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Predictors of Hypotension following spinal anaesthesia in lower segment caesarean section – A clinical study

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Abstract

During caesarian delivery most common and important problem is obstetric spinal hypotension. This is likely to affect both mother and fetal well-being. Studies have been aimed at defining risk factors, clarifying pathophysiology, and creating prophylaxis and management protocols. Identifying patients at risk for hypotension may guide clinical decision-making and allow timeous referral. Objective is to identify the subset of pregnant patients at higher risk for post spinal hypotension based on preoperative vital signs before and after subarachnoid block in lower segment caesarian section. Using these preoperative risk factors, predicting incidence of hypotension. This prospective, single-centre, observational study of 200 pregnant patients aged 20–35 years, of American Society of Anaesthesiologists (ASA) grade I or II, scheduled for elective or urgent caesarean section under spinal anaesthesia. Patients were assessed for perfusion index, body mass index, baseline heart rate, baseline mean arterial pressure (MAP)and maternal age as predictors of spinal hypotension (systolic blood pressure> 90mmHg). Vitals were recorded with the patient in the lateral and supine position. After administering bupivacaine during subarachnoid block, vitals were obtained at every two minutes for 10 minutes. Ephedrine treatment was administered based on the degree of hypotension observed. Hemodynamic parameters were correlated to ephedrine requirements. From 200 eligible patients, Maternal age (26±6.0 (Mean±SD), Rho coefficient =0.32; p=0.01), BMI (26±6.4 (Mean±SD), Rho coefficient =0.64; p=0.02), perfusion index (3.8±1.8 (Mean±SD), Rho coefficient =0.41; p=0.01), preoperative heart rate (85.92±11.28 (Mean±SD), Rho coefficient =0.33; p=0.01) and preoperative MAP (86.90±6.92 (Mean±SD), Rho coefficient =-0.5; p=0.02), were found to be predictors of hypotension following obstetric spinal

anaesthesia. This analysis concluded that advancing age, a higher preoperative heart rate, lower preoperative MAP and higher perfusion index were associated with an increased incidence of hypotension in pregnant patients following spinal anaesthesia in lower segment caesarean section.

Keywords: caesarian section, perfusion index, predictors, parameters, spinal hypotension.

Introduction

Spinal Anaesthesia is a safe and reliable technique for surgery of the lower abdomen and lower limbs, nervertheless, some of its characteristics may limit its use for ambulatory surgeries including ambulation to be delayed, risk of urinary retention and pain after block effect is finished. Hypotension following spinal anaesthesia results from the sympathetic blockade and decreased cardiac output [(1)]. Pregnant women sensitivity is more for local anaesthetics and are less responsive to vasopressors at term. Hence, parturients can develop profound hypotension following central neuraxial blockade for the lower segment caesarean section (LSCS). Hypotension in regional subarachnoid blocks has been defined as the most important and most deleterious side effect for the well-being of the mother and the fetus[(2)]. Hypotension during caesarean delivery is a potentially life-threatening event and is associated with nausea and vomiting [(3)], loss of consciousness, cardiac arrest, death and fetal compromise [(4)]. Perfusion index (PI) is defined as the ratio of pulsatile blood flow to non-pulsatile blood flow in the peripheral vascular tissue, measured using a pulse oximeter based on the amount of Infrared light absorbed [(5)]. Healthy pregnancy shows decrease in systemic vascular resistance, increased total blood volume and cardiac output. The reduction of systemic vascular resistance may vary in parturients depending on various factors. This decrease in tone will correspond to higher perfusion index values due to increase in pulsatile component due to vasodilatation. Induction of a sympathectomy by spinal anaesthesia will cause a further decrease peripheral vascular tone and increase pooling and hypotension. Parturients with high baseline perfusion index are expected to have lower peripheral vascular tone and hence are at higher risk of developing hypotension following spinal anaesthesia. Scoring systems helps to enhance anaesthetic planning, guide clinical decision-making and make timeous referral possible where appropriate. This study was designed to evaluate whether haemodynamic parameters obtained prior to spinal anesthesia (SA) in the supine and standing position would be useful to predict a subset of pregnant patients that might be at high risk for post spinal hypotension.

