Holding and Mobility of Pediatric Patients With Transthoracic Intracardiac Catheters

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Background Nursing care of pediatric patients after cardiac surgery consists of close hemodynamic monitoring, often through transthoracic intracardiac catheters, requiring patients to remain on bed rest and limiting holding and mobility.
Objectives The primary aim of this quality improvement project was to determine the feasibility of safely mobilizing pediatric patients with transthoracic intracardiac catheters out of bed. Once feasibility was established, the secondary aim was to increase the number of days such patients were out of bed.
Methods and Interventions New standards and procedures were implemented in July 2015 for pediatric patients with transthoracic intracardiac catheters. After initiation of the new policies, complications were tracked prospectively. Nursing documentation of activity and positioning for all patients with transthoracic intracardiac catheters was extracted from electronic health records for 2 fiscal years before and 3 fiscal years after the new policies were implemented. The Cochran-Armitage test for trend was used to determine whether patterns of out-of-bed documentation changed over time.
Results A total of 1358 patients (approximately 250 to 300 patients each fiscal year) had activity and positioning documented while transthoracic intracardiac catheters were in place. The Cochran-Armitage test for trend revealed that out-of-bed documentation significantly increased after the new policies and procedures were initiated ($P < .001$). No major complications were noted resulting from patient mobility with transthoracic intracardiac catheters.
Conclusion Pediatric patients with transthoracic intracardiac catheters can be safely held and mobilized out of bed. (*Critical Care Nurse*. 2020;40[4]:16-24)

CE 1.0 hour, CERP B

This article has been designated for CE contact hour(s). The evaluation tests your knowledge of the following objectives:
1. Describe the need for holding and mobility of pediatric patients with transthoracic intracardiac catheters (TICs).
2. Outline unit-based holding and mobility guidelines and specific dressing and securement processes required for mobilizing pediatric patients with TICs.
3. Assess the impact of these unit-based guidelines on the feasibility of safely mobilizing patients with TICs out of bed.

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Children undergoing cardiac surgery are often cared for postoperatively in a pediatric cardiac intensive care unit (PCICU) and require close hemodynamic monitoring, often by means of transducing transthoracic intracardiac catheters (TICs).[1] Transthoracic intracardiac catheters are vascular catheters that are placed in the operating room at the end of cardiac surgery directly into the right atrium, left atrium, common atrium, pulmonary artery, or Fontan connection, depending on the anatomy of the child and the hemodynamic monitoring needs after surgery. According to recent benchmarking data, TICs are used widely in pediatric patients after cardiac surgery.[2] The advantages of TICs include their sterile placement in the operating room, the ability to monitor postoperative intracardiac pressures, and sparing of blood vessels in patients with limited central access points. Transthoracic intracardiac catheters have a low reported incidence of complications (<2%), such as dislodgment, bleeding, thrombosis, occlusion, or failed removal.[3] Although TICs have been used for decades,[4,5] the literature on their use is sparse and, until recently, did not generally address nursing practice.[2,6]

Historically, the policy for all patients with indwelling TICs in the PCICU at Children's Hospital of Philadelphia was to keep them on bed rest, limiting holding and mobility in the postoperative period. In 2014, our PCICU team began to question the risk-benefit ratio of prolonged immobility versus the safety of early mobility in patients with indwelling TICs. At that time, we could not find any literature addressing the mobility of pediatric patients with TICs.

Current Knowledge and Rationale

Early mobility has been well studied in adult critically ill patients, and the benefits are evident, with improvements in muscle strength,[7,8] functional ability, and ambulation[8-11] as well as reductions in hospital and intensive care unit (ICU) length of stay,[10,12-14] delirium,[11,12] ventilator-associated pneumonia,[14] ventilator-dependent days,[11] and other complications.[15] The optimal timing of mobilization for patients with TICs has not been determined; however, a general consensus has emerged for ICU patient mobilization of 2 to 5 days after admission.[16] In 1 study in which the researchers evaluated an early mobility pathway in 235 adult postoperative patients with indwelling TICs, no patients experienced complications related to mobilization.[6] Less research on early mobility has been conducted in pediatric populations, but some studies have provided support that early mobility interventions are safe and feasible.[17-20]

With regard to infant mobility, research has demonstrated that mothers perceive stress from the inability to hold their infants in the PCICU,[21,22] and developmental care is being recognized as essential to integrate into the care of infants requiring cardiac surgery.[23-26] Skin-to-skin contact between parents and their infants has been shown to improve infant physiological stability, increase growth, and reduce nosocomial infections.[27] Although studies have demonstrated the safety of holding infants with endotracheal tubes and central catheters, we are not aware of any studies examining the safety of holding infant patients with TICs.

