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Seasonal Factors and The Potential of Artificial Insemination (AI) in Dairy Cattle

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ABSTRACT

Dairy cattle are dominant milk producer in Indonesia. Several programs have been carried out to increase the population of dairy cattle and milk production, one of which is Artificial Insemination (AI). Indonesia is a tropical country that has two seasons, namely the rainy season and the dry season. This study was conducted in the KPSBU Lembang working area, West Java, from November 2019 to January 2020. Rainfall data from the BMKG Dramaga Climatology Station and artificial insemination (AI) records of Frisian Holstein dairy cattle from 2017 to 2019 were collected. AI success was assessed using the Service per Conception (S/C) and Conception Rate (CR) parameters, obtained through pregnancy checks two months after insemination. Pregnancy checks were conducted using rectal palpation to confirm conception. Statistical analysis focused on seasonal differences in reproductive performance based on these metrics. Highest S/C value was 2.02 with CR Value 53.27% on rainy season with rainfall 253.67 mm month-1. The analysis showed a strong correlation (α = 0.005) between S/C and CR value (0.89*), very weak correlation between rainfall with S/C (r = -0.05) and CR (r = -0.08). The results of the research show that the rainy season and the dry season are not the main factors affecting the AI in dairy cattle, however they didn't directly affect the season to increase the productivity of saplings.

Keywords: artificial insemination, dairy cows, dry season, rainy season

ABSTRAK

Sapi perah merupakan penghasil susu dominan di Indonesia. Beberapa program telah dilakukan untuk meningkatkan populasi sapi perah dan produksi susu, salah satunya adalah Inseminasi Buatan (IB). Indonesia merupakan negara tropis yang mempunyai dua musim yaitu musim hujan dan musim kemarau. Penelitian ini dilaksanakan di wilayah kerja KPSBU Lembang, Jawa Barat, pada bulan November 2019 hingga Januari 2020. Data curah hujan Stasiun Klimatologi BMKG Dramaga dan rekaman inseminasi buatan (AI) sapi perah Frisian Holstein dari tahun 2017 hingga 2019 dikumpulkan. Keberhasilan AI dinilai menggunakan parameter Service per Conception (S/C) dan Conception Rate (CR) yang diperoleh melalui pemeriksaan kehamilan (PKB) dua bulan setelah inseminasi. Pemeriksaan kebuntingan dilakukan dengan menggunakan palpasi rektal untuk memastikan konsepsi. Analisis statistik berfokus pada perbedaan musim dalam kinerja reproduksi. Nilai S/C tertinggi sebesar 2.02 dengan Nilai CR 53.27% pada musim hujan dengan curah hujan 253.67 mm bulan-1. Hasil analisis menunjukkan adanya korelasi yang kuat (α = 0.005) antara nilai S/C dengan nilai CR (0.89*) dan korelasi yang sangat lemah antara curah hujan dengan nilai S/C (r = -0.05) dan CR (r = -0.08). Hasil penelitian menunjukkan bahwa musim hujan dan musim kemarau bukan merupakan faktor utama yang mempengaruhi IB pada sapi perah, namun perbedaan musim memiliki pengaruh secara langsung untuk meningkatkan produktivitas walaupun tidak nyata.

Kata kunci: inseminasi buatan, sapi perah, musim hujan, musim kemarau.

INTRODUCTION

Indonesia is located between 6° N to 11° S and 95° E to 141° E and has a tropical climate. Indonesia experiences two main seasons: rainy and dry (Pasaribu 2015). In tropical climates, the average rainfall exceeds 1800 mm per year (Buatama 2013). Although tropical climates generally have high environmental temperatures, some areas in the highlands have low temperatures, making them ideal for developing dairy farming areas. Dairy cattle are the most dominant type of milk producing livestock compared to other dairy cattle (Schmidt *et al.* 1988; Atabany 2012). In many countries, dairy cattle are maintained because they are one of the pillars of a nation's economy. Based on data from the Badan Pusat Statistik (2018), the population of dairy cows in Indonesia reached 550,141 heads, with fresh milk production of 909,638 tons per year. With Indonesia's population reaching 257.9 million people in Indonesia, milk consumption per year is estimated to be around 11.8 liters per capita, including processed products containing milk (DPKH 2016). To increase dairy cow population and domestic milk production, several programs have been implemented, one of which is artificial insemination (AI). AI is an effort to optimally utilize superior male seeds to improve the genetic quality of livestock (BSN 2008). The aim of the AI program is to maximize the use of disease-free bulls with high genetic quality. Siatka *et al.* 2017 confirms that seasonal variations significantly impact the number of services per conception (S/C) in dairy cattle. Heat stress, particularly during summer, has been shown to increase the S/C ratio due to reduced feed intake, hormonal imbalances, and impaired reproductive functions like ovarian steroidogenesis. High ambient temperatures can also reduce intrauterine blood flow, compromising embryo survival.

