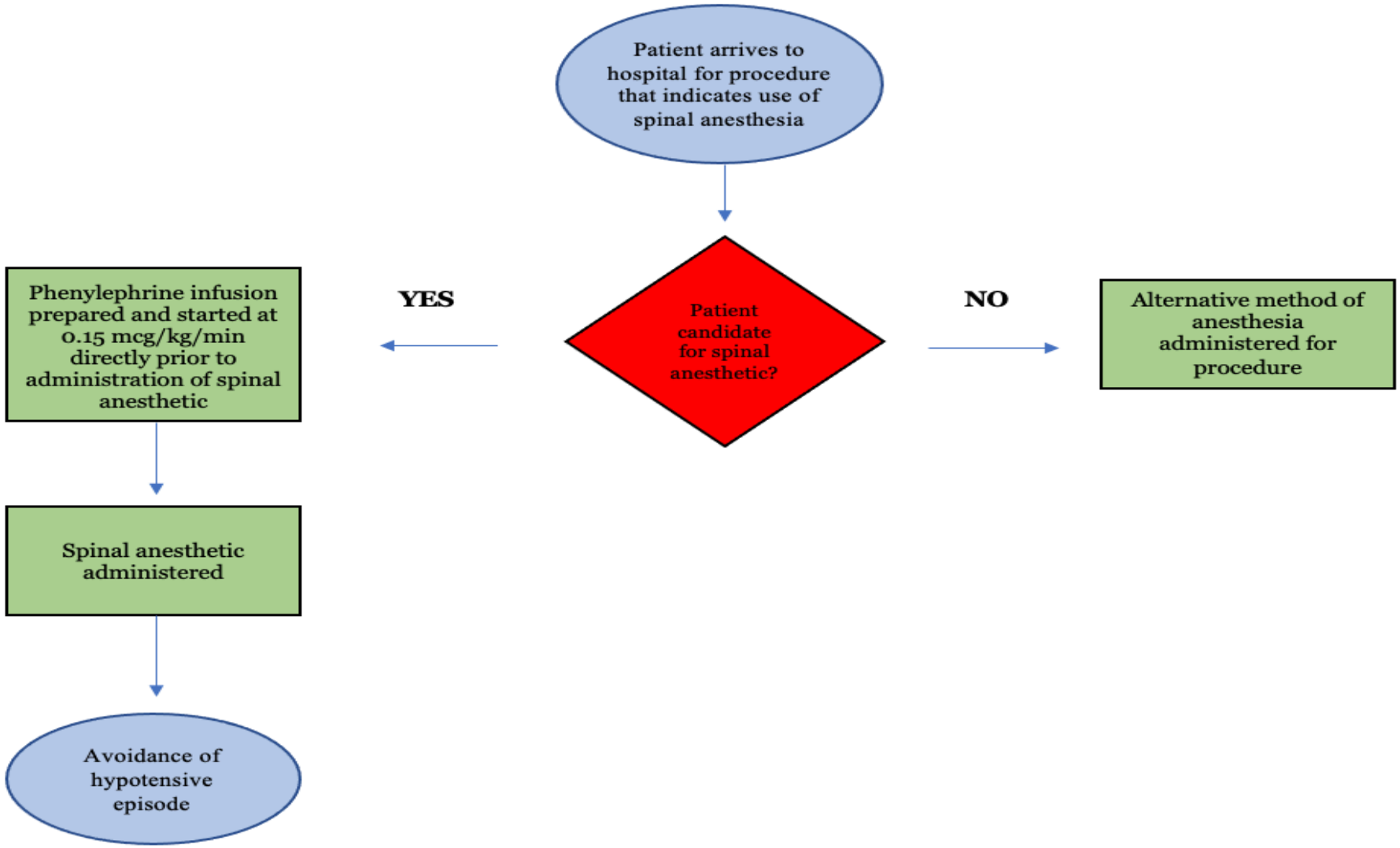
Pre-Implementation Process Map



Note. Oval = start/end of process; Diamond = decision to be made; Rectangle = action occurs