Skin-to-skin contact between parents and their infants has been shown to improve infant physiological stability, increase growth, and reduce infections.

Researchers have acknowledged that patient acuity, catheters, and lack of local guidelines constitute barriers to developmental care and mobility of pediatric

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patients.[18,25,28] In 1 study, pediatric ICU providers reported that dislodgment of endotracheal tubes and indwelling central venous catheters was the top perceived barrier to early mobility in children.[29] Interestingly, most providers reported that they believed early mobility would benefit pediatric patients, specifically in terms of decreased ICU length of stay, length of mechanical ventilation, incidence of delirium, and use of sedation and improved family satisfaction and sleep.[29]

Specific Aims

The primary aim of this quality improvement (QI) project was to determine the feasibility of safely mobilizing pediatric patients with TICs in the PCICU out of bed. Once feasibility was established, the secondary aim was to increase the number of days patients with TICs were out of bed.

Methods

A team of advanced practice nurses, clinical nurse specialists, unit-based leadership nurses, a cardiothoracic surgeon, a surgery physician assistant, and bedside nurses formed in the PCICU to collaborate on this initiative. Our team recognized that to assess feasibility, we first needed to establish new TIC practice standards to support early mobility and holding for pediatric patients after cardiac surgery. A new TIC dressing and securement procedure was created through an iterative process of trialing various dressings and securement devices and eliciting feedback from the interdisciplinary team. According to the final version of the procedure (Figure 1), the TIC insertion site is covered with a SorbaView dressing (Centurion Medical Products). A DuoDERM hydrocolloid dressing (ConvaTec) is placed on the skin proximal to the SorbaView dressing. The TICs are coiled once and positioned on top of the DuoDERM dressing. A Tegaderm transparent dressing (3M Medical) is then placed on top of the coiled TICs, with every effort made to minimize the amount of Tegaderm contacting the skin to reduce skin irritation. Finally, a Grip-Lok securement (TIDI Products) is placed distal to the DuoDERM/Tegaderm securement for additional safety.

First, we needed to establish new TIC practice standards to support early mobility and holding.

Our team updated the PCICU's holding and mobility guidelines to include the mobility of patients with TICs

Figure 1 Dressing and securement of transthoracic intracardiac catheter.

(Table 1). We also provided step-by-step instructions on how to prepare and monitor patients with TICs during mobilization (Table 2). These new standards were trialed in the unit on several patients, with strict oversight by the clinical nurse specialist and the interdisciplinary team. Patients were included in the trial only after approval by the surgical and medical teams in the PCICU, and an activity order was entered to allow the patient to be mobilized out of bed. After 6 patients had been included in the trial and no TICs were dislodged, the policies were approved by the PCICU physician, surgeon, and nursing leadership teams, as well as the hospital nursing department, which published the documents in the hospital nursing policy manual, and the staff received unit-wide education. This project followed SQUIRE (Standards for Quality Improvement Reporting Excellence) 2.0 guidelines for QI projects.

The formal implementation of the new policy began in July 2015, the start of the 2016 fiscal year. Safety was evaluated prospectively by tracking all complications that were reported to be associated with TICs in the PCICU. Staff members reported complications, which were followed up by the nursing leadership team to

Table 1 Holding and mobility guidelines in the PCICU

The purpose of these guidelines is to encourage the multidisciplinary team to support holistic care for patients. If the patient is unstable, if the risk of movement outweighs the benefit, or if there is a question about whether or not the patient can be held or mobilized, discuss with the PCICU attending physician and the multidisciplinary team.

All catheters, tubes, wires, and drains should be secured to the patient using appropriate securement devices and pinned to the patient's gown or diaper to prevent dislodgment.