Materials And Methods

We undertook prospective, single centre, observational study of patients undergoing caesarean section and assessing predictors of hypotension following spinal anaesthesia was conducted in department of Anaesthesiology, GMC Bhopal and associated Sultania Zanana hospital from October 2019 to December 2019, in accordance with Helsinki Declaration of 1975, as revised in 2000. Institutional ethics committee approval was obtained. Written informed consent was obtained and patient related confidentiality was maintained. The hospital runs three obstetric theatres during normal working hours and two theatres during emergency.

For this analysis we included all 200 patients of ASA grade 1, 2 posted for caesarian section with age ranging from 20-35 years undergoing spinal anaesthesia, i.e. both elective and emergency cases. Patients who underwent conversion to general anaesthesia during the time period assessed (insertion of spinal until 15 minutes after delivery of the baby), patient refusal, ASA grade III and IV, patients on alpha-2 antagonist treatment, anti-coagulation

treatment (INR >1.5), patients with infection at the site of injection, with coagulopathy, bleeding diathesis, congenital abnormalities of lower spine and meninges, spine/neurological deformity, history of allergy to local anesthetics or alpha-2 adrenergic agonists, any drug allergy, uncontrolled systemic illness like diabetes mellitus, hypertension, uncorrected hypovolemia, any severe liver or kidney diseases were excluded from analysis.

After pre-anaesthetic checkup and a written informed consent a common standard anaesthetic regimen was followed for all the patients who included lignocaine sensitivity test. Relevant patient data recorded during the initial assessment included clinical history, height, weight, maternal age and urgency of surgery, thorough physical and systemic examination, routine investigation which includes complete blood count, urine (routine and microscopy), blood sugar, renal function test, serum electrolytes, X-ray chest PA view, ECG and any special investigation if required was done for the study. BMI was noted, NBM (nil by mouth) status was confirmed and anti-aspiration prophylaxis was taken. In the operation theatre, initially 4-6 liters of supplementary oxygen was started. Baseline vital parameter (heart rate and non-invasive blood pressure) with electrocardiogram (ECG), oxygen saturation (SpO2) and perfusion index was recorded in the theatre in supine position prior to administering spinal anaesthesia. An intravenous access was secured using 18G cannula and 500ml of RL infusion (10 ml per kg body wt.) was started to all patients half an hour before anesthetic procedure as pre-loading. An injection of Ondansetron-4mg, Ranitidine-50mg was administered intravenously prior to induction of anaesthesia. After finishing infusion, the parturient women were converted to the left lateral recumbent position. The subarachnoid block was performed at the level of L3-L4 interspace after anaesthetized with 2ml of 2% lignocaine in all patients in left lateral position under strict aseptic precautions using 23G Quincke needle in the midline. After observing the free flow of CSF, 2.2ml of 0.5% hyperbaric bupivacaine was given slowly, and the patient was immediately moved to the supine position and uterus was transposed to the left by at least 15º by placing a wedge under right buttock, in order to prevent supine hypotensive syndrome. The level of sensory block was considered appropriate at T5-6 and assessed by response to cold sensation by alcohol swab. The maternal hemodynamic parameters: Heart Rate (HR), NIBP and peripheral blood saturation (SpO2) every 2 minutes up to 10 minutes and then at every 10 minutes interval till the end of the surgery. Intravenous fluids were administered at a rate of 100 ml in 10 minutes. Sensory block level was assessed by pin prick test and motor block by Modified Bromage Scale. This scale was used to assess the degree and duration of motor blockade. The perfusion index was measured in the supine position using a specific pulse oximeter probe which will be attached to the left index finger of all parturients to ensure uniformity in measured PI values. Hypotension was managed according to unit protocol. Vasopressor boluses was given if the MAP was <80% of baseline MAP or the systolic Blood pressure was <90 mmHg. If the heart rate was > 70 bpm, phenylephrine (50 - 100 µg) was administered, and if the heart rate <70 bpm, ephedrine (5-10 mg) was administered. After delivery, 10 IU oxytocin was given in the subsequent litre of fluid as an infusion. The incidence of other side effects such as nausea, vomiting if observed was recorded. Data was manually recorded by the attending anaesthetist, entered into a Microsoft Excel spreadsheet and then checked by one of the study investigators to ensure data fidelity. Data were exported to a statistical program for further analysis. The influence of perfusion index, body mass index, baseline heart rate,

baseline mean arterial pressure (MAP) and maternal age on incidence of hypotension were the primary outcome measures. The degree of hypotension as measured by vasopressor (ephedrine) usage and the incidence of nausea and vomiting were secondary measures.

