Community-onset bloodstream infection during the 'after hours' is not associated with an increased risk for death

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KB Laupland, PC Kibsey, JC Galbraith. Community-onset bloodstream infection during the 'after hours' is not associated with an increased risk for death. *Can J Infect Dis Med Microbiol* 2012;23(4):170-172.

BACKGROUND/OBJECTIVE: Patients admitted to hospital during the 'after hours' (weekends and evenings) may be at increased risk for adverse outcome. The objective of the present study was to assess whether community-onset bloodstream infections presenting in the after hours are associated with death.

METHODS: All patients in the Victoria area of British Columbia, who had first admissions with community-onset bloodstream infections between 1998 and 2005 were included. The day of admission to hospital, the day and time of culture draw, and all-cause, in-hospital mortality were ascertained.

RESULTS: A total of 2108 patients were studied. Twenty-six per cent of patients were admitted on a weekend. Blood cultures were drawn on a weekend in 27% of cases and, in 43%, 33%, and 25% of cases, cultures were drawn during the day (08:00 to 17:59), the evening (18:00 to 22:59) and night (23:00 to 07:59), respectively. More than two-thirds (69%) of index cultures were drawn during the after hours (any time Saturday or Sunday and weekdays 18:00 to 07:59). The overall in-hospital case fatality rate was 13%. No difference in mortality was observed in relation to the day of the week of admission or time period of sampling. After-hours sampling was not associated with mortality in a multivariable logistic regression model examining factors associated with death.

CONCLUSION: Presentation with community-onset, bloodstream infection during the after hours does not increase the risk of death.

Key Words: Bacteremia; Bloodstream infection; Mortality; Weekend

Many studies conducted in a number of different medical, surgical and critically ill populations have indicated that patients admitted to hospitals on weekends and evenings ('after hours') may experience a higher mortality rate (1-9). Many processes of care have been proposed to explain these observations including physician fatigue, lower levels of staffing, restricted availability of tests and procedures, and differences in case-mix, with a potentially higher acuity during these times. We recently reported on a study from the Calgary (Alberta) area that did not find any significant increased risk of death associated with admission with community-onset bloodstream infection during the after hours (10). However, this study requires confirmation in other populations. The objective of the present study was to assess whether the timing of admission for patients with community-onset, bloodstream infection influenced the risk of death in Victoria, British Columbia, between 1998 and 2005.

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Une bactériémie d'origine non nosocomiale « après les heures de travail » ne s'associe pas à un risque accru de décès

HISTORIQUE et OBJECTIF : Les patients hospitalisés « après les heures de travail » (soir et fin de semaine) sont peut-être plus vulnérables aux issues indésirables. La présente étude visait à évaluer si les cas de bactériémie d'origine non nosocomiale qui se présentent après les heures de travail s'associent à des décès.

MÉTHODOLOGIE : Tous les patients de la région de Victoria, en Colombie-Britannique, qui avaient été hospitalisés pour la première fois en raison d'une bactériémie d'origine non nosocomiale entre 1998 et 2005 ont participé à l'étude. Les chercheurs ont déterminé le jour de l'hospitalisation, le jour et l'heure du prélèvement de culture et la mortalité toutes causes confondues en milieu hospitalier.

RÉSULTATS : Au total, 2 108 patients étaient à l'étude. Vingt-six pour cent ont été hospitalisés pendant la fin de semaine. Des cultures sanguines ont été prélevées la fin de semaine dans 27 % des cas, et dans 43 %, 33 % et 25 % des cas, elles l'ont été pendant la journée (entre 8 h et 17 h 59), le soir (18 h à 22 h 59) et la nuit (23 h à 7 h 59), respectivement. Plus des deux tiers (69 %) des cultures de référence avaient été prélevées après les heures de travail (en tout temps le samedi ou le dimanche et la semaine entre 18 h et 7 h 59). Le taux cas-décès global en milieu hospitalier s'élevait à 13 %. Les chercheurs n'ont observé aucune différence de mortalité selon le jour d'hospitalisation ou la période de l'échantillonnage. D'après le modèle de régression logistique multivariable portant sur les facteurs liés aux décès, les cas après les heures de travail ne s'associaient pas à des décès.

CONCLUSION : Le fait de se présenter avec une bactériémie d'origine non nosocomiale après les heures de travail n'accroît pas le risque de décès.

