Central venous catheter practice in an adult intensive care setting in the eastern province of Saudi Arabia

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ABSTRACT

الأهداف: دراسة مستوى ممارسة استخدام القسطرة الوريدية المركزية (CVC) في وحدة العناية المركزة (ICU)، والتعرف على نقاط التطوير الكامنة.

الطريقة: إجراء دراسة استطلاعية وصفية في وحدة العناية المركزة، مستشفى الملك عبد العزيز الذي يحتوي على 300 سرير، الأحساء، المملكة العربية السعودية. تم دراسة كل المرضى المنومين خلال 18 شهر من أبريل 2007م إلى سبتمبر 2008م. دونت التفاصيل الخاصة بالقسطرة المركزية الوريدية (CVCs) وتشمل، دواعي الاستعمال، والمضاعفات، والتفاصيل الجغرافية الخاصة بالمرضى.

النتائج: أجريت 474 عملية قسطرة وريدية مركزية(CVC) ل 379 مريض، ويعادل 3024 يوم قسطرة بمعدل استخدام 6.35 ± 4.7 يوم (95% CI: 5.92-6.78). كان الموضع الأكثر استخداماً لإدخال القسطرة الوريدية كالتالي، من الوريد الوداجي الداخلي 230 (48.5%)، قسطرة من تحت الترقوة 192 (40.5%)، ومن الفخذ 52 (11%). كان معدل استخدام القسطرة الوريدية المركزية 0.64 ومعدل الخمج الموضعي المصاحب لاستخدام القسطرة 4.6 لكل 1000 يوم، كان أكثرها في موضع الفخذ، ومعدل الخمج الدموي المصاحب لاستخدام القسطرة 1.98 لكل 1000 يوم قسطرة أكثرها في الموضع الوداجي. هناك مضاعفات أخرى ميكانيكية قليلة سجلت في الدراسة وهي الاسترواح الصدري في مريضين، وقسطرة الشريان في 5 مرضى و انزياح للقسطرة من الوريد أدى إلى فشل في التنفس في مريض واحد.

خاتمة: تشير نتائج الدراسة إلى أن معايير الممارسة الحالة للقسطرة المركزية الوريدية سوف تمكننا من الحفاظ على معدل المضاعفات المنخفضة التي يمكن مقارنتها مع المعايير العالمية.

Objectives: To study the standard central venous catheter (CVC) practice in an adult intensive care unit (ICU) for potential improvement.

Methods: This is a prospective descriptive study conducted in an adult ICU of the 300-bedded King Abdul-Aziz Hospital, Al-Ahsa, Saudi Arabia. All consecutive patients admitted over 18 months (April 2007 to September 2008) were included. Details of CVCs, indications, complications, and patients' demographic information were recorded daily until CVCs were removed.

Results: Overall, 379 patients had 474 CVCs, which accounted for 3024 catheter-days, with a mean duration of 6.35 ± 4.7 days (95% confidence intervals: 5.92-6.78). The most common site of insertion was the internal jugular vein (230 [48.5%]); 192 (40.5%) subclavian catheters, and 52 (11%) femoral. The CVC utilization ratio was 0.64. The catheter related local infection (CRLI) rate was 4.6 per 1000 catheter-day (the highest in the femoral site) and the catheter-related bloodstream infection (CRBSI) rate was 1.98 per 1000 catheter-day (the highest for the jugular route). There were only a few mechanical complications including 2 pneumothoraces, 5 arterial cannulations, and a single significant catheter dislodgement causing respiratory failure.

Conclusion: Our results suggest that the current CVC practice enabled us to keep the rate of complications low, which is comparable to international standards.

Saudi Med J 2010; Vol. 31 (7): 803-807

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Received 31st March 2010. Accepted 14th June 2010.