Special considerations for infants: Remember to dress infants in a hat, gown, and 2 blankets when removing them from a radiant warmer bed for holding (unless performing skin-to-skin care). Also may use warm blankets. Take temperature after 15 minutes and then hourly if stable.

Safe to hold or mobilize out of bed	Requires discussion with PCICU attending physician	Must remain in bed
Chest tube	Transthoracic intracardiac catheters	Open chest
Pleural catheter	Peripheral arterial catheter	New tracheostomy tube before first tracheostomy tube change (unless ENT attending approves mobilization or holding)
Tracheostomy	Pacing wires in active use	Critical airway for intubated patient with ordered bed rest
Umbilical arterial and venous catheter	Endotracheal tube (respiratory therapist must be present at bedside for transfer into and out of holding)	Tandem Heart ventricular assist device
Peripherally inserted central catheter	Ventricular assist devices (except Tandem)	
Central catheter (eg, femoral, IJ, EJ)	ECMO	
Enteral feeding tube (eg, NG, ND, NJ, GT)	All require a written order for activity out of bed.	
Pacing wires not in use		
Continuous EEG		

Abbreviations: ECMO, extracorporeal membrane oxygenation; EEG, electroencephalography; EJ, external jugular catheter; ENT, ear nose and throat; GT, gastrostomy tube; IJ, internal jugular catheter; ND, nasoduodenal tube; NG, nasogastric tube; NJ, nasojejunal tube; PCICU, pediatric cardiac intensive care unit.

Table 2 Preparing to move the patient with a TIC

Perform the following before patient mobility:

1. Evaluate patient's condition and readiness to tolerate mobility. This should be discussed during morning/evening rounds.
2. Confirm with the cardiothoracic surgical team that the patient may advance his or her mobility/activity level.
3. Verify that a physical therapy or occupational therapy consultation is ordered for all patients who are advancing their mobility/activity level.
4. Ensure that the bedside nurse is able to stay with the patient for the entire time the patient is out of bed.
5. Confirm TIC placement with PCICU provider through patient assessment and, if available, latest chest radiograph review.
6. Confirm that an activity order was entered in the electronic health record (mobility of patients with TICs is not permitted without an order). The order will specify the level of activity appropriate for the patient:
    1. Out of bed and held by parent or caregiver
    2. Out of bed to chair
    3. Ambulation with assistance
7. Confirm that TICs are dressed and secured per guidelines.
8. Confirm that the surgical suture is secured. If there is a concern about the position of the TIC, notify the provider immediately.
9. Assess transduced waveform if applicable (not all TICs are transduced).
10. Use 2 or more health care professionals to assist with the out-of-bed transfer. This will allow for continuous monitoring of the TICs while the patient is moving.

Perform the following after patient mobility is complete (eg, bed to chair, chair to bed, or ambulation):

1. Confirm that the surgical suture and dressing are still intact/secure.
2. Assess the TIC loop to ensure it is still in place between the Tegaderm and DuoDERM, and that the TIC securement device maintained a stable position.
3. Inspect TICs for secure connections and integrity. If there is new leakage or a break in the catheter, notify the provider immediately.
4. Inspect infusions and pumps for functionality.
5. If there is a concern about the position of the TIC, notify the provider immediately.

Abbreviations: PCICU, pediatric cardiac intensive care unit; TIC, transthoracic intracardiac catheter.

determine whether they occurred as a result of patient mobility and to identify any risk factors or causes of TIC complications. In August 2018, nursing documentation of activity and positioning data fields for all patients with TICs was extracted from the electronic health records for 2 fiscal years before the new policies were implemented and 3 fiscal years afterward.

Statistical Analysis

Descriptive statistics of patient demographic data on age and diagnosis as well as activity and positioning data were calculated for each fiscal year. Documentation data were categorized into 2 groups: bed-rest documentation and out-of-bed documentation. Bed-rest documentation included positions such as side lying, prone, and head of bed elevated and activity documentation such as bed rest. Out-of-bed documentation included positions such as held, sitting in a chair, and standing and activity documentation such as ambulates, chair, dangle, and stand. The Cochran-Armitage test for trend was used to determine whether patterns of out-of-bed documentation changed over time. In addition, the percentage of days on which patients were documented out of bed while they had indwelling TICs was calculated. The Kruskal-Wallis test was used to determine whether patients experienced significantly more days out of bed after the new policies were implemented.