The primary outcome as the prediction of hypotension, defined as SBP <90mmHg, from the time of spinal insertion until 15 minutes after delivery of the baby.

Statistical Analysis

We planned to examine five variables (perfusion index, body mass index (BMI), baseline heart rate, baseline MAP and maternal age) as predictors of hypotension. Correlation analysis (Spearman's rank test) was performed to find the correlations of perfusion index, body mass index (BMI), baseline heart rate, baseline MAP and maternal age with the incidence of hypotension. For analytical purposes, original data was presented with defined class intervals. The incidence of hypotension, level of sensory block and vasopressor use was categorized accordingly. Comparisons between normally distributed continuous data were done using one-way ANOVA test and Chi-square test was applied for categorical data. $P < 0.05$ was considered statistically significant for all the tests. The data were analyzed using SPSS 22 version software (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.).

Results

Two hundred parturients were scheduled for the elective caesarian section under spinal anaesthesia. No one was excluded from the study after the inclusion criteria had been met. The mean age, weight, height & BMI of parturients enrolled for the study were 26.0 ± 6.0 years, 80.07 ± 16.4 kg, 156 ± 7.8 cm & 26 ± 6.4 respectively (Table 1). The anesthetic technique in the left lateral position was the most frequent (85%), with the use of the 23G spinal needle in 99.1% of cases. The most common access was the L3 to L4 space (88.5%), achieving sensory levels between T2 and T5, the most frequent being T4 (75%). Mean onset of sensory block was 2.41 ±0.49 whereas mean onset of motor block was 4.27 ±0.72 minutes. Maximum sensory block was achieved at T4 level in 83.5% patients (Table 2). All patients were followed through to the end of the surgical and anesthetic procedures. The time period between 4 and 8 minutes after anesthesia induction was the most hemodynamically labile. Over the 30 min observation period following SAB no hypotension was observed in 20 subjects (15%), mild hypotension in 60 (25%), and moderate to marked hypotension in 114 subjects (60%) as shown in Graph 1. The incidence of hypotension in the cesarean section under spinal anesthesia using bupivacaine 0.5% (H) was 71.5% (143 out of 200 parturients). The incidence of hypotension was higher with increasing maternal age (90.90 % with age >25years), with increasing BMI (96.96 % with BMI > 25kg/ m2) and with increasing perfusion index (82.03% with perfusion index >25, correlation coefficient $\rho = 0.01$) (Graph 2, Table 3). The incidence of hypotension was higher with higher baseline heart rate similarly, incidence of hypotension was higher with lower baseline MAP and both were statistically significant ($P < 0.05$) (Graph 3, Table 4). Similarly, rescue dose of ephedrine was higher with age >25yrs and BMI >25kg/m2. Similarly, incidence of nausea & vomiting was also greater in parturients with age>25yrs (81.88%) as compared to parturients with AG ≤25 yrs (16.43%) ($p<0.05$). This analysis confirmed that advancing age, higher BMI, higher perfusion index, a higher preoperative heart rate and a lower preoperative MAP were associated with an increased incidence of hypotension following spinal anaesthesia (Table 5).

Discussion

This prospective, observational single-centre study aimed to identify preoperative risk factors for obstetric spinal hypotension. Obstetric spinal hypotension is common, with up to 80% of cases requiring treatment with a vasopressor[6] It is potentially life threatening and is associated with nausea and vomiting[3] , loss of consciousness, cardiac arrest, death and fetal compromise[4]. Anaesthetists in developing-world conditions face unique challenges, including a lack of training and experience[7].There is an urgent need to better identify patients at risk and implement strategies to prevent associated morbidity and mortality. The incidence of hypotension is difficult to quantify owing to inconsistencies in the definitions used across studies. Klohr et al[8] found 15 different definitions across 63 different publications, with a 10-fold difference in incidence, depending on the definition used. We used an absolute cut-off of SBP <90mmHg to define hypotension, as this is both clinically relevant and simple to use.