Figure 4

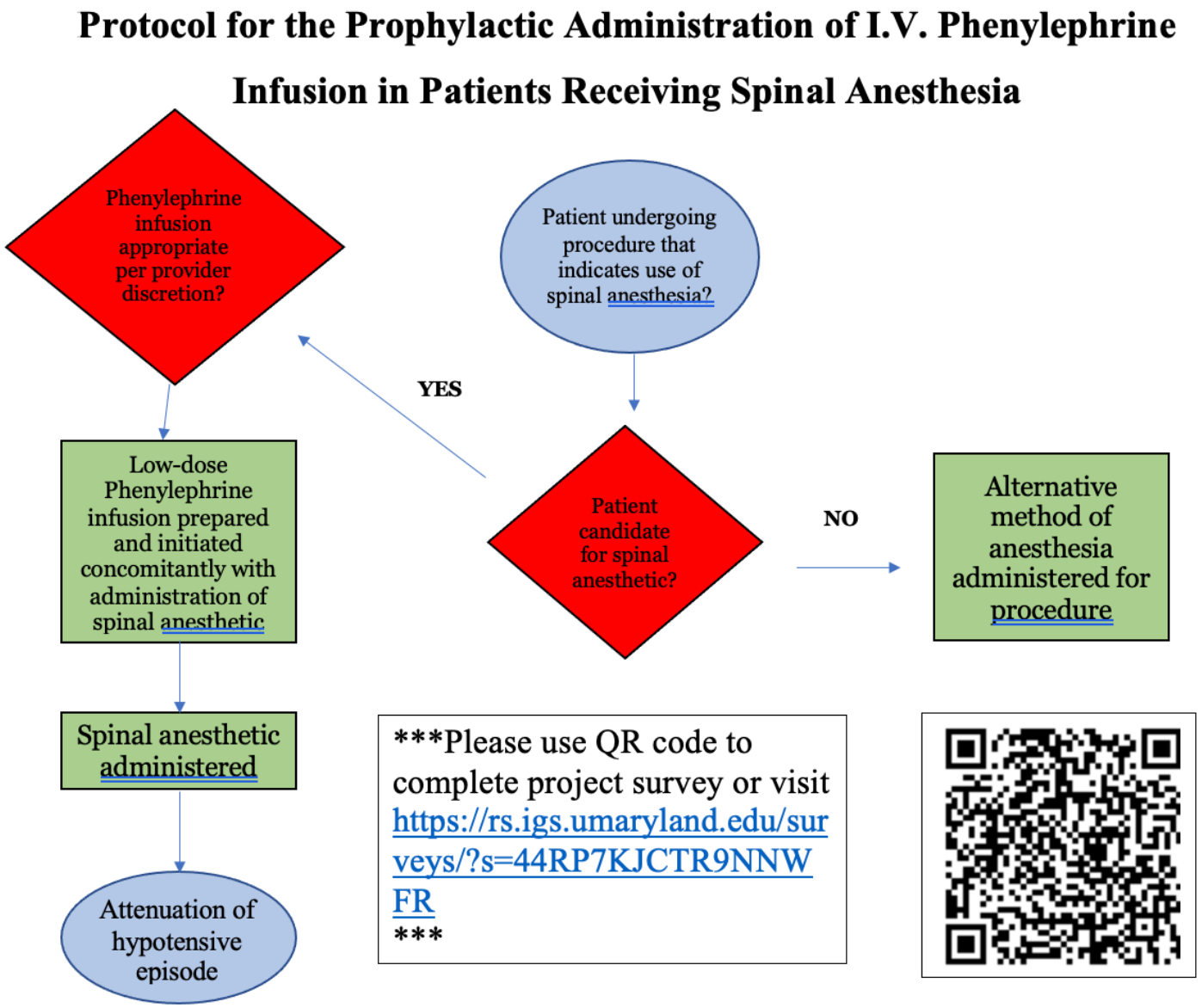
Desired Process Map



Note. Oval = start/end of process; Diamond = decision to be made; Rectangle = action occur

Figure 5

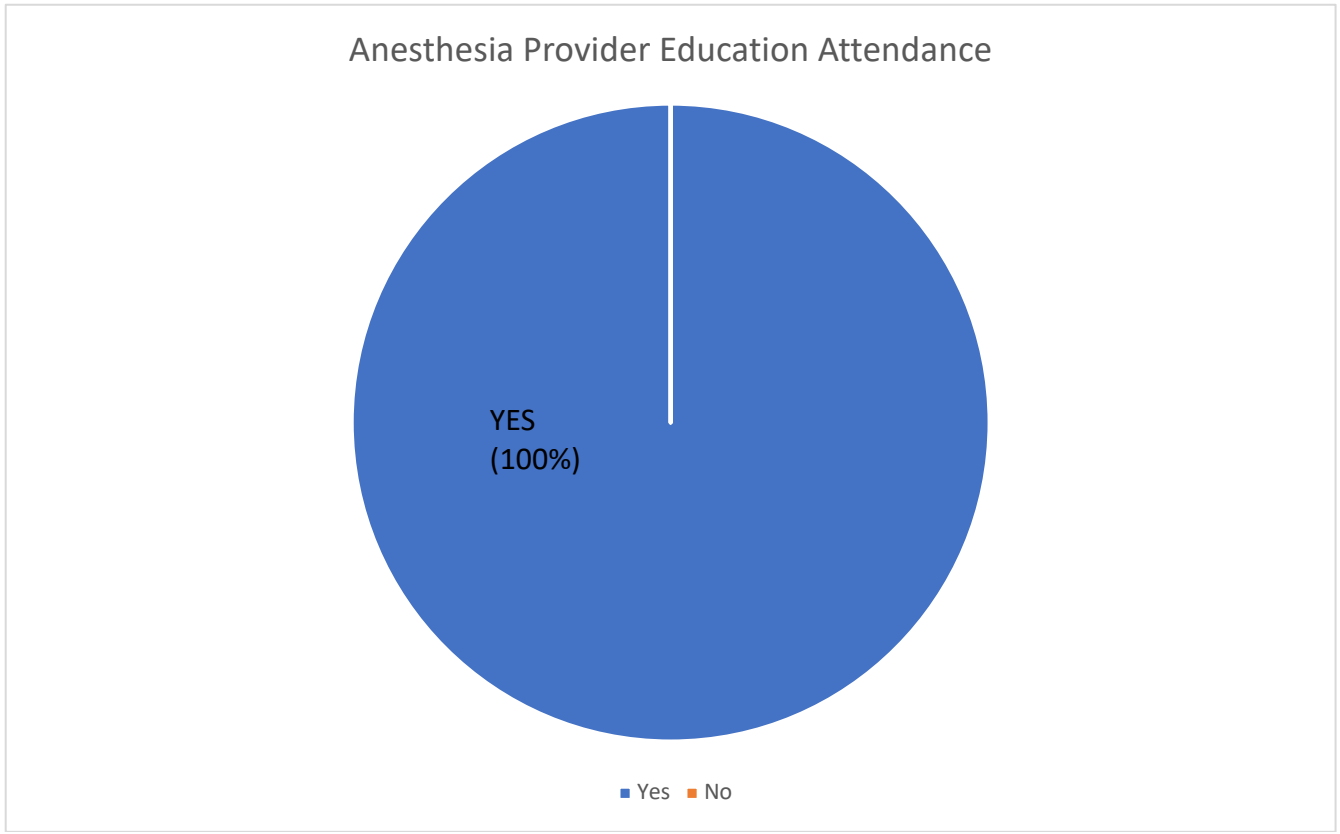
Protocol for Initiation of Intravenous Phenylephrine Infusion Concomitantly with Administration of Spinal Anesthetic



Note. Final approved protocol found in operating rooms.