METHODS

Patient population

The Vancouver Island Health Authority (VIHA) is one of five health regions within the province of British Columbia. It administers virtually all publicly funded health care to the more than 750,000 residents of Vancouver Island and an adjacent area of the mainland. The south local health area (SLHA) of VIHA (2005 population 357,768) includes the Greater Victoria area and the surrounding communities of Saanich, Sooke and the Gulf Islands. The SLHA has three main acute care institutions, The Royal Jubilee Hospital (Victoria, British Columbia), The Victoria General Hospital (Victoria) and the Saanich Peninsula Hospital (Sannichton, British Columbia). These institutions provide nearly all of the acute inpatient care for residents of the SLHA, with only patients requiring acute bone marrow or organ transplantation and a few other highly specialized services routinely referred

Figure 1) Admission day to Victoria (British Columbia) area hospitals and outcome from community-onset bloodstream infection

to Vancouver (British Columbia). All patients with first admissions to one of the study hospitals with community-onset bloodstream infections during the eight-year period between January 1, 1998 and December 31, 2005 were included. Patients were defined as being SLHA residents based on postal code. The present study was approved by the ethics review board at the VIHA.

Study protocol

All patients with community-onset bloodstream infections who were admitted to hospital were identified using the regional hospital microbiology laboratory databases (11). Basic demographic, hospital length of stay and in-hospital mortality outcome information was obtained, and patients receiving renal dialysis and active cancer patients were identified from the regional hospital microbiology database. The time of blood culture was defined as the time that the culture was registered in the laboratory system as being drawn. A weekend was a priori defined by the period from 00:00 Saturday to 23:59 Sunday, days as 08:00 to 17:59, evening as 18:00 to 22:59 and nights as 23:00 to 07:59 (12). Weekday days were defined by days (08:00 to 17:59) from Monday to Friday, and the after hours included all other times (anytime Saturday or Sunday and weekdays 18:00 to 07:59).

Laboratory procedures and definitions

All blood was cultured using the BACTEC 9240 automated instrument (Becton Dickinson, USA). A blood culture set consisted of an aerobic/anaerobic lytic bottle pair of BACTEC bottles obtained from a single draw. Organisms were isolated and identified using standard methods. A bloodstream infection was defined as the growth of a pathogenic organism from at least one set of blood cultures. Organisms frequently associated with contamination, including coagulase-negative staphylococci, viridans group streptococci, or *Bacillus*, *Corynebacterium*, or *Propionibacterium* species, were a priori required to have at least two sets of positive blood cultures to be included in the analysis (13). Community-onset bloodstream infections were classified as those obtained from patients that were not admitted to hospital or identified within the first two days of stay in those admitted to an acute care hospital. Infections occurring in the first 28 days of life were also classified as nosocomial and were excluded. Polymicrobial bloodstream infections were those that had more than one incident species coisolated within a two-day period of the index culture draw.

Data management and statistical analysis

Analysis was performed using Stata version 11.2 (StataCorp, USA). To avoid the assessment of multiple outcomes for a single patient, only the first admission per patient was included in the present study. Non-normally distributed variables were reported as medians with inter-quartile ranges (IQR) and compared using the Mann-Whitney U test. Differences in proportions among categorical data were assessed using

Figure 2) Day of culture draw and outcome for patients with community-onset bloodstream infection admitted to Victoria (British Columbia) area hospitals

Figure 3) Timing of sampling and outcome of community-onset bloodstream infection for patients with community-onset bloodstream infection admitted to Victoria (British Columbia) area hospitals

Fisher's exact test for pair-wise comparisons and the χ^2 test for multiple groups. In all mortality analyses, all-cause in-hospital case fatality was assessed. A multivariable logistic regression model was developed to assess factors associated with mortality. Variables included in the initial model were culture draw during the after hours, age, sex, SLHA residency status, polymicrobial versus monomicrobial infection, and cancer and renal dialysis patients. After hours culture draw was kept in the model and other variables were eliminated ($P > 0.1$) in a backward stepwise fashion to develop the final model. Discrimination was assessed using the area under the ROC curve and calibration using the Hosmer-Lemeshow goodness of fit test.

RESULTS

During the eight-year study period, a total of 2108 patients had first admissions to study hospitals with community-onset bloodstream infection. Fifty-three per cent ($n=1107$) of patients were male and the median age was 70.1 (IQR 48.1 to 80.7) years. Twenty-six per cent ($n=554$) of patients were admitted on a weekend. Blood cultures were obtained on a weekend in 577 (27%) cases and in 902 (43%) patients cultures were drawn during 08:00 to 17:59, 687 (33%) were drawn during 18:00 to 22:59 and 519 (25%) during 23:00 to 07:59. More than two-thirds ($n=1456$ [69%]) of index cultures were drawn during the after hours (evenings, nights and/or weekends).

The overall in-hospital case fatality rate was 13% (269 of 2108). The case-fatality rate was not associated with either the day of admission to hospital ($P=0.47$; Figure 1) or the day of sampling ($P=0.26$; Figure 2). There was no difference in in-hospital case fatality rates between individuals admitted (67 of 554 [12%] versus 202 of 1554 [13%]; $P=0.61$) or who had cultures drawn (69 of 577 [12%] versus 200 of 1331 [13%]; $P=0.56$) on weekends as compared with weekdays. The timing of culture draw varied according to the time of day with a nadir at 03:00 to 04:59 and then a gradual increase until a peak at 20:00 to 20:59 (Figure 3). There was no significant difference ($P=0.33$) in case fatality depending on whether cultures were drawn during 08:00 to 17:59 (126 of 902 [14%]), 18:00 to 22:59 (79 of 687 [12%]) or 23:00 to 07:59 (13%).

TABLE 1
Logistic modelling of factors associated with in-hospital death among patients with community-onset bloodstream infections admitted to Victoria (British Columbia) area acute care hospitals

Factor	OR	95% CI	P
After hours culture	0.92	0.70–1.22	0.563
Cancer patient	3.03	2.01–4.55	<0.001
Age (per year)	1.02	1.01–1.03	<0.001
SLHA resident	0.69	0.46–1.04	0.077
Renal patient	0.45	0.18–1.14	0.092

SLHA South Local Health Area

Culture draw during the after hours (weekends and evenings/nights) compared with weekday days did not increase the risk of death. (181 of 1456 [12%] versus 88 of 652 [14%]; $P=0.53$).

No significant differences in median age, sex, species or proportion of polymicrobial infections were observed between individuals with cultures drawn during the after hours compared with regular hours. The length of hospital stay was shorter for individuals sampled in the after hours compared with the weekday days (8.5 versus seven days [$P=0.005$]). The multivariable logistic regression model for factors associated with in-hospital death (area under ROC curve 0.644 [goodness of fit $P=0.76$]) found that, as with the crude analyses, after hours culture was not independently associated with mortality (Table 1).

DISCUSSION

The present study demonstrated no association between death and presentation with community-onset bloodstream infection during the after hours (weekends, evenings and nights) compared with regular (weekday days) hours. The present study confirms previous findings of a similarly designed study recently conducted in Calgary (10). These studies suggest that the provision of acute care for community-onset infections is consistent during different times of day and days of the week in these centres.

It is not known whether the after hours effect observed in many other studies may be disease or centre specific. While the Calgary and Victoria areas share many common features in, most notably that hospitals are fully publicly funded and that they are in the same country, although in

different provinces, there are a number of distinct differences. Victoria is a moderately sized, suburban, coastal city characterized by a large elderly retirement population. Hospitals are predominantly community based with a small number of medical trainees. Calgary is a significantly larger urban city in the prairie region that has the youngest population in Canada. All acute care hospitals in Calgary are teaching facilities with a major presence of medical trainees in many cases. Despite the differences between these two regions, the observations surrounding case-fatality rates and the lack of an after hours effect are remarkably similar.

Where significant after hours effects have been observed in other studies conducted in other regions and with other health-related states, a number of factors have been proposed to explain an after-hours or weekend effect (1-9). The case-mix of patients is an important determinant of outcome and variation during times of the day and days of the week and likely explains, at least in part, the after hours increased mortality effect seen in many studies conducted in other conditions to date (14). Reduced staffing or decreased access to tests and procedures in the after hours and health care worker fatigue and resulting error in the after hours may be contributors (5,15,16). Institutional status as a teaching facility may also play a role (4).

There are a number of potential limitations of the present study that merit discussion. While we included more than 2000 patients, the present study was not powered to exclude very small but potentially statistically significant differences in risk. However, it is notable that the order of effect observed suggests, that if anything, that there may be a reduced risk for death in the after hours (Table 1). Another limitation is that we had limited clinical data on our patients, such that further evaluation of the confounding effects of comorbidity, diagnosis, measures of severity of illness and treatment adequacy could not be included (14,17). Finally, it would be valuable to have specific staffing measures as well as exact times of attendance by the attending services and the actual times of completion of investigations and consults to better explain our observations (5).

In summary, the present study found no association between the timing of presentation during the week or time of day and outcome associated with community-onset bloodstream infections.

DISCLOSURES: No external funding was received in support of the present study. The authors have no conflicts of interest to disclose.

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