Reproductive issues in livestock are generally attributed to genetic factors, inadequate management, and an unfavorable environment (Hardjopranoto 1995). In tropical regions, suboptimal rearing conditions can negatively impact the performance of dairy cattle (Anggraeni *et al.* 2000). During the dry season, when quality of feed is poor, livestock may experience nutritional deficiencies that can contribute to reproductive disorders (Manan 2002). The mechanism by which different seasons affect the service per conception (S/C) score in dairy cattle is driven by a combination of environmental stressors and physiological responses. Heat stress can affect embryo viability. High ambient temperatures during conception or early gestation reduce the chances of embryo survival, resulting in early embryonic loss. When conception does occur during high-stress periods, early embryo loss often follows, leading to higher services per conception. This is supported by evidence that high temperature-humidity index (THI) reduces the conception rate and embryo development (Roth 2008) to address these issues, research was conducted to investigate the influence of the rainy and dry seasons on the success of the Artificial Insemination (AI) program, with a focus on environmental conditions based on rainfall.

MATERIAL AND METHODS

This research was conducted in the people's livestock area in the working area of KPSBU Lembang, West Java, Section IB and animal health of KPSBU Lembang and the BMKG Climatology Station, Dramaga, Bogor Regency, West Java. This study was conducted from November 2019 to January 2020.

The materials used in the research were rainfall data obtained from the BMKG for the KPSBU Lembang working area and AI service data collected from KPSBU Lembang, including records of AI services for Frisian Holstein dairy cattle. These data were collected from 2017 to 2019.

Data Collecting

The rainfall data for the Lembang region during the years 2017 to 2019 were gathered from the BMKG Dramaga Climatology Station, located in Bogor Regency, West Java, and from the official website of the Badan Meteorologi, Klimatologi, dan Geofisika (BMKG). Rainfall measured using rain gauges in millimeters (mm) over a given period. Rainy Season characterized by higher rainfall, typically exceeding 150-200 mm per month. Dry Season defined by lower rainfall, usually below 50-100 mm per month. Rainfall is often measured by total millimeters of precipitation over specific months, categorizing the year into wet and dry seasons. For instance, regions experiencing more than 60 mm of rainfall for consecutive months are classified under the rainy season, while periods of lesser precipitation fall into the dry season (Tata *et al.* 2012).

High temperatures are associated with heat stress. The data on dairy cattle from the KPSBU Lembang area were obtained from both the IB and Keswan sections of the KPSBU Lembang. Additionally, secondary data were utilized, which included information on AI implementation and pregnancy examinations for productive female Frisian Holstein (FH) cattle.

The data collected for this study included records of dairy cattle that underwent artificial insemination (AI) and those that successfully became pregnant. AI success was measured through two key parameters: Service per Conception (S/C) and Conception Rate (CR). These parameters were obtained during routine pregnancy examinations (PKB). The pregnancy checks were used to determine the outcome of AI and calculate the reproductive efficiency of the cows during different seasons. AI sucsess was analyzed using S/C and CR parameters obtained from pregnancy examination activities. Pregnancy checks were carried out two months after AI was performed using the rectal exploration method, namely by examining the uterus with a hand inserted into the rectum (Suwito 2013).