Figure 6

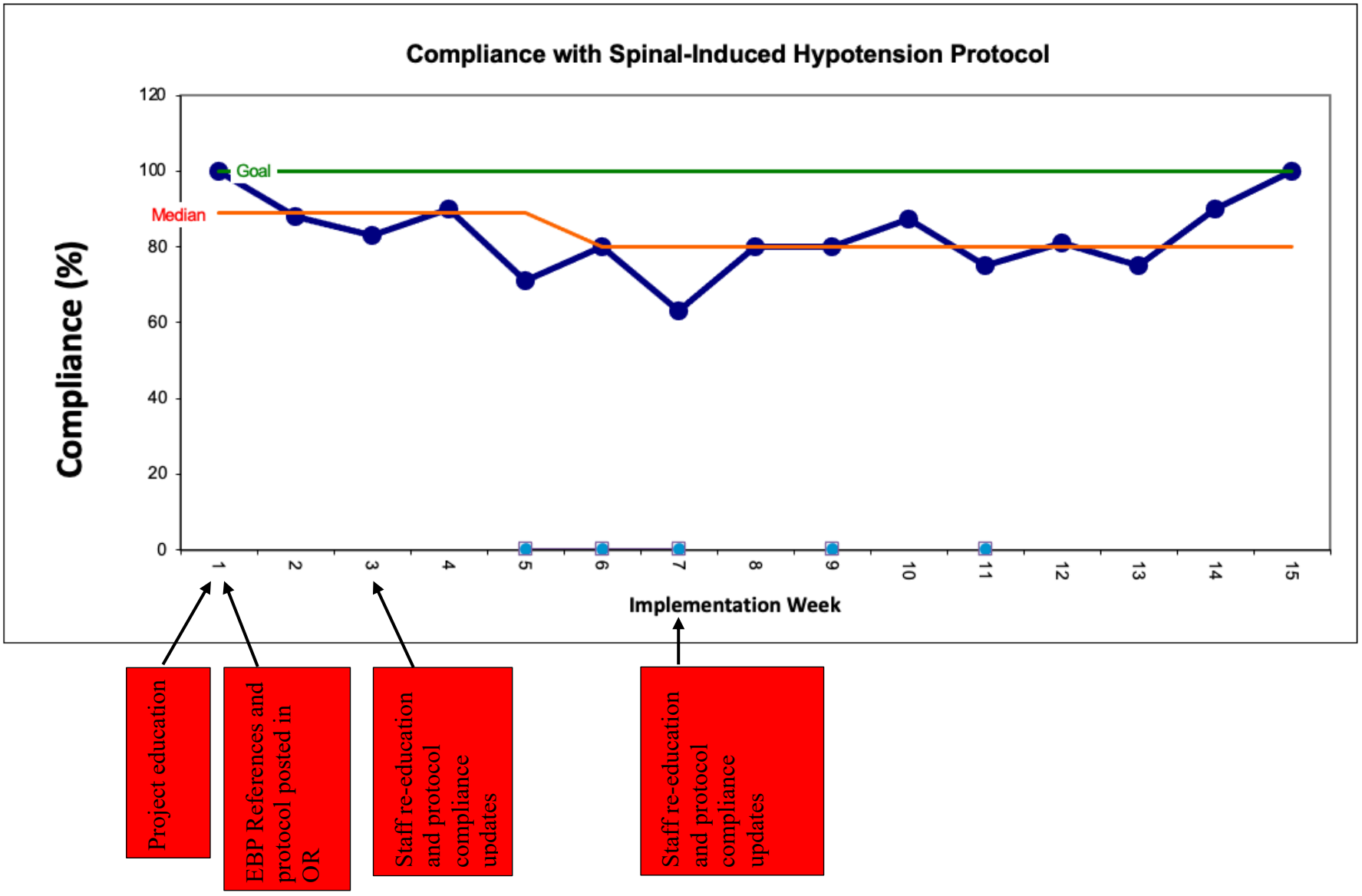
Pie Chart of Attendance with Project Education Period



Note. Pie chart showing percentage of anesthesia staff that received education and evidence-based practice references.

Figure 7

Run Chart Depicting Compliance with Intervention Protocol



Note. Run chart depicting compliance rates with the quality improvement project protocol.

Appendix A

Evidence Review Table

Citation: Shafeinia, A., Ghaed, M. A., & Nikoubakht, N. (2020). The Effect of Phenylephrine Infusion on Maternal Hemodynamic Changes During Spinal Anesthesia for Cesarean Delivery. *Anesthesiology and Pain Medicine*, *10*(1), e99094. https://doi.org/10.5812/aapm.99094	**Level and Quality: IA**
Purpose or Hypothesis	The objective of this study was to determine the effect of phenylephrine on maternal hemodynamic changes during spinal anesthesia for cesarean delivery.
Type of Evidence Research Design	Research: Prospective, double-blind randomized controlled trial
Sample Population, Size, Setting	**Sampling Technique:** Convenience. **Eligible Participants:** Women undergoing elective cesarean section under spinal anesthesia. **Setting:** Labor & Delivery Operating Room – Shahid Akbarabadi Hospital, Tehran **Excluded:** History of allergy to phenylephrine, body mass index (BMI) > 30kg/m^2, hypertension (>140/90mmHg), contraindication to spinal anesthesia, severe cardiovascular disease, prematurity, emergency cesarean section, and inadequate analgesia after spinal anesthesia. **Accepted:** Pregnancy women aged 18-45 years, being a candidate for spinal anesthesia. **Control:** 58 female patients **Intervention:** 58 female patients **Power analysis/Achieved:** A sample size of 116 patients was determined by power analysis (confidence level 5%, CI 95%) to detect a relative risk of the primary outcome at 0.05 alpha, and moderate effect size – Power analysis met. **Group Homogeneity**: It was assumed that treatment differences were homogenous with respect to extent, variation, and sample size per control/intervention group.
Intervention Procedures	**Control Protocol:** Administration of intravenous infusion of normal saline 0.9% directly prior to spinal anesthetic. **Intervention Protocol:** Administration of intravenous phenylephrine infusion 35 mcg/min directly prior to spinal anesthetic. **Treatment Fidelity:** There was no commercial participation in this trial. All authors stated that there was no conflict of interest. The research protocol was in accordance with the principles expressed in the Declaration of Helinski and approved by the Deputy of Research and Ethics Committee of Iran University of Medical Sciences. Additionally, this clinical trial was registered at the Iranian Registry of Clinical Trials.
Primary Outcome and Measures	**Dependent Variable:** Development of hypotension greater than 20% from baseline following administration of spinal anesthetic **DV Measure:** Data was collected using a checklist, including the demographic and clinical characteristics, including systolic and diastolic blood pressures, nausea and vomiting, and others. Following the intervention/control protocols, the patients received 12mg Bupivacaine 0.5% in the sitting position. After delivery of the subarachnoid block, the patients were placed in the supine position with left uterine displacement. Blood pressure was measured and recorded every two minutes until delivery.

