論文

台灣某大型教學醫院對於血液與體液暴觸事件的介入與監控經驗

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摘要

研究背景：減少醫療照護相關肝炎感染的最有效方式是預防血液與體液暴觸事件，然而醫療照護人員對於事件通報不足一直是職業防護上重要議題。因此許多研究文獻都建議醫療院所應當鼓勵常規通報機制、並且採取適當控制策略。本研究旨在瞭解大型教學醫院內事件發生率及其持續性介入措施的潛在效應。

研究方法：我們在具有2,200住院病床的三級照護醫學中心，於西元2006年時成立工作小組，依據先前血液與體液暴觸事件根本原因分析結果，進行前瞻性介入研究，在推動各項防護措施過程中持續監控各種危險因素相關的事件，考量病人住院總日數、平均佔床數、或全時間作業員工等量數估算發生率，以卡方線性趨勢檢定確認於西元2004至2008年間的增減趨勢與工作小組介入前後的差異。

研究結果：我們發現於西元2004年至2008年間在醫院共發生1,769件血液與體液暴觸事件，年度發生率介於每百床17.0至13.7件之間。若考量病人住院平均佔床數，事件發生率在整體上有明顯逐年降低趨勢、特別在護理人員上；若考量病人住院總日數，事件發生率在整體上於針器使用後而未棄置前、或棄置期間有明顯逐年降低趨勢；若考量全時間作業員工等量數，事件發生率在實習醫學生上有非顯著性逐年增高趨勢，但是在工作小組介入後，發生率於經皮

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注射相關處置、或針器使用後而未棄置前有大幅減少。

研究結論：我們發現整合性團隊的努力在血液與體液暴觸事件的介入與監控上有正向效果，其中對於易感族群採取工程控制措施、進行特定職前與在職繼續教育訓練是非常重要的策略，但是爭取管理階層支持以不斷推動運作更是不可或缺的。

關鍵字：針扎、經皮穿刺傷、經黏膜表皮接觸、血液與體液暴觸。

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Research Articles

The Intervention and Surveillance Experience for Blood and Body Fluid Exposures at a Major Teaching Hospital in Taiwan

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Abstract

Background: The most effective means of reducing health care associated hepatitis infection is to prevent the blood and body fluid exposures (BBFE). However, under-reporting of accidents is evading the issue of occupational protection among health care workers . It is advised to encourage routine BBFE reporting program and to take control strategies accordingly. The study aimed to survey the levels of BBFE in the major teaching hospital, and to evaluate the potential effects of various ongoing measures during this intervention period of time.

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Methods: At a 2,200-bedded tertiary referral hospital center, we organized a task group in 2006, conducting a prospective interventional study based on the respectively causal analyses. We analyzed incidences by hospitalized inpatient days (IPD), full-time equivalent employees (FTE), and occupied beds (OB), and patterns of BBFE related to jobs, places, tasks, & steps involved with the device use, comparing the differences with Chi-square (x^2) for trend tests.

Results: There were 1,769 BBFE in 5 years with the incidence of 17.0-13.7/ 100OB per annum overall, and the significantly decreasing trend overall (p=0.028) and especially noted among nurses (p=0.019). Using index of IPD, a significant reducing trend (p<0.001) in the overall BBFE mostly appeared after the use or before the disposal (p=0.001), and during disposal of devices (p=0.017). A non-significantly increasing incidence trend of BBFE by index of FTE was observed among interns (p=0.484), but their incidence of BBFE due to percutaneous injection (-6.7/ 100FTE), and after use & before disposal of the device (-2.2/ 100FTE) were reduced.

Conclusion: The team effort has monitored and controlled the BBFE effectively. Engineering control, pre & post occupational tailored trainings and on-site continuous education are most crucial, especially for the vulnerable subgroups. Continual collaborative promotion with authority supports and prudent interpretation of indices are also indispensable.

Keywords: Needlestick injury, Percutaneous injury, Mucocuatneous exposure, Blood and body fluid exposure

Introduction

The Blood and body fluid exposure (BBFE) in health care workers may transmit infections of human immunodeficiency virus (HIV), hepatitis B & C viruses (HBV & HCV), and syphilis through needlesticks and other cuts or punctures related percutaneous injuries (PCI), and less often, mucocutaneous exposures (MCE). The risk of seroconversion was significant in Taiwan, and the positive HBsAg and anti-HCV rates were 12.5% and 14.9% of source patients respectively [1]. The most effective means to reduce such transmission is to avoid BBFE [2].On the other hand, the prevention of infectious transmission not only protects the safety and health of health care workers, but also ensures the improvement in the quality of patient care [3].

Various studies have revealed that there are modifiable and non-modifiable factors that place health care workers at risk of BBFE [4-6]. The current BBFE prevention that emphasizes on organizational processes provides a range of comprehensive interventions. They include combined education, training, safer work practices, incorporating safety-engineered protection mechanisms and personal protective equipment [7-10]. Our statistical analyses have allowed us to compare the level and details on BBFE in order to track the effects of those interventions. For example, the index of occupied beds (OB), full-time equivalent employees (FTE), and inpatient-days (IPD) have been used as denominators for the estimation of incidence rate performance in national, regional, and organizational surveys [7-19].

Certain hospital-wide studies [14-18] have shown the overall improved incidences from intervention and some [19] have not, and others have been hindered by under-reporting [20]. Nevertheless, a number of these studies have evaluated how BBFE differs before and after intervention with greater prospective and comprehensive approaches. Since June 2006, we have organized a task force at the major teaching hospital NTUH in Taiwan to conduct an interventional study to characterize BBFE changes from the intervention program. The study aimed to survey the levels of BBFE in the major teaching hospital, and to evaluate the potential effects of various ongoing measures during this intervention period of time.

Methods

1. Hospital setting

NTUH is a 2,200-bed medical centre in Taipei, Taiwan, with a mean bed occupancy rate of 87.2% in the study period. For 118 years, NTUH has been providing primary to tertiary medical care in the daily treatment of approximately 2,000 inpatients, 7,000 outpatients, and 300 emergency cases. As a teaching hospital, NTUH provides training for residents and nurses from the affiliated university and other medical colleges and hospitals. Annually, more than 150 clerks, 250 interns, and 750 residents undergo training at the facility.

2. Surveillance system

The Occupational Safety and Health (OSH) office oversees the control of BBFE. Exposed

HCW are required to report the incident and fill out a standardized questionnaire. The management protocol is compatible with the guidelines established by the Center of Infection Control, Department of Health, as illustrated elsewhere [18]. Immediately following a search for viral markers of HIV, HBV and HCV, and serologic syphilis [VDRL], the exposed workers are required to follow up at one, three, and six months post exposure. On a quarterly basis, statistical analysis is presented to the bylaw Committee of OSH in NTUH.

3. Intervention program

A task force was designated by the superintendent in 2006 to enhance controlling BBFE by a new intervention protocol. The protocol followed the quality assurance management principles [5] to explore the underlying causal factors. The anti-BBFE team was formed by OHS, infection control centre, and representatives from the Departments of Education, Nursing, Emergency Medicine, Environmental & Occupational Medicine (EOM). The group meeting was held quarterly and updates were transmitted to chief managers of units particularly prone to this danger, who were required to report back concerning the improvements. The intervention measures and schedules included engineering, administration, work practices, and universal control programmes as illustrated in figure 1.