In choosing the candidate variables for this study, a higher priority was given to parameters that are easily measured and readily available and would have practical significance to the attending anaesthetist in a resource-constrained setting. Five variables in this study have previously shown promise as predictors of spinal hypotension. Preoperative heart rate was 85.92 ± 11.28 bpm, (p = 0.01) which was statistically significant and comparable to D G Bishop et al[9] who conducted a study on obstetric spinal hypotension: preoperative risk factors and the development of a preliminary risk score – the PRAM score. Preoperative heart rate was 92 ± 15.0 bpm. Baseline heart rate(10,11) and advancing maternal age(12,13)were predictors in retrospective studies, which our study confirmed. Advancing maternal age[9] was associated with an increased incidence of hypotension (SBP < 90 mmHg). The mean maternal age was 27.4 ± 6.3 yrs, (p < 0.005). Odds ratio was 1.05 with 95% confidence interval of 1.02 - 1.08 (p = 0.002) similar to our study.

Lower preoperative MAP[9] was 86.90 ± 6.92 mmHg, associated with an increased incidence of hypotension (SBP <90 mmHg). A retrospective study demonstrated an association between a higher preoperative MAP and significant hypotension under spinal anaesthesia in elective cases[12]. However, these authors used a relative definition for hypotension of an MAP reduction of >30% from baseline rather than an absolute definition, which may explain why our study found the opposite.

BMI has previously been shown to predict hypotension in obstetric spinal anaesthesia,[13,14] but in our study Mean BMI[17,23,24] was 26 ± 6.4 kg/m^2 did not confirm this association with an increased incidence of hypotension. We did not aim to include methods of prediction such as heart rate variability[1,9] because the equipment required is not universally available. Given this high event rate, it could be argued that there is little practical value in attempting to predict hypotension. Preoperative identification of high-risk patients could enable targeted prophylactic interventions such as use of a prophylactic phenylephrine infusion.

Higher perfusion index[15] was associated with an increased incidence of hypotension (SBP <90 mmHg). Mean perfusion index was 3.8 ± 1.8 (p = 0.01) which was statistically significant, comparable to Devika et al[15] conducted a study for perfusion index as a predictor of hypotension following spinal anaesthesia in lower segment caesarian section, the incidence and severity of hypotension, vasopressor requirement was higher in parturients whose baseline PI values were greater than 3.5. PI has been used in the study by Mowafi et al[16] to detect intravascular injection of the epinephrine-containing epidural test dose; hence its reliability to detect vaso

constriction has been demonstrated successfully. The cut-off value of baseline perfusion index for prediction of hypotension following spinal anaesthesia was chosen as 3.5 based on a study conducted by Toyama et al[17] who did regression analysis and ROC curve analysis and concluded that a baseline perfusion index cut-off point of 3.5 could be used to identify parturients at risk for such hypotension. In contrast, a recent study performed by Yokose et al[3] demonstrated that PI had no predictive value for hypotension in parturients undergoing LSCS following SAB.

Table 1: Demographic variables of patients

Characteristics	Mean	Standard deviation	P value
Age (yrs)	26.0	6.0	0.01
Weight (kg)	80	16.4	1.0
Height (cm)	156	7.8	0.07
BMI (kg/m2)	26	6.4	0.02
Perfusion Index	3.8	1.8	0.01

Table 2: Characteristics of spinal anesthesia

Spinal Anaesthesia	Mean	Standard Deviation
Onset of Sensory block	2.42	0.50
Onset of Motor block	4.25	1.50
Level of Anaesthesia	Frequency	Percentage
T2	1	0.5
T4	150	75
T5	19	9.5
T6	30	15

Table 3: Haemodynamic Parameters of patients

Parameters	Mean	Standard deviation	P value
Baseline Heart rate (bpm)	85.92	11.28	0.013
Baseline SBP (mmHg)	119.71	6.36	0.51 (NS)
Baseline DBP (mmHg)	70.50	7.88	0.37 (NS)
Baseline MAP (mmHg)	86.90	6.92	0.001

Table 4: Comparison of Maternal Age, Body mass index (BMI) and Perfusion Index with the incidence of hypotension