This QI initiative demonstrated that pediatric patients with TICs after cardiac surgery can be safely held and mobilized.

Results

A total of 2740 pediatric patients younger than 18 years underwent cardiac surgery requiring cardiopulmonary bypass over the 5 fiscal years: 541 in 2014, 512 in 2015, 532 in 2016, 586 in 2017, and 569 in 2018. Of these, a total of 1358 patients (50%) were given TICs for vascular access, or approximately 250 to 300 patients each fiscal year: 280 in 2014, 250 in 2015, 244 in 2016, 302 in 2017, and 282 in 2018. Each fiscal year, patient ages ranged from newborn to young adult: median (range) of 0.4 (0-16.9) in 2014, 0.3 (0-17.8) in 2015, 0.2 (0-17.6) in 2016, 0.3 (0-17.8) in 2017, and 0.3 (0-17.9) in 2018. Age did not differ significantly across groups according to Kruskal-Wallis tests ($P = .07$). Patients had a wide range of diagnoses each year (Table 3). No significant differences were found in diagnoses across years according to χ^2 test analysis ($P = .75$). Over the 5 fiscal years, there were 1024 bed-rest positions and activities documented for patients with TICs and 334 out-of-bed positions and activities documented.

The Cochran-Armitage test for trend revealed that out-of-bed documentation significantly increased after the new TIC policies and procedures were initiated ($P < .001$) (Table 4). We also calculated the percentage of days on which patients were documented out of bed while they had indwelling TICs. A box plot was created to visualize the distributions each year (Figure 2). The Kruskal-Wallis test confirmed that after the new TIC policies and procedures were initiated, patients experienced significantly more days out of bed ($P < .001$; Table 5). The median number of days patients were first documented out of bed after surgery across all fiscal years was 3, with a minimum of zero and maximums ranging from 17 to 42, with no significant differences found across time points (Table 6).

A total of 3 patients were confirmed to have a complication of internal malposition of their TICs that occurred within 12 hours of mobilization: 1 patient was held and 2 patients had ambulated. Despite these 3 catheter complications, no mobilized patients required chest reexploration, blood transfusions, or any other major interventions.

Discussion

This QI initiative demonstrated that pediatric patients with indwelling TICs after cardiac surgery can be safely held and mobilized. With regard to the care of patients with TICs, clinicians have emphasized the importance of pioneering and implementing new practices in areas where evidence-based literature is lacking.[6] To the best of our knowledge, this is the first article to describe methods and outcomes for mobilization of pediatric patients with TICs out of bed. The new standards and procedures for TIC dressing, securement, and mobility helped staff members provide safe care to patients with TICs during mobilization out of bed. Significant improvements were noted in out-of-bed documentation over time. After implementation of the new policies and procedures, patients with TICs were documented out of bed 269 times during fiscal years 2016 through 2018.

Three adverse events of TIC internal malposition occurred within 12 hours of mobilization. After close examination of these incidents, we found that in all 3 cases, securement had not been performed according