Results/Conclusions	**Statistical Results:** Statistical significance was demonstrated. The intervention group had a reduced incidence of hypotension (23%) compared to the control group (88%). There was an absence of nausea in 74.1% of patients in the intervention group compared to 34.5% in the control group ($P < 0.001$). Systolic blood pressure four minutes after administration of the spinal anesthetic was 125.92 +/- 14.31 in the intervention group and 99.09 +/- 15.14 in the control group ($P < 0.001$). The results of the repeated measures ANOVA test showed that the values and reduction of the arterial pressure, systolic and diastolic blood pressures in the intervention group were less than the control group and different time points. Data were analyzed using SPSS software and P value < 0.05 was considered as significant. **Conclusions**: Phenylephrine is effective in the reduction of hypotension, nausea, and vomiting following administration of spinal anesthesia. These effects are not associated with adverse neonatal outcomes.

Citation: Choudhary, M., & Bajaj, J. K. (2018). Study Comparing Phenylephrine Bolus and Infusion for Maternal Hypotension and Neonatal Outcome during Cesarean Section under Spinal Anesthesia. *Anesthesia, Essays and Researches*, *12*(2), 446–451. https://doi.org/10.4103/aer.AER_23_18	**Level and Quality: IA**
Purpose or Hypothesis	The primary aim of this study was to compare bolus doses of 50 mcg of phenylephrine with a fixed infusion rate of 50 mcg/min of the same drug given prophylactically. The secondary aim was to study the neonatal outcome and side effects with the two regimes.
Type of Evidence Research Design	Prospective, randomized, double-blind, placebo-controlled, comparative study
Sample Population, Size, Setting	**Sampling Technique:** Convenience. **Eligible Participants:** Women of ASA class I and II scheduled for elective or emergency cesarean section under subarachnoid block in a tertiary care teaching hospital. **Setting:** Labor and delivery Operating Room – Tertiary care academic teaching hospital. **Excluded:** Preexisting or pregnancy-induced hypertension, prenatal fetal distress, significant cardiovascular, respiratory, neurological, and coagulation disorders. **Accepted:** Age between 18 and 40 years, heights between 150 and 170 cm, BMI <30kg/m^2, and singleton pregnancies. **Control:** 50mcg IV bolus of phenylephrine after significant hypotension (decrease in blood pressure greater than 20% from baseline). **Intervention:** Intravenous phenylephrine infusion at 50mcg/min through a syringe pump (B Braun Infusomat) started immediately after the administration of subarachnoid block. **Power analysis/Achieved:** It was estimated that the minimum required sample size with 95% power and 5% level of significance was nine patients in each study group. 50 patients were recruited in each group to compensate for potential subject loss – Power analysis met. **Group Homogeneity**: Intervention/Control homogenous based on NS p values for clinical characteristics.
Intervention Procedures	**Control Protocol (Group A):** Administration of 50 mcg intravenous bolus of phenylephrine after development of significant hypotension. **Intervention Protocol (Group B):** Prophylactic phenylephrine 50 mcg/min infusion started immediately after the administration of subarachnoid block. **Treatment Fidelity:** There was no commercial participation in this trial, and the authors reported that there were no conflicts of interest. Anesthesia was administered according to routine clinical practice. Blinding of the researcher could not be done as manual interventions are needed to treat episodes of hypotension. Anesthesia providers had no involvement or incentive to alter clinical practice as part of being involved in the trial. Internal validity therefore is maintained.

Primary Outcome and Measures	**Dependent Variable:** Development of hypotension greater than 20% from baseline following administration of spinal anesthetic. **DV Measure:** On arrival to the operating room, monitors were connected, and heart rate, oxygen saturation (SpO_2), and noninvasive blood pressure (NIBP) were measured. The NIBP was measured three times and the least systolic value was taken as the baseline value. A subarachnoid block was given in the sitting position using a 25-G lumbar puncture needle in the L_2–L_3 or L_3–L_4 intervertebral space ensuring all aseptic precautions. Injection fentanyl 10 mcg was added to 10 mg of 0.5% bupivacaine (heavy) with an insulin syringe (total volume 2.1 ml), and the mixture was injected intrathecally. After administration of subarachnoid block, patients were placed supine with left uterine displacement. NIBP was measured at 2 min interval and the time at which hypotension developed was noted.
Results/Conclusions	**Statistical Results:** Statistical significance was demonstrated. In group A, systolic BP trend showed a fall in BP of >20% from the baseline at about 6 min when bolus 50 mcg was administered in 44 patients. The mean percentage fall in SBP was −28.06 ± 5.3 mmHg % (95% CI). In group B, the mean percentage fall in SBP was only − 0.44 ± 4.3 mmHg% (95% CI). **Conclusions**: The results of this study suggest that phenylephrine, when given as a prophylactic infusion, leads to a significantly better control of post-spinal hypotension during CS and lesser intraoperative maternal side effects such as nausea and vomiting. When used in the dose of 50 mcg/min, it does not lead to any reflex bradycardia or reactive hypertension.

Citation: Ferré, F., Marty, P., Bruneteau, L., Merlet, V., Bataille, B., Ferrier, A., Gris, C., Kurrek, M., Fourcade, O., Minville, V., & Sommet, A. (2016). Prophylactic phenylephrine infusion for the prevention of hypotension after spinal anesthesia in the elderly: A randomized controlled clinical trial. *Journal of Clinical Anesthesia*, *35*, 99–106. https://doi.org/10.1016/j.jclinane.2016.07.020	**Level and Quality: IA**
Purpose or Hypothesis	The objective of this study was to evaluate the efficacy and safety of prophylactic infusion of phenylephrine after subarachnoid block for orthopedic surgery in the elderly.
Type of Evidence Research Design	Research: Prospective, double-blind, randomized, placebo-controlled clinical trial
Sample Population, Size, Setting	**Sampling Technique:** Convenience. **Eligible Participants:** Patients older than 60 years undergoing elective lower limb surgery under spinal anesthesia. **Excluded:** 83 patients were excluded due to denial of participation, hearing or vision deficits, illiteracy, Parkinson's disease, dementia, use of antidepressants, and alcohol abuse. **Accepted:** 54 patients older than 60 years of age undergoing elective lower limb surgery **Control (Group C):** Infusion of 0.9% sodium chloride. **Intervention (Group P):** 100mcg/mL solution of intravenous phenylephrine infused a 1 mL/min directly after placement of subarachnoid block. **Power analysis/Achieved:** A sample size of 52 patients was determined by power analysis to provide 90% power to detect a 0.79 relative risk of the primary outcome at moderate effect size and at 0.05 alpha – Power analysis met. **Group Homogeneity**: Intervention/Control homogenous based on NS p values included for clinical characteristics.
Intervention Procedures	**Control Protocol:** Administration of 0.9% sodium chloride infusion. **Intervention Protocol:** Administration of intravenous phenylephrine 100mcg/mL at 1mL/min directly following placement of subarachnoid block. **Treatment Fidelity:** There was no commercial participation in this trial. The authors also vouch for the completeness and accuracy of the data and for the fidelity of the trial to the protocol. All authors stated that there was no conflict of interest or relationship with industry. Anesthesia was administered according to routine clinical practice. No discussion of complications resulting in discontinuation of protocol, protocol monitoring, or compliance with protocol. Internal validity therefore is reduced.