Parameters		Number of parturients	Hypotension				P value	Rescue dose of ephedrine (mg)
			Yes	%	No	%		
Maternal age	<25 years	46	12	26.08	34	73.91	0.01	5.06±0.52
	>25 years	154	140	90.9	14	9.09		8.54±0.08
BMI	<25 kg/m2	68	4	7.47	64	94.11	0.02	5.02±2.20
	>25 kg/m2	132	128	96.96	4	3.03		10.65±3.04
Perfusion Index	< 3.5	33	8	24.24	25	75.75	0.01	5.08±0.50
	>3.5	167	137	82.03	30	17.9		9.45±2.40

Table 5: Correlation of hypotension with maternal age, BMI, Perfusion Index, Baseline Heart Rate and Baseline MAP

Parameters	Hypotension	
	Rho Co-efficient	P value
Age	0.32	0.01
BMI	0.64	0.02
Perfusion Index	0.41	0.01
Baseline Heart Rate	0.33	0.013
Baseline MAP	-0.5	0.02

Figure 1 Incidence of Hypotension

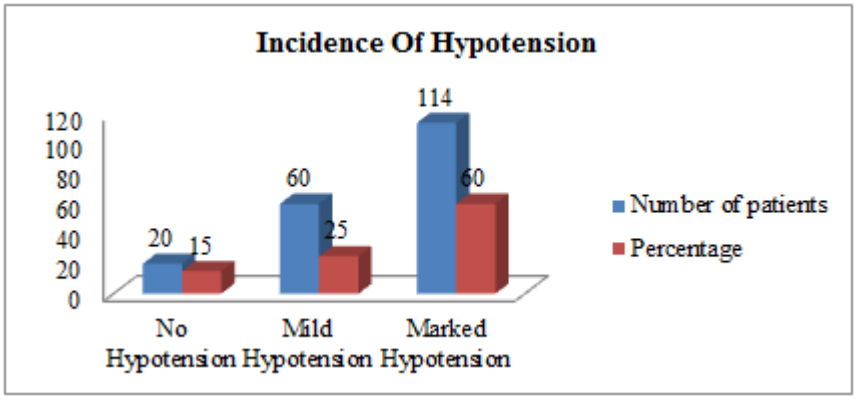
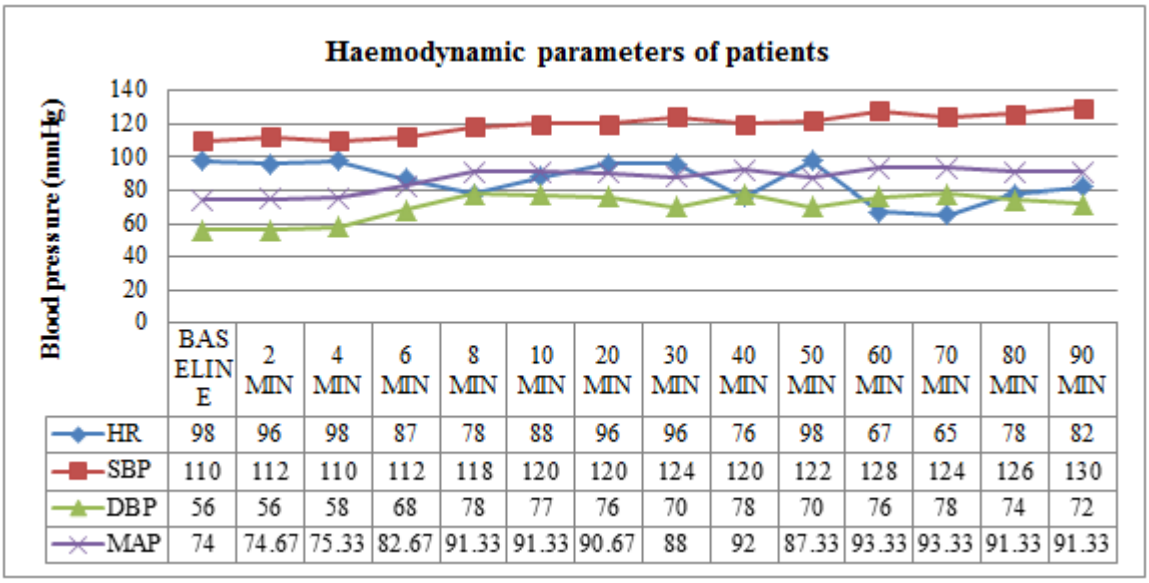
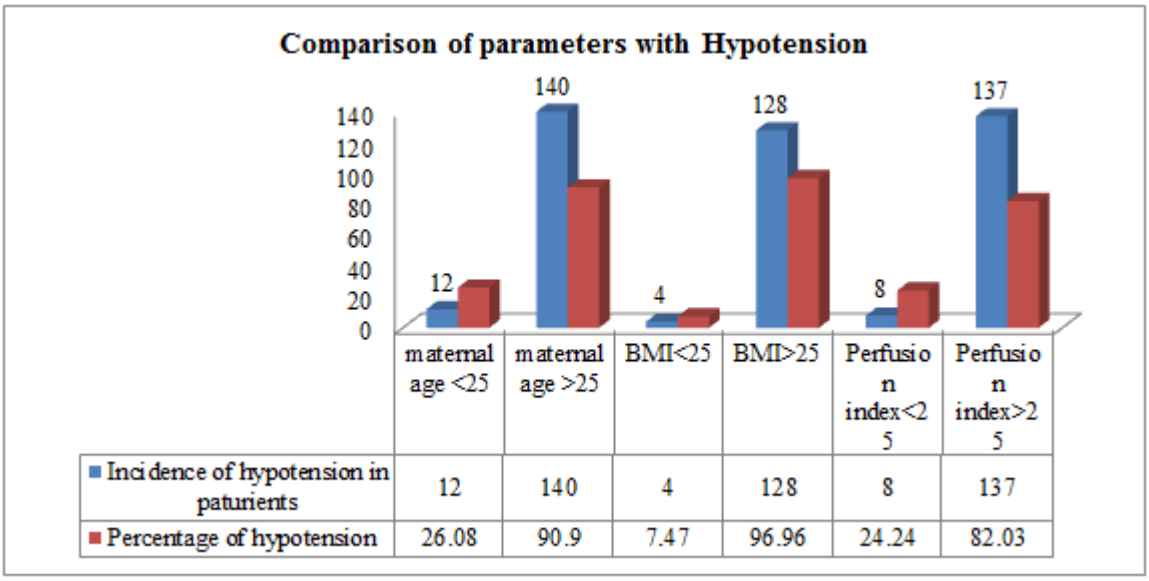