Statistical Techniques Executed

The data collected for this study included records of dairy cattle that underwent artificial insemination (AI) and those that successfully became pregnant. AI success was measured through two key parameters: Service per Conception (S/C) and Conception Rate (CR). These parameters were obtained during routine pregnancy examinations. The pregnancy checks were used to determine

the outcome of AI and calculate the reproductive efficiency of the cows during different seasons.

$$S/C = \frac{\text{Total Number of AI Services (inseminations)}}{\text{Number of successful conception}}$$

A lower S/C value indicates higher reproductive efficiency.

$$CR\ (\%) = \frac{\text{Number of successful conceptions}}{\text{Total number of AI services}} \times 100$$

RESULTS AND DISCUSSION

Rainfall in the Lembang KPSBU Working Area

Rainfall in the KPSBU Lembang working area in the 2017 to 2019 period was classified as medium, with a range of 74.73-151.91 mm per month (Table 1). During 2017 and 2018, the rainy season in this region lasted for six months, from January to April and from November to December, with rainfall ranging from 137.4-366 mm per month. During this period, the dry season with low rainfall, namely 0-98 mm per month, occurs from May to October. The dry season is characterized by rainfall ≤100 mm per month, while the rainy season is characterized by rainfall ≥300 mm per month (BMKG 2019). The rainfall criteria are low (0-100 mm per month), medium (101-300 mm per month), and high (301-500 mm per month) (BMKG 2019).

In 2019, low rainfall lasted for quite a long time, from March to October (approximately 0-11 mm per month), so the dry season was longer than in the previous two years. The rainy season in 2019 was characterized by moderate rainfall that occurred at the beginning of the year (January to February) and the end of the year (October to December). Rainfall in February 2019 (275 mm per month) was higher than that in January (182 mm per month) but decreased drastically in March to 7.7 mm per month. This decrease in rainfall was caused by the El Niño phenomenon, which resulted in a 20–30% reduction in rainfall (Klingaman 2015; Rezekitiani 2018). In addition, in the last ten years, there have been changes in rainfall patterns in several regions of Indonesia, including the Lembang District, which experienced differences in rainfall patterns from 2017 to 2019 in the KPSBU Lembang working area.

Over the last three years, the long dry season has resulted in a decrease in water availability in the Lembang KPSBU area. As a result, the supply of drinking water for cows becomes limited and the conditions in the pens become dirtier. Very low rainfall can also impact the health of cattle, especially because of the reduced availability of clean water and forage, as well as the possibility of heat stress due to high environmental temperatures (Yani and Purwanto 2006). In contrast, in the rainy season, even though green food is abundant, the cage becomes more humid and dirty. Buatama (2013) revealed that very high and prolonged rainfall can increase the risk of various diseases appearing in dairy cattle, especially diseases caused by bacteria, fungi and viruses, as well as diseases related to the availability of nutrients in feed. It is possible that this condition could affect the production and reproductive performance of dairy cattle.

Service per Conception

Service per conception (S/C) is a number that shows the average number of matings (AI services) required to achieve pregnancy. The results of research regarding the S/C value in KPSBU Lembang for 2017 to 2019 can be seen in Table 2. The average S/C value in the KPSBU Lembang area during this period was between 1.82 to 1.92 times. The S/C value is considered ideal if it ranges from 1.6 to 2.0 (Hafez 2000), so the S/C value in the KPSBU Lembang area is classified as ideal.

The Service per conception (S/C) value in the KPSBU Lembang working area showed significant variations and was influenced by various specific factors in each region. Over the last three years, the range of S/C values was as

Tabel 1. Rainfall (mm month^{-1}) in Lembang, West Java 2017-2019

Year/ Month	1	2	3	4	5	6	7	8	9	10	11	12	Rainfall (mm month^{-1})
2017	89*	204.3	337.5	144.1	137.4	80.8*	50.9*	2*	70.1*	242.9*	366	98*	151.9±109.1
2018	248	155	267	149	76*	46*	0*	17*	14*	66*	342	361	145±124.6
2019	182	275	7.7*	11*	8.3*	0.8*	0*	0*	1.89*	0*	121	289	74.7±108
x̄	173	211.3	204.1	101.3	73.7*	71.4*	16.9*	16.9*	28.6*	103	276.3	249.3	

Rainfall data sources were obtained from the Dramaga Bogor Climatology Station and Bandung Geophysics Station, West Java (BMKG 2019). * indicates low rainfall.

Table 2. S/C values in the Lembang KPSBU area from 2017 to 2019.