Primary Outcome and Measures	**Dependent Variable:** Occurrence of hypotensive episodes greater than 20% decrease from baseline mean arterial pressure. **DV Measure:** The baseline mean arterial blood pressure (MAP) was calculated as the average of 3 consecutive measurements before placement of the SA. After placement of the SA, the patient's heart rate and noninvasive blood pressure were obtained every minute for 20 minutes and thereafter, in accordance with standard clinical practice, every 5 minutes until the end of surgery. Immediately following intrathecal injection of the local anesthetic, the infusion of phenylephrine (or isotonic sodium chloride solution) was started via infusion pump at 1 mL/min on the closest port of a patient's IV dedicated line.
Results/Conclusions	**Statistical Results:** T-test comparison revealed statistical significance in the study results. Mean arterial pressures were higher in group P than in group C (92 +/- 2 vs 82 +/- 2 mmHg, mean +/- SD, P < 0.001). The number of hypotensive episodes per patient was higher in group C compared with group P (9[0-39] vs 1 [0-10]. The time to first hypotension was shorter in group C (3 [1-13] vs 15 [1-95] minutes, P = .004). The proportion of patients without hypotension was better in group P (P = .04). **Conclusions**: Prophylactic phenylephrine infusion is an effective method of reducing spinal-induced hypotension in the elderly. Compared with a control group, it delays the time to onset of hypotension and decreases the number of hypotensive episodes per patient.

Citation: Xu, C., Liu, S., Huang, Y., Guo, X., Xiao, H., & Qi, D. (2018). Phenylephrine vs ephedrine in cesarean delivery under spinal anesthesia: A systematic literature review and meta-analysis. *International Journal of Surgery (London, England)*, *60*, 48–59. https://doi.org/10.1016/j.ijsu.2018.10.039	**Level and Quality: IA**
Purpose or Hypothesis	This systematic literature review and meta-analysis was conducted to compare phenylephrine versus ephedrine in cesarean delivery under spinal anesthesia.
Type of Evidence Research Design	Retrospective, systematic literature review and meta-analysis
Sample Population, Size, Setting	**Sampling Technique:** Several databases (PubMed, Embase, Web of Science and Cochrane Library) were searched from inception to April 2018 for trials comparing phenylephrine with ephedrine in cesarean delivery. **Eligible Participants:** Women undergoing cesarean section with spinal anesthesia. **Setting:** Labor & Delivery Operating Room **Excluded:** 15 studies were excluded that did not meet the inclusion criteria listed below. **Accepted:** The 44 included studies met the following criteria: (1) parturients undergoing cesarean delivery, including elective surgery, emergency surgery and patients with pre-eclampsia; (2) spinal anesthesia or combined spinal epidural anesthesia; (3) either a phenylephrine group or an ephedrine group without combination of the two; (4) at least one of the required outcomes: Maternal outcomes: incidence of hypotension, hypertension, bradycardia, tachycardia, and nausea or vomiting; neonate outcomes: incidence of fetal acidosis, the number of Apgar scores, umbilical artery and umbilical vein blood gas analysis; (5) study design: randomized-controlled trials. **Control:** Patients in the reviewed RCTs that received placebo **Intervention:** Patients in the reviewed RCTs that received either phenylephrine or ephedrine to attenuate spinal-induced hypotension following subarachnoid block for cesarean section. **Power analysis/Achieved:** Trial sequential analysis was conducted for the primary outcome (maternal hypotension rate), and the required information size was 2523. The total information size of the included studies was 1159, which did not fulfill the required information size. The results of the trial sequential analysis demonstrated that more RCTs should be included to obtain a conclusive result – Power analysis not met. **Group Homogeneity**: Random-effects models were selected for the meta-analysis to increase group homogeneity. Outcomes with a P value of < 0.1 were regarded as obviously heterogenous, warranting cautious interpretation of the result. If obvious heterogeneity occurred, sensitivity analysis was

	conducted to judge whether this result was robust via excluding one trial at a time and synthesizing the remaining trials. Every outcome of all included studies was analyzed. The statistically significant threshold was $P < 0.05$.
Intervention Procedures	**Control Protocol:** Administration of placebo, or therapeutic treatment of hypotensive episode (decrease in blood pressure of greater than 20% from baseline value). **Intervention Protocol:** Administration of either phenylephrine or ephedrine for treatment of spinal-induced hypotension in patients undergoing cesarean section. **Treatment Fidelity:** This meta-analysis was based on former studies and the ethical approval was not required in this meta-analysis. The authors did not list any conflicts of interest. There was no commercial participation in this trial. The authors also couch for the completeness and accuracy of the data and for the fidelity of the trial to the protocol. The risk of bias was determined by the Cochrane risk of bias tool specifically evaluating the bias of the RCTs. Bias assessment was conducted by two researchers individually followed by a discussion to resolve differences.
Primary Outcome and Measures	**Dependent Variable:** Incidence of maternal hypotension. **DV Measure:** The statistical software programs used in the meta-analysis were Review Manager 5.3, and Stata 12.0. Parturients who only received phenylephrine were included in the intervention group, and those who received only ephedrine were included in the comparison group. Before data collection, a data extraction form was designed by the authors. If the required data was unavailable, then the relevant authors were contacted for detailed information. The data was collected individually by two researchers. If controversy arose, a third researcher was consulted to achieve a definitive conclusion.
Results/Conclusions	**Statistical Results:** Thirty-six trials (2439 patients) with elective cesarean delivery, three trials (400 patients) with emergency cesarean delivery and three trials (192 patients) with parturients with pre-eclampsia were included and analyzed. The incidence of hypotension did not differ in the elective surgery group (relative risk 0.83, 95% CI 0.66 to 1.05), emergency surgery group (relative risk 1.02, 95% CI 0.87 to 1.19) and pre-eclamptic parturients group (relative risk 0.93, 95% CI 0.63 to 1.37). The phenylephrine group had a higher incidence of bradycardia and lower incidences of tachycardia and nausea or vomiting in all three patient groups. The phenylephrine group also had lower fetal acidosis rate, higher umbilical artery and vein pH values and less base excess in the elective surgery. **Conclusions**: The study revealed that both phenylephrine and ephedrine were effective in maintaining maternal hemodynamic balance in cesarean delivery. Fetal acid-base equilibrium was better controlled in the phenylephrine group in elective cesarean delivery, but not in emergency cesarean delivery or in parturients with pre-eclampsia.