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Every year, more than 5 million central venous catheters (CVCs) are inserted,[1] which accounts for 15 million catheter days per year in the United States intensive care units (ICUs).[2] The CVCs are commonly used for intravenous fluids, vasopressors, blood products, parenteral nutrition, and monitoring of hemodynamic variables, and up to 78% of patients in ICUs receive CVC.[3] Approximately 15% of patients with CVC develop catheter related complications.[1] The major complications associated with CVC insertion are bloodstream infections, hemorrhage, and pneumothorax.[4-7] The United States National Healthcare Safety Network (NHSN) reported catheter related blood stream infections (CRBSI) rates of 1.5-6.5 per 1000 catheter-days for 2006 in the ICUs.[8] Infection rates of 5.4 and 2.8 per 1000 catheter days were found in teaching and non-teaching hospitals of the United Kingdom.[9] Various methods have been described to decrease CVC related complications.[1,10] One study described the rate of CRBSI in the Kingdom of Saudi Arabia (KSA) as part of a multicenter international prospective study comparing US and non-US central venous catheter infection rates,[11] however, this study did not look at the other complication rates in KSA. The King Abdulaziz Hospital (KAH) ICU is a 10-bedded combined medical and surgical unit. It serves the National Guard along with their families and local population. It has a quality assurance (QA) program since January 2005.[12] Our QA program has an outcome and process measures. Outcome measures reflect patient's subsequent health status and included ICU mortality rate, ICU length of stay (LOS) >7 days, average ICU LOS, average days on mechanical ventilation, rate of unplanned re-admission, CRBSI and rate of resistant infections. Process measures are a result of physician/health care professional's interaction with patients and included appropriate sedation, prevention of ventilator associated pneumonia (VAP), peptic ulcer disease (PUD) prophylaxis, deep vein thrombosis (DVT) prophylaxis, and appropriate use of blood transfusions. To reduce CRBSI, a CVC bundle based on the Center of Disease Control (CDC) recommendations was put in place to ensure that a procedure is performed using the latest evidence based techniques. This bundle includes hand washing, using full barrier precautions (cap, mask, full sterile gown, sterile gloves and large sterile patient drape), using chlorhexidine for skin cleaning, avoidance of femoral site if possible and removing the unnecessary catheters.[13] The objective of this study was to study the current standard CVC practice in the ICU to identify the aspects of CVC care for potential improvement.

Methods. This is an 18-month prospective descriptive study from April 2007 to September 2008. Informed consent was waived because the central line insertion was in the general ICU/operating room (OR) admission consent form. The study was approved by the Regional Research Committee, National Guard Health Affairs, Eastern Region, KSA. Catheters were inserted by the intensive care physicians in the ICU and wards and by the anesthetists in the operating theater, and assisted by the dedicated nursing staff. The optimal site of catheter insertion was chosen according to the clinical situation and anatomy. All operators were well experienced in inserting catheters in subclavian (SC), internal jugular (IJ), and femoral sites. Femoral sites were avoided if possible. The skin was prepared by Povidone-Iodine as Chlorhexidine was non-formulary in KAH at that time. All barrier precautions were strictly followed and the non-impregnated triple lumen CVC (Arrow International, Reading, Pennsylvania, USA) were inserted by the Seldinger technique and sutured by silk 3.0. Iodine ointment was not placed at the insertion site and a transparent dressing was used to maximally visualize the insertion site. After CVC insertion, data collection forms were completed by the operating physician indicating their name; and patient's age, gender, diagnosis, indication, site of insertion, date of insertion, and immediate complications such as pneumothorax, hemothorax, or arterial cannulation. Chest x-ray was routinely performed to confirm the position of catheter and ruled out any mechanical complications. Patients clinical status was assessed according to the acuity by the ICU specialists and consultants. The CVC insertion site was assessed for infection as a routine part of the clinical assessment. On a daily basis, the need of CVC was discussed and it was removed if no justification was found and the date of removal was documented. Apart from the ICU staff, a personnel from the Infection Control and Prevention Department independently observed the compliance of the CVC bundles. If the CVC was inserted in another facility before transferring to our ICU, it was replaced by a new catheter as per our ICU policy. On suspicion of CVC infection, the catheter was removed, and detailed sepsis screening was performed including analysis of CVC tip for semi-quantitative culture, urine analysis and culture, blood cultures, and chest x-ray. To locate the focus of infection, other investigations were carried out at the discretion of the attending physicians. Catheter related local infections (CRLI) and CRBSI were defined according to the criteria established by the CDC.[14]

Statistical analysis. The data were entered into the Statistical Package for Social Sciences (SPSS Inc. Chicago, IL, USA) Version 14.0 and analyzed using descriptive statistics. Continuous variables were reported as means and standard deviation, and categorical variables as

percentages. Statistical analysis was performed using Chi-Square for the categorical, and Student t-test for the continuous variables. Catheter utilization ratio was calculated by number of CVC-days divided by number of patient-days, while CRLI/CRBSI rates were calculated by dividing the catheter related local/ catheter related bloodstream number of infections by the total number of catheter-days and multiplying it by 1000 to calculate the number of infection per 1000 catheter-days.[15] Catheter related local infections and CRBSI numbers were insufficient to perform any statistical analysis to reach the level of significance.

Results. There were 812 (438 males and 374 females) patients admitted during the study period. Three hundred and seventy-nine (217 males and 162 females) patients had CVC insertion. The various indications were hemodynamic monitoring including vasopressor and inotropic support 297 (62.6%), hemodialysis 47 (9.9%), total parenteral nutrition 31 (6.5%), poor peripheral venous access 38 (8%), and 61 (13%) were inserted in the OR. There were 547 (67.3%) medical, 85 (10.5%) cardiac, and 180 (22.2%) surgical patients in the study. **Table 1** summarizes the patient characteristics stratified by catheter placement. Patients with CVC had statistically significant higher Acute Physiology And Chronic Health Evaluation (APACHE II) score, length of stay, and mortality compared to the patients without CVC. These 379 patients had 474 catheter insertions, 3024 CVC days, and 4731 patient-days in the ICU, accounting for CVC utilization ratio of 0.64. **Table 2** summarizes the most common site of insertion. Three hundred and twenty-one patients had single CVC insertion, while 58 (15.3%) patients had more than one CVC insertions. Three hundred eighty-four (81%) of the CVCs were inserted in the ICU, 61 (13%) in the OR, 12 (2.5%) in the ward before transferring the patients to ICU as an immediate resuscitation measure, while 17 (3.5%) were inserted in other facilities before transfer to our hospital. Four hundred and seventy-four CVCs were in situ for a total of 3024 catheter-days, with a mean duration of 6.35 ± 4.7 days ([95% CI: 5.92-6.78] [median - -5 days; range: 1-27]). In total, 408 (86%) CVCs were removed due to no further clinical indication for use, 43 (9%) were removed due to blockage and 23 (4.8%) due to clinical suspicion

Table 1- Patient characteristics stratified by the central venous catheter (CVC) placement.

Patients characteristics	Patients without CVC (%)	Patients with CVC (%)	*P*-value
Number of patients	433 (53.3)	379 (46.7)	
Males	221 (51.0)	217 (57.2)	0.91
Females	212 (49.0)	162 (42.7)	0.56
Mean age (years) (mean ±SD)	55.6 ± 22.5	62.8 ± 19.9	0.86
Mean APACHE II (mean ±SD)	12.9 ± 6.1	18.4 ± 7.4	0.001
Medical	251 (58.0)	296 (78.1)	0.62
Surgical	97 (22.4)	83 (21.9)	0.58
Cardiac	85 (19.6)	None	-
Median length of ICU stay (days)	2.0	4.5	0.001
Mortality	6 (1.4)	56 (14.8)	0.001

APACHE II - Acute physiology and chronic health evaluation II, ICU - intensive care unit

Table 2 - Catheter related local and bloodstream infections according to the site.

Site	No. of CVCs (%)	Days of CVC	No. of CRLI	CRLI per 1000 catheter days	No. of CRBSI	CRBSI per 1000 catheter days
Jugular	230 (48.5)	1413	8	5.6	5	3.54
Subclavian	192 (40.5)	1302	2	1.5	0	0.00
Femoral	52 (11)	309	4	12.9	1	3.24
Total	**474**	**3024**	**14**	**4.6**	**6**	**1.98**

CVC - central venous catheter, CRLI - catheter related local infection, CRBSI - catheter related bloodstream infections

Table 3 - Organisms cultured from various catheter sites causing bloodstream infections.

No	Site	Organisms Cultured	Sensitivity
1	Jugular	*Candida albicans*	Fluconazole, voriconazole
2	Jugular	*Pseudomonas aeruginosa*	Carbapenems, piperacillin/tazobactam, polymyxin B
3	Jugular	*Klebsiella pneumoniae*	Ceftriaxone, cefuroxime, ciprofloxacin, gentamicin
4	Jugular	*Stenotrophonomonas (Xanthomonas) Maltophilia*	Trimethoprim/sulfamethoxazole, levofloxacin, ceftazidime, minocycline.
5	Jugular	1- *Pseudomonas aeruginosa*	Polymyxin B, colistin
		2- *Enterococcus*	Vancomycin
6	Femoral	*Candida tropicalis*	Fluconazole, voriconazole, amphotericin B

of infection. Fourteen patients developed CRLI and 6 patients developed CRBSI. Catheter related local infections and CRBSI rate during the study period was 4.6 and 1.98 per 1000 catheter-days as shown in **Table 2**, and the organism cultured from various CVC sites causing bloodstream infections are shown in **Table 3**. Two patients had a pneumothorax; one each from SC and IJ line requiring a chest tube drainage in one case, while the other was managed conservatively. There was no tension pneumothorax or hemothorax during the study period. Arterial cannulation occurred in 5 cases, 2 each in the carotid and subclavian arteries; and one in a femoral artery, and were safely removed without any further complications. There was a significant dislodgement of internal jugular catheter in one case, which led to extravasation of fluid in the neck leading to respiratory distress requiring mechanical ventilation for one day.

Discussion. The most common site of insertion was the internal jugular vein, while the CVC utilization ratio was 0.64. The CRLI rate was 4.6 per 1000 catheter days, and the CRBSI rate was 1.98 per 1000 catheter days. In our ICU, we found that 46.7% of patients underwent central venous placement. During the initial period of study, there was no separate coronary care unit in our hospital, and acute cardiac patients were admitted in the ICU. During the study period, 85 cardiac patients were admitted to the ICU and those patients have no indication for CVC placement. The rate of CVC became 52.2% after excluding those patients, which is quite low as compared with reported literature,[3] which may raise the question of whether the patients were appropriately triaged to the ICU or not. This low rate of CVC insertion is partly explained by less catheter requirement in surgical patients. Also, if we compare the catheter utilization ratio used by the National Nosocomial Infections Surveillance (NNIS) System of the CDC,[15] we stand at approximately the 90th percentile in the combined medical/surgical category, suggesting high utilization of CVC. High APACHE II scores, length of stay, mortality, and CVC utilization ratio suggests that very sick patients were admitted to our ICU. Six patients without CVC died either due to the complications following acute coronary syndromes, or they had "do not resuscitate" orders, and therefore CVC insertion was not indicated in these patients. The overall rate of CVC associated infectious complications was low in our ICU. There were 6 cases of CRBSI making it 1.98 per 1000 catheter days. According to the NNIS system of the CDC the average rate of CRBSI in all ICUs in the USA is 1.8-5.2 per 1000 catheter days and our ICU stands approximately on the 25th percentile.[15] The causative pathogens were similar to the organisms identified to cause CRBSI in the literature.[16] There were only 14 (3%) cases of catheter related local infections (CRLI), which are comparable to the published results.[17] The rate of mechanical complications in our ICU was also low. There were only 2 cases of pneumothoraces, one each from IJ (0.4%) and SC sites (0.5%), which is comparable to reported literature.[1] In 1.3% of cases, arterial cannulations occurred without any deleterious consequences. None of the patients developed hemothorax, tension pneumothorax, major vessel or right atrial perforation, the known mechanical complications associated with CVC insertion.

The results of this study have led us to suggest changes in the departmental practice. Our results suggest that the SC vein should be the preferred site of insertion to minimize the CVC-related infection risk. Although CRBSI rates are low, we are in negotiation with the pharmacy for the availability of Chlorhexidine. The infection prevention measures, including barrier precautions, are emphasized again to be applied uniformly throughout the hospital.

There were some study limitations. The study was confined to one hospital, and its findings may not be applicable to other settings. Although we carried out appropriate investigations to look for thrombosis of major vessels as a complication of CVC when indicated,

this variable was not included in our data collection. We excluded complications, such as localized hematoma at the insertion site or arterial puncture, as we only monitored major complications associated with CVC cannulation.

In conclusion, we found that our current practice enabled us to use CVC appropriately in ICU patients, and kept complication rates under control. However, it will be interesting to further study the risk factors of acquiring CVC related bloodstream infections.

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Related topics

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