Table 3 Diagnosis by fiscal year

Diagnosis	Fiscal year, No. (%) of patients					
	2014	2015	2016	2017	2018	Total
Aortic arch hypoplasia	4 (1.43)	5 (2.00)	7 (2.87)	8 (2.65)	11 (3.91)	35
Aortic atresia/aortic stenosis/insufficiency	4 (1.43)	7 (2.80)	1 (0.41)	4 (1.32)	5 (1.78)	21
Atrial septal defect	1 (0.36)	1 (0.40)	2 (0.82)	0	0	4
Atrioventricular canal	22 (7.86)	21 (8.40)	19 (7.79)	25 (8.28)	27 (9.61)	114
Cardiomyopathy	7 (2.50)	3 (1.20)	6 (2.46)	6 (1.99)	3 (1.07)	25
Coarctation of the aorta	10 (3.57)	12 (4.80)	7 (2.87)	8 (2.65)	6 (2.14)	43
Double outlet right ventricle	8 (2.86)	12 (4.80)	15 (6.15)	16 (5.30)	15 (5.34)	66
Hypoplastic left heart syndrome	58 (20.71)	51 (20.40)	37 (15.16)	48 (15.89)	57 (20.28)	251
Interrupted aortic arch	10 (3.57)	6 (2.40)	5 (2.05)	8 (2.65)	5 (1.78)	34
Mitral valve disease	1 (0.36)	0	3 (1.23)	1 (0.33)	1 (0.36)	6
Myocarditis	1 (0.36)	2 (0.80)	0	1 (0.33)	1 (0.36)	5
Pulmonary stenosis, hypoplasia, or atresia	13 (4.64)	10 (4.00)	9 (3.69)	17 (5.63)	10 (3.56)	59
Single ventricle, other	35 (12.50)	30 (12.00)	26 (10.66)	35 (11.59)	31 (11.03)	157
Tetralogy of Fallot	30 (10.71)	29 (11.60)	33 (13.52)	37 (12.25)	35 (12.46)	164
Total anomalous pulmonary venous connection	4 (1.43)	5 (2.00)	9 (3.69)	13 (4.30)	6 (2.14)	37
Transposition of the great arteries	27 (9.64)	31 (12.40)	24 (9.84)	25 (8.28)	27 (9.61)	134
Tricuspid valve disease	5 (1.79)	3 (1.20)	2 (0.82)	3 (0.99)	4 (1.42)	17
Truncus arteriosus	13 (4.64)	2 (0.80)	8 (3.28)	11 (3.64)	7 (2.49)	41
Ventricular septal defect(s)	14 (5.00)	6 (2.40)	13 (5.33)	21 (6.95)	17 (6.05)	71
Other	13 (4.64)	14 (5.60)	18 (7.38)	15 (4.97)	13 (4.63)	73
Total	280	250	244	302	281	1357[a]

[a] One patient is missing from the total.

Table 4 Out-of-bed documentation by fiscal year[a]

Documentation	Fiscal year, No. (%) of patients					
	2014	2015	2016	2017	2018	Total
Bedrest	257 (91.79)	208 (83.20)	164 (67.21)	208 (68.87)	187 (66.31)	1024
Out of bed	23 (8.21)	42 (16.80)	80 (32.79)	94 (31.13)	95 (33.69)	334
Total	280	250	244	302	282	1358

[a] Cochran-Armitage test for trend $P<.001$.

to the new guidelines: 1 patient did not have a Grip-Lok in place and the other 2 did not have the DuoDERM/Tegaderm coil distal to the dressing. All 3 patients had negative blood return from the TIC, with internal malposition confirmed on saline contrast echocardiography. No catheters were dislodged at the skin or cracked. The interdisciplinary team could not identify any cause of the internal malposition complications. Although the recommended securement guidelines were not followed, it is unlikely that the malpositions were related to mobility, because there was no evidence of external dislodgment, pulling, or other damage to the TICs. Internal