Citation: Abbasivash, R., Sane, S., Golmohammadi, M., Shokuhi, S., & Toosi, F. D. (2016). Comparing prophylactic effect of phenylephrine and ephedrine on hypotension during spinal anesthesia for hip fracture surgery. *Advanced Biomedical Research*, *5*, 167. https://doi.org/10.4103/2277-9175.190943	**Level and Quality: IA**
Purpose or Hypothesis	The purpose of this study was to compare the effect of prophylactic phenylephrine versus ephedrine in the prevention of hypotension during spinal anesthesia in hip fracture surgery.
Type of Evidence Research Design	Research: Prospective, randomized double-blind clinical trial

Sample Population, Size, Setting	**Sampling Technique:** Convenience. **Eligible Participants:** Patients aged between 40 and 72 years old, ASA class I and II undergoing hip fracture surgery with spinal anesthesia. **Setting:** General orthopedic operating room **Excluded:** Patients with any conditions in which spinal anesthesia had been contraindicated for them and a history of allergies to medications. **Accepted:** Ninety-two patients undergoing hip fracture with spinal anesthesia with ASA class I or II. **Control:** No control group **Intervention Group E:** 46 patients receiving prophylactic ephedrine bolus **Intervention Group P:** 46 patients receiving prophylactic phenylephrine bolus **Power analysis/Achieved:** On the basis of the formula for the comparison of two ratios, and the ratio of pressure loss Groups E and P were 70% and 93.3%, respectively, the significance level was 5%, power of 80%, equal sample size in each group, 46 patients were assigned in each group. The sample size was calculated using software STATA 14 and comparing two ratios – Power analysis met. **Group Homogeneity**: Intervention/Control homogenous based on NS p values in the Figure 1 for clinical characteristics.
Intervention Procedures	**Control Protocol:** No control group **Intervention Protocol Group E:** Intravenous bolus of 10mg ephedrine injected immediately before spinal anesthetic administration. **Intervention Protocol Group P:** Intravenous bolus of 50 mcg phenylephrine injected immediately before spinal anesthetic administration. **Treatment Fidelity:** There was no commercial participation in this trial. The authors did not report any conflicts of interest. Patients received one of two pre-determined anesthetic interventions.
Primary Outcome and Measures	**Dependent Variable:** Incidence and severity of hypotension following administration of spinal anesthetic of greater than 20% from baseline. **DV Measure:** Patients were monitored by noninvasive blood pressure recording prior to administration of spinal anesthetic to obtain baseline blood pressure values. Spinal anesthesia was performed. Ephedrine or phenylephrine was blindly administered, and blood pressures were measured and recorded every 3 minutes for the first 10 minutes and then every 5 minutes until 30 minutes after spinal anesthetic was administered.
Results/Conclusions	**Statistical Results:** The frequency of hypotension was significantly lower in MAP, systolic and diastolic pressure in phenylephrine group at 3, 6, and 9 minutes after spinal anesthesia (P = 0.002, P = 0.001). In the phenylephrine group, lower additional vasopressor was used (8.7% and 23.9%) (P = 0.04). **Conclusions**: The obtained results showed that the average hypotension was lower in the group that received phenylephrine and the difference was significant. At the doses of ephedrine and phenylephrine administered in this trial, phenylephrine was better to prevent hypotension during hip fracture surgery with spinal anesthesia. Higher frequency of hypotension was observed in the ephedrine group.

Citation: Mostafa, M., Hasanin, A., Mostafa, M., Taha, M. Y., Elsayad, M., Haggag, F. A., Taalab, O., Rady, A., & Abdelhamid, B. (2021). Hemodynamic effects of norepinephrine versus phenylephrine infusion for prophylaxis against spinal anesthesia-induced hypotension in the elderly population undergoing hip fracture surgery: A randomized controlled trial. *Korean Journal of Anesthesiology*, *74*(4), 308–316. https://doi.org/10.4097/kja.20519	**Level and Quality: IA**
Purpose or Hypothesis	This study aimed to compare the hemodynamic effects of prophylactic infusion of norepinephrine (NE) versus phenylephrine (PE) in elderly patients undergoing hip fracture surgery under spinal anesthesia.
Type of Evidence Research Design	Research: prospective, randomized-controlled trial