Year/ Month	1	2	3	4	5	6	7	8	9	10	11	12	Rainfall (mm month^{-1})
2017	1.71	1.78	1.85	1.79	1.84	1.79	1.79	1.76	1.84	1.80	1.89	2.09	1.82± 0.09
2018	1.93	2.03	1.90	2.00	1.96	1.91	1.92	1.93	1.86	1.81	1.95	1.92	1.92±0.05
2019	1.92	1.95	1.99	1.82	1.76	1.76	1.84	1.88	1.90	1.91	1.77	1.75	1.85± 0.07
S/C Month^{-1}	1.85	1.92	1.91	1.87	1.85	1.82	1.85	1.86	1.87	1.84	1.87	1.92	

Sumber data nilai S/C dari Kantor IB dan Keswan KPSBU Lembang.

Table 3. Value (S/C) in the KPSBU Lembang area 2017-2019

Year	Location	Month												x̄
		1	2	3	4	5	6	7	8	9	10	11	12	S/C month^{-1}
2017	Central	1.64	1.69	1.66	1.61	1.74	1.68	1.60	1.65	1.69	1.67	1.65	1.74	1.66±0.04
	East	1.79	2.03	2.19	1.98	1.95	1.92	1.92	1.87	2.02	2.06	2.11	2.30	2.01±0.13
	West	1.74	1.82	1.73	1.81	1.85	1.81	1.93	1.78	1.87	1.77	2.00	2.30	1.86±0.15
2018	Central	1.88	1.79	1.66	1.79	1.91	1.70	1.68	1.61	1.69	1.71	1.62	1.78	1.73±0.09
	East	1.95	2.36	2.40	2.22	2.18	2.26	2.18	2.32	2.15	1.98	2.26	2.05	2.19±0.13
	West	1.95	2.03	1.73	2.03	1.82	1.85	1.94	1.97	1.78	1.77	1.86	1.96	1.89±0.09
2019	Central	1.79	1.81	1.81	1.79	1.67	1.64	1.68	1.69	1.70	1.81	1.63	1.63	1.72±0.07
	East	2.17	2.15	2.70	1.89	1.94	1.85	2.08	2.01	2.04	2.17	1.82	1.91	2.06±0.22
	West	1.84	1.93	1.94	1.80	1.71	1.80	1.80	1.98	2.00	1.78	1.88	1.74	1.85±0.09

follows: central region 1.66-1.73, eastern region 2.01-2.19, and western region 1.85-1.86. Based on the results of the T test with a 95% confidence interval, the T value (1.57) was greater than the P value (0.216), which indicates that rainfall does not have a significant influence on the S/C value. S/C values in the eastern region tend to be high, and Muray (2009) states that S/C values exceeding 2.0 indicate problems with the reproductive system. The factors causing high S/C values include breeders' delays in detecting signs of heat or reporting to the inseminator, insufficient inseminator skills, limited insemination facilities, and transportation problems (Hadi and Ilham 2002). According to Fitrianti (2003), the fertility of female animals is influenced by reproductive health and rearing management, with reproductive disorders such as endometritis and retentiono secundinae often reducing the fertility of dairy cattle (Dascanio *et al.* 2000; Ratnawati *et al.* 2007).

Environmental factors and maintenance management influence IB success. Important factors that influence S/C include inseminators, ovulation time, frozen semen quality, season, estrus detection, and environmental factors (Fekadu *et al.* 2014). Accurate detection of estrus by breeders is crucial for the success of AI. Farmers are responsible for the fertility of their livestock with the help of a veterinarian who monitors the health of the cows, and implementing AI is the responsibility of the inseminator (Kurniadi, 2002). The eastern region of KPSBU consists of six areas with less than optimal environmental conditions, including the availability of forage and water. This region is also a livestock development area; therefore, human resources in the area influence the implementation of the AI program.

In 2018, the S/C value in the eastern region was 2.19, while in the central region it was 1.73 and in the western region 1.89 (Table 3). During the dry season, the availability of forage in the eastern region decreases; therefore, farmers have to use straw as an additional feed. Nuswantara *et al.* (2006) shows that the use of rice straw as the main feed does not meet the protein and energy needs of livestock. The quality of feed in the Lembang KPSBU area is generally better during the rainy season than during the dry season (Hartono 2014).