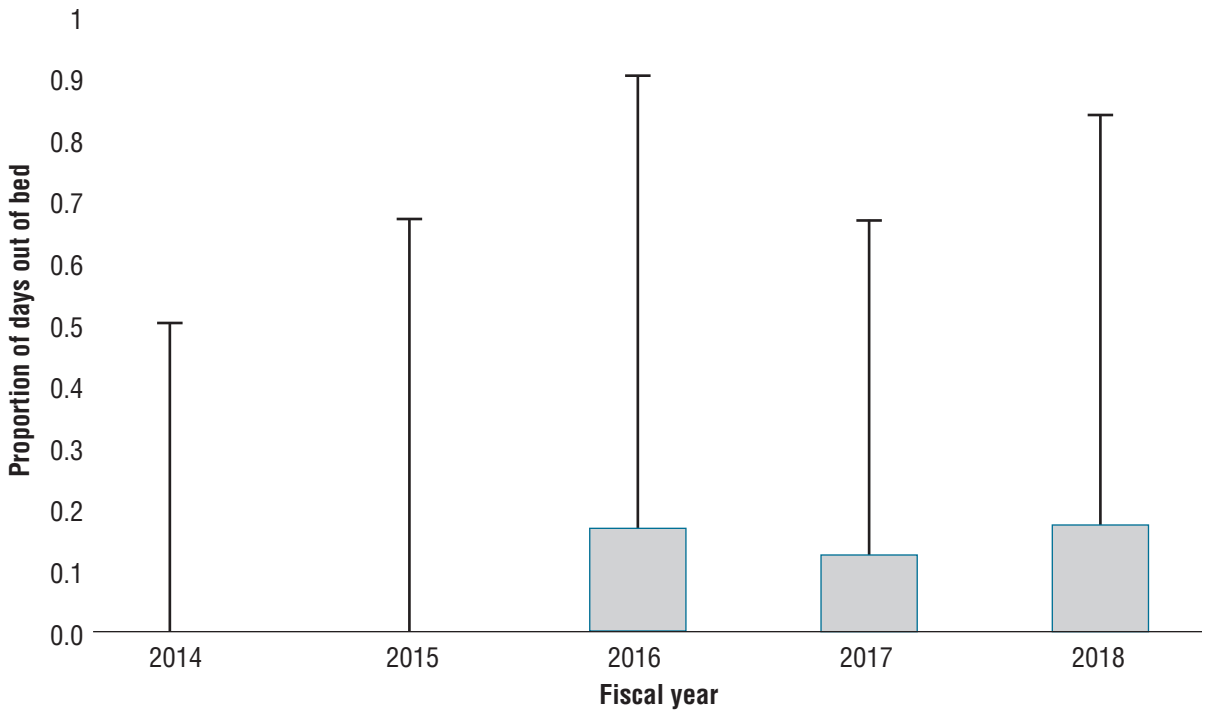

Figure 2 Out-of-bed documentation for fiscal years 2014 through 2018. The lower end of the boxes is the median, first quartile, and lowest value. The upper end of the boxes is the third quartile. The whiskers indicate the highest value.

Table 5 Number of days patients with transthoracic intracardiac catheters documented out of bed

Fiscal year	Total	Median	Quartile 1	Quartile 3	Minimum	Maximum
2014	23	1	1	1	1	3
2015	42	1	1	2	1	3
2016	80	2	1	3	1	14
2017	94	2	1	3	1	14
2018	95	2	1	3	1	6

Table 6 Number of days after surgery patients were first documented out of bed[a]

Fiscal year	Median	Quartile 1	Quartile 3	Minimum	Maximum
2014	3	1	4	0	18
2015	3	1	5	0	17
2016	3	2	5	0	42
2017	3	1	6	0	35
2018	3	1	5	0	18

[a] Kruskal-Wallis test $P = .54$.

malposition is a known complication of TICs, occurring independently of external securement, even in patients on bed rest.[30] Although we followed up on all reported complications to determine if they occurred within 12 hours of mobility, we did not track complication rates or adverse events associated with TICs before implementation of the new policies and procedures; therefore, we were unable to determine whether overall rates of complications changed over time.

Standardizing care with procedures and guidelines increased both the percentage of patient days and the number of days on which pediatric patients with TICs were documented out of bed after surgery. Although these increases were statistically significant, there was still a wide range of outcomes for individual patients, as indicated in Figure 2. Most patients with TICs were documented out of bed on less than 20% of their postoperative days, although for some patients this percentage was as high as 90%. Thus, the new TIC procedures and guidelines did not yield similar outcomes for all patients. These procedures and guidelines can be incorporated into early mobility protocols or clinical pathways in PCICUs to further enhance the mobilization of patients with TICs.[16]

Limitations

The results of this QI project should be interpreted with caution. This project was conducted in a single PCICU, limiting generalizability to other units. Adverse event data were based on self-report only. Although we are not aware of any dislodgments related to the mobility of patients with TICs out of bed and it is unlikely that a dislodgment occurred and was not reported, limitations of self-report must be acknowledged.

Conclusion

Pediatric patients with TICs can be safely mobilized out of bed when established dressing, securement, and mobilization guidelines are incorporated into the standard of care in PCICUs. More research is needed to determine whether these guidelines can be adopted by other PCICUs and integrated into early mobility protocols for pediatric patients after cardiac surgery. Outcomes of early mobility in patients with indwelling TICs should be investigated, including the overall patient-family experience. CCN

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See also

To learn more about pediatric care in the critical care setting, read "Continuous Versus Bolus Gastric Feeding in Children Receiving Mechanical Ventilation: A Systematic Review" by Brown et al in the *American Journal of Critical Care,* 2020;29(1):33-45. Available at **www.ajcconline.org.**

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