Sample Population, Size, Setting	**Sampling Technique:** Convenience. **Eligible Participants:** Elderly patients (>60 years of age), American Society of Anesthesiologists physical status I-II, scheduled for hip fracture surgery under spinal anesthesia **Setting:** Orthopedic surgical theater at Cairo University Hospital **Excluded:** Patients with known cardiac abnormalities, uncontrolled hypertension, hyperthyroidism, and monoamine oxidase inhibitor use were excluded from the study, as well as patients with a history of allergy to any of the study drugs and patients who had contraindications for spinal anesthesia. **Accepted:** 68 elderly patients undergoing hip fracture surgery with a spinal anesthetic **Control:** No control group **Intervention Group NE:** 34 patients **Intervention Group PE:** 34 patients **Power analysis/Achieved:** MedCalc Software version 14 was used to determine that a minimum of 28 patients were required to have a study power of 80% and an alpha error of 0.05. The study power was increased to 99%, which increased the sample size to 62 patients (31 per group). To compensate for any dropouts, the final number of participants was increased to 68 (34 per group) – Power analysis met. **Group Homogeneity**: Intervention/Control homogenous based on NS p values on Figure 1 for demographic data and baseline hemodynamic characteristics.
Intervention Procedures	**Control Protocol:** No control group **Intervention Protocol Group NE:** Patients in the NE group received NE infusion 4mg/4mL at a starting rate of 1mL/min of 8mcg/mL solution immediately after administration of the spinal anesthetic. **Intervention Protocol Group PE:** Patients in the PE group received PE infusion at a starting rate of 1mL/min of 100mcg/mL solution immediately after administration of the spinal anesthetic. **Treatment Fidelity:** The authors did not report any potential conflict of interest relevant to this study. Anesthesia was administered according to routine clinical practice. No discussion of complications resulting in discontinuation of protocol, protocol monitoring, or compliance with protocol. The trial was conducted in accordance with the Helsinki Declaration-2013.
Primary Outcome and Measures	**Dependent Variable:** Mean heart rate during vasopressor infusion; mean blood pressure **DV Measure:** Prior to initiation of spinal anesthetic, 4-lead EKG device was applied to all study patients. Spinal anesthesia was performed, and vasopressor infusion according to randomization was initiated. Blood pressure was obtained prior to spinal anesthetic to determine baseline, then every 2 minutes after spinal anesthetic for 20 minutes, then every 5 until the end of the operation.
Results/Conclusions	**Statistical Results:** The mean heart rate during vasopressor infusion was higher in the NE group than in the PE group (79 ± 8.4 and 68 ± 4.4 beats/min, respectively, $P < 0.001$). The heart rate was generally maintained during NE infusion in relation to the baseline readings. During PE infusion, the heart rate decreased in relation to the baseline reading. Furthermore, the incidence of bradycardia was lower in the NE group than in the PE group (3/31 [10%] and 11/31 [36%], respectively, $P = 0.031$). None of the included patients developed tachycardia or hypotension. There was no statistically significant difference in mean blood pressure readings between both groups during drug infusion. **Conclusions**: Both NE and PE infusions effectively prevented spinal-induced hypotension in elderly patients undergoing hip fracture surgery. NE provided more hemodynamic stability than PE in the form of maintaining the heart rate, higher cardiac output, less reactive bradycardia, and hypertension.

Citation: Pereira das Neves, J. F. N. P., Monteiro, G. A., de Almeida, J. R., Sant'Anna, R. S., Bonin, H. B., & Macedo, C. F. (2010). Phenylephrine for blood pressure control in elective cesarean section: Therapeutic versus prophylactic doses. *Revista Brasileira De Anestesiologia*, *60*(4), 391–398. https://doi.org/10.1016/S0034-7094(10)70048-9	**Level and Quality: IA**
Purpose or Hypothesis	The purpose of this study was to determine the efficacy of intravenous phenylephrine administered prophylactically vs. therapeutically for the maintenance of normotension in patients receiving spinal anesthesia for elective cesarean section.
Type of Evidence Research Design	Prospective, double-blind randomized controlled trial, approved by the Ethics on Research Committee
Sample Population, Size, Setting	**Sampling Technique:** Convenience. **Eligible Participants:** Gravidas undergoing elective cesarean sections under spinal block **Setting:** Labor & Delivery Operating Room **Excluded:** refusal of the patient to participate in the study, history of hypertension or pregnancy-induced hypertension, cardiovascular or cerebrovascular disease, fetal abnormalities, history of hypersensitivity to the drugs used in the study, and contraindications to spinal anesthesia. **Accepted:** physical status ASA I, term pregnancy of a single fetus, and indication for elective cesarean section. **Control:** Group 3: 40 patients were assigned to the control group **Intervention:** 2 groups, 40 patients were assigned to intervention group 1; 40 patients were assigned to intervention group 2 **Power analysis/Achieved:** A sample size of 120 patients was determined by power analysis (confidence level 5%, CI 95%) to detect a relative risk of the primary outcome at 0.05 alpha, and moderate effect size – Power analysis met. **Group Homogeneity**: Intervention/Control homogenous based on NS p values in the Tables 1 and 2 for preoperative and intraoperative parameters
Intervention Procedures	**Control Protocol:** Administration of a single dose of phenylephrine 50mcg in the event of hypotension (a drop in systolic BP of greater than 20% from baseline) following placement of spinal block. **Intervention Protocol:** Group 1: continuous prophylactic infusion of phenylephrine, using an infusion pump at 0.15mcg/kg/min initiated after the spinal block; Group 2: single dose of prophylactic phenylephrine 50mcg administered after the spinal block **Treatment Fidelity:** There was no commercial participation in this trial. Trial approved by the Ethics on Research Committee and informed consent was signed by the participants. The authors also vouch for the completeness and accuracy of the data and for the fidelity of the trial to the protocols. No discussion regarding how the anesthesia providers were trained or educated on study procedures. No discussion of complications resulting in discontinuation of protocol, protocol monitoring, or compliance with protocol. Internal validity therefore is reduced.
Primary Outcome and Measures	**Dependent Variable:** Development of hypotension following administration of spinal anesthetic of greater than 20% from baseline. **DV Measure:** Patients were placed in dorsal decubitus position with blood pressure and heart rate recorded three times in three-minute intervals between measurements to obtain mean baseline levels. With the patient in the sitting position, spinal block was performed with a 27G Quickne needle in the L3/L4 interspace, using 10mg hyperbaric bupivacaine 0.5% and 100mcg of morphine. In all groups, the "Baxter" volumetric infusion pump was connected. In Group 1, a solution containing 10 mL of NS with 10 mg of phenylephrine (100 mcg/mL) was prepared; in Groups 2 and 3, a solution containing 100 mL of NS was prepared. Only the anesthesiologist responsible for the anesthesia was aware of which group the patient belonged to and which medications were being administered. This anesthesiologist was not involved in data collection or analysis of the results. In all groups, the use of a bolus of 30 mcg of phenylephrine IV repeated every 2 minutes, in case of a drop in blood pressure greater than 20%, not controlled with the therapeutic regimen used, was allowed. Episodes of hypotension defined as a drop in SBP and/or DBP greater than 20% were recorded. Reactive hypertension was characterized as a blood pressure 20% greater than baseline mean levels after the use of the vasopressor. Heart rate lower than 50 bpm characterized bradycardia, and when associated with hypotension it was treated with 0.5 mg of atropine IV. Nausea, vomiting, and the need of rescue doses of phenylephrine were recorded.