The availability of water during the dry season in the eastern region is very limited so that the cages become dirty and drinking water is provided in limited quantities. Tillman *et al.* (1989) stated that the drinking water consumption of adult dairy cattle in a comfortable environment ranges from 3.0-3.5 L kg^{-1} and will increase under heat stress conditions. The activity of bathing cattle is carried out only once a day or not at all, so that the cleanliness of the pen and livestock is not maintained.

The highest average S/C value at KPSBU occurred in the 2018 rainy season, namely 2.02 with rainfall of 253.67 mm month^{-1} (Table 4). The 2018 rainy season is longer than 2017 and 2019. The rainy season lasts for 6 months, from January to April and November to December. The highest S/C value was in the 2018 rainy season, namely 2.02 times, while the lowest S/C was in the 2017 rainy season, namely 1.83 times. This shows that the S/C value is not only influenced by rainfall, but is also influenced by other environmental factors that influence reproductive performance. The S/C value is influenced by female fertility, frozen semen quality, accuracy of estrus detection, inseminator skills, feed quality, and recording (Setiawan *et al.* 2019).

Conception Rate

Conception rate (CR) is the percentage of cattle that became pregnant as a result of the first AI in all cattle that were first inseminated. The research results showed that the average CR value for dairy cows in the Lembang KPSBU area from 2017 to 2019 was 53.72%-56.11% (Table 5). The CR value in the Lembang KPSBU area has not yet reached an ideal value. Dirgahayu *et al.* (2015) stated that the CR value is influenced by several factors, including re-coursing after giving birth and re-marriage after giving birth. The lowest CR value in 2017-2019 was in December 2017

Table 4. Average rainfall (mm month^{-1}) and S/C values in the rainy season and dry season 2017-2019

	Dry Season		Rain Season	
	Average rainfall (mm month^{-1})	S/C	Average rainfall (mm month^{-1})	S/C
2017	65.13	1.84	238.70	1.83
2018	36.50	1.89	253.67	2.02*
2019	3.72	1.86	216.75	1.84

*S/C value above 2.0

Table 5. CR value (%) in KPSBU Lembang 2017-2019

Year/ Month	1	2	3	4	5	6	7	8	9	10	11	12	Rainfall (mm month^{-1})
2017	60.08	57.29	54.72	57.60	54.50	56.36	57.79	57.76	55.21	55.80	56.56	49.69	56.11±2.45
2018	54.40	51.57	55.20	52.03	51.96	54.00	52.95	53.31	55.64	57.19	52.92	53.49	53.72±1.49
2019	51.78	51.91	51.96	56.02	57.71	57.49	56.64	54.31	52.22	51.52	58.34	58.01	54.83±2.69
CR Value month^{-1}	55.42	53.59	53.96	55.22	54.72	55.95	55.79	55.13	54.36	54.84	55.94	53.73	

The data source for CR values in the KPSBU Lembang area was obtained from the IB and Keswan KPSBU Lembang offices.

Table 6. CR percentage value in the KPSBU Lembang working area

Year	Location	Month												Average of CR (%)
		1	2	3	4	5	6	7	8	9	10	11	12	
2017	Central	63.58	60.42	61.27	63.22	54.55	59.99	62.32	56.23	60.22	59.19	60.03	58.48	59.96±2.54
	East	57.02	54.26	44.46	51.00	51.11	53.03	54.69	53.58	49.89	49.26	54.45	40.06	40.0 ±2.54
	West	59.15	56.82	56.96	57.63	57.57	55.57	56.16	60.97	54.82	57.74	55.12	49.24	56.46±2.73
2018	Central	58.06	59.86	62.32	56.92	60.93	59.80	59.43	63.59	59.55	60.20	56.96	57.39	59.59±1.98
	East	51.81	40.68	41.46	44.79	43.86	41.79	44.71	40.95	45.69	50.30	45.10	48.61	44.98±3.50
	West	51.89	52.49	59.28	53.17	54.35	58.08	53.45	53.60	59.68	59.72	55.26	53.73	55.39±2.83
2019	Central	56.08	54.42	53.44	54.06	58.54	59.38	62.07	58.65	59.82	52.20	62.28	61.63	57.72±3.41
	East	44.67	45.99	44.01	55.05	52.42	53.94	50.25	49.14	48.61	42.44	54.74	53.48	49.56±4.27
	West	53.35	54.16	56.63	58.47	60.96	58.50	56.68	54.39	48.15	57.73	56.33	58.23	56.13±3.17

(49.69%), whereas the highest CR value was in January 2017 (60.08%). The average CR value per month for the last three years was 53.59%-55.95%. The highest average value was recorded in June (55.95 %), while the lowest average was recorded in February (53.3 %). The CR value at KPSBU Lembang is influenced by reproductive disorders such as silent heat, anestrus, and delayed ovulation. Hardjopranoto (1995) stated that reproductive disorders occur in livestock because the environment is less harmonious.