Figure 2: Haemodynamic parameters of patients



	BASELINE	2 MIN	4 MIN	6 MIN	8 MIN	10 MIN	20 MIN	30 MIN	40 MIN	50 MIN	60 MIN	70 MIN	80 MIN	90 MIN
HR	98	96	98	87	78	88	96	96	76	98	67	65	78	82
SBP	110	112	110	112	118	120	120	124	120	122	128	124	126	130
DBP	56	56	58	68	78	77	76	70	78	70	76	78	74	72
MAP	74	74.67	75.33	82.67	91.33	91.33	90.67	88	92	87.33	93.33	93.33	91.33	91.33

Figure 3: Comparison of parameters with hypotension



	maternal age <25	maternal age >25	BMI<25	BMI>25	Perfusion index<25	Perfusion index>25
Incidence of hypotension in paturients	12	140	4	128	8	137
Percentage of hypotension	26.08	90.9	7.47	96.96	24.24	82.03

Conclusions

This study found preoperative advancing maternal age, BMI, perfusion index, preoperative heart rate and preoperative MAP to be predictive of hypotension. Perfusion Index (PI) can be used as a tool for predicting hypotension in healthy parturients undergoing elective caesarean section under SAB. Parturients with baseline PI >3.5 are at higher risk of developing hypotension following SAB compared to those with baseline PI ≤3.5. It shows as a preliminary method to identify the high risk patient for obstetric spinal hypotension using basic, readily available clinical parameters.

Abbreviations

LSCS- lower segment caesarean section, SAB- subarachnoid block, ECG- electrocardiogram, MAP- Mean arterial pressure, SBP- systolic blood pressure, DBP- diastolic blood pressure, PI- perfusion index, BMI-

body mass index, CSF- cerebrospinal fluid, yr- year, kg- kilogram, cm- centimeter, mmHg- millimeter of mercury, bpm- breath per minute, g/dL- gram per deciliter, mL- milliliter.

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