Results/Conclusions	**Statistical Results:** The incidence of hypotension was significantly greater in Group 3, affecting 85% of the parturients. In Group 1 and Group 2, hypotension was seen in 17.5 and 32.5% of the cases, respectively ($p < 0.001$). The rate of nausea was much higher in Group 3, occurring in 40% of the patients while only occurring in Groups 1 and 2 at 10% and 15%, respectively, which was statistically significant as well. **Conclusions**: This study showed that prophylactic continuous infusion of phenylephrine initiated immediately after the spinal block for cesarean section is more effective in reducing the incidence of hypotension and maternal and fetal side effects.

Note. Evidence was graded using the Johns Hopkins Evidence-Based Practice Model for Nursing and Health Care Professionals (2022), Appendix D. All articles were retrieved from the Pubmed database.

Appendix B

Evidence Synthesis Table

Project Title: Attenuating Spinal-Induced Hypotension with Prophylactic Phenylephrine Infusion

PICO(T): Among (P) patients receiving spinal anesthesia, does (I) the initiation of a prophylactic phenylephrine infusion, compared to (C) no phenylephrine infusion initiated, affect (O) the incidence and severity of spinal-induced hypotension (a decrease in blood pressure greater than 20% from baseline)?

JHNEBP Model Level	Total Number of Sources	Author and Quality Rating of each study	Synthesis of Findings
Level 1 Experimental study · Randomized Controlled Trial (RCT) · Systematic review of RCTs with or without meta-analysis	**(7)** 6 randomized controlled trials and one systematic review of RCTs with meta-analysis	(Abbasivash et al., 2016) **A** (Choudhary et al., 2018) **A** (Ferré et al., 2016) **A** (Mostafa et al., 2021) **A** (Pereira das Neves et al., 2010) **A** (Shafeinia et al., 2020) **A** (Xu et al., 2018) **A**	Abbasivash et al., (2016) found that the frequency of hypotension in patients undergoing hip fracture surgery with spinal anesthesia was significantly lower in the phenylephrine group compared to the ephedrine group. Also, there was lower additional vasopressor use in the phenylephrine group. Phenylephrine was found to be more effective in preventing hypotension during hip fracture surgery with spinal anesthesia. Similar results regarding phenylephrine were observed in a different population, where Choudhary et al., (2018) found that in patients receiving spinal anesthesia for cesarean section, systolic blood pressure fell more than 20% from baseline in 44/50 patients in the control group (therapeutic bolus of phenylephrine only), with a mean decrease in systolic blood pressure of -28.06 +/- 5.3 mmHg. In the prophylactic phenylephrine infusion group, the mean decrease in systolic blood pressure was only -0.44 +/- 4.3 mmHg. Choudhary et al., (2018) found that there was a tighter control of blood pressure in the infusion group vs. the therapeutic bolus group. In the geriatric population, Ferré et al., (2016) found that prophylactic phenylephrine infusion is an effective method of reducing spinal-induced hypotension in elderly patients. The number of hypotensive episodes was nine times greater in the to control group as compared to the prophylactic phenylephrine infusion group. Also, the time to first hypotensive episode was shorter in the control group than in the phenylephrine group. Similarly, Mostafa et al., (2021) compared the hemodynamic effects of prophylactic phenylephrine to norepinephrine in elderly patients undergoing hip fracture surgery under spinal anesthesia and found that both norepinephrine and phenylephrine infusions effectively prevented spinal anesthesia-induced hypotension. Reverting to the obstetric population, Pereira das Neves et al., (2010), compared both therapeutic bolus of intravenous phenylephrine and prophylactic infusion of phenylephrine to a control group to determine the effectiveness in reducing the incidence of hypotension in patients undergoing cesarean section with spinal anesthesia. The study concluded that prophylactic continuous infusion of phenylephrine is more effective in reducing the incidence of hypotension and maternal fetal side effects. Shafeinia et al., (2020) also

			investigated the effect of phenylephrine on maternal hemodynamic changes during spinal anesthesia for cesarean delivery. It was similarly determined that phenylephrine is effective in the prevention of complications such as reduced mean arterial pressures, systolic and diastolic pressures, nausea, and vomiting. Lastly, Xu et al., (2018) conducted a meta-analysis of dozens of studies over a 20-year period comparing phenylephrine with ephedrine to prevent or treat hypotension in elective or emergency cesarean delivery and parturients with pre-eclampsia. It was concluded that phenylephrine and ephedrine were both effective in maintaining hemodynamic balance, but newborns benefited more from phenylephrine in elective cesarean delivery.
Overall Quality Rating w/rational and Recommendations Based on Evidence Synthesis: **A**; Strong, compelling evidence, consistent results. Results consistently showed that intravenous phenylephrine was effective in reducing the incidence and/or severity of hypotension in patients undergoing procedures with spinal anesthesia. The overall quality of evidence was high. Solid indication for a practice change.			

Note. Evidence was graded using the Johns Hopkins Evidence-Based Practice Model for Nursing and Health Care Professionals (2022), Appendix D. All articles were retrieved from the Pubmed database.

Appendix C

Education Attendance Audit Tool

Page 1

Education Attendance Survey

Please complete the survey below.

Thank you!

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1) 1) Did you attend the in-person education session, or view the recording of the education session?

☐ YES - In-Person or Recording
☐ NO - I did not attend or view the education session

Note. REDCap data collection tool used to audit education session attendance.

Appendix D

Protocol Compliance Audit Tool

Spinal Anesthesia & Phenylephrine

Please complete the survey below.

Thank you!

Date of Operation	_____
Did patient receive spinal anesthesia?	◯ Yes ◯ No
Did you initiate I.V. phenylephrine infusion concomitantly with administration of spinal anesthetic?	◯ Yes ◯ No
Why wasn't the phenylephrine infusion initiated?	_____ (Patient history, allergy, situation, etc.)

Note. REDCap data collection tool used to audit protocol compliance.