The CR value in each KPSBU Lembang area varied significantly. The highest average CR value was 59.96%, namely in the central region in 2017, whereas the lowest average CR value was 44.98%, namely in the eastern region in 2018 (Table 6). A low CR value can cause economi losses to breeders, because they require IB services more than once (Febrianthoro *et al.* 2015). The central region has a high range of CR values over the last three years compared to the western and eastern regions, namely 57.72%-59.96%. The average CR value in the Lembang KPSBU work area over the last 3 years was quite good.dari 1 kali (Febrianthoro *et al.* 2015).

The highest average CR value was found in the 2017 dry season (57.44 %), coinciding with low average rainfall (65.13 mm month^{-1}) (Table 7). The lowest CR value was found in the 2018 rainy season (53.27 %), which coincided with the highest average rainfall (253.67 mm month^{-1}). The average rainfall was the highest in the last three years. The lowest rainfall occurred in the 2019 dry season (3.72 mm month^{-1}). Low CR values were obtained when rainfall was extreme. Rainfall that is too high or too low affects the CR value. The CR value during the 2017 and 2018 rainy seasons was smaller than the CR value during the dry season. In 2019, the CR value during the rainy season was higher than that during the dry season. Environmental factors that influence reproductive efficiency include temperature, sunlight intensity, air humidity, wind speed, and rainfall, which greatly contribute to the level of heat stress in dairy cattle (De Rensis and Scaramuzzi 2003).

Correlation of Rainfall with AI Success

The success of AI can be determined using the S/C and CR data. Based on the results of the T test, it was found that the relationship between the rainy and dry seasons had no significant effect on the S/C value. The P-value obtained was <0.05, that is, 0.001, with a 95% confidence interval. The success of livestock pregnancy through the AI program is determined by several factors, including male livestock, female livestock, breeders, and AI implementers (Samsudewa and Suryawijaya 2008). Based on the analysis (Table 7), the results show that there is a correlation (α=0.005) between the S/C and CR values (0.89*), and there

Table 7. Average rainfall (mm month^{-1}) and CR percentage values in the rainy season and dry season 2017-2019

Year	Dry Season		Rain Season	
	Average rainfall (mm month^{-1})	CR (%)	Average rainfall (mm month^{-1})	CR (%)
2017	65.13	57.44	238.7	56.08
2018	36.50	54.18	253.67	53.27
2019	3.72	54.73	216.75	55.01

Table 8. Correlation value of rainfall with S/C and CR values

	S/C Value		CR Value	
	r	P	r	P
Rainfall	-0.05	0.91	-0.08	08.7
S/C	1.00	-	-0.89*	0.01
CR	-0.89*	0.01	1.00	-

*There is a significant correlation between variables at the 5% test level, (-) : A negative relationship between two variables means that as one variable increases, the other variable tends to decrease, and vice versa.

is no correlation (α=0.005) between rainfall and the S/C (r=-0.05) and CR (r=-0.08). The research results show that the rainy and dry seasons are not the main factors influencing the success of artificial insemination at KPSBU Lembang. Lamy *et al.* (2012) explained that in the rainy season the amount of forage is very large and has good nutrient content, while in the dry season the forage has poor nutrition with high fiber content and low protein. Comfortable environmental conditions and good food provide animals with better reproduction and productivity. The feed given to livestock affects their performance of the livestock itself (Toharmat 2003).

CONCLUSION

The success of artificial insemination (AI) in the Lembang KPSBU area does not seem to be significantly influenced by rainfall. Neither the rainy season nor the dry season had a notable impact on the success of AI, although the dry season showed a slightly higher influence than the rainy season. However, seasonal factors are not the main determinants of AI success in this region. Other factors, such as the health of the cattle, the quality of insemination techniques, and the timing of the procedure, are likely to have a greater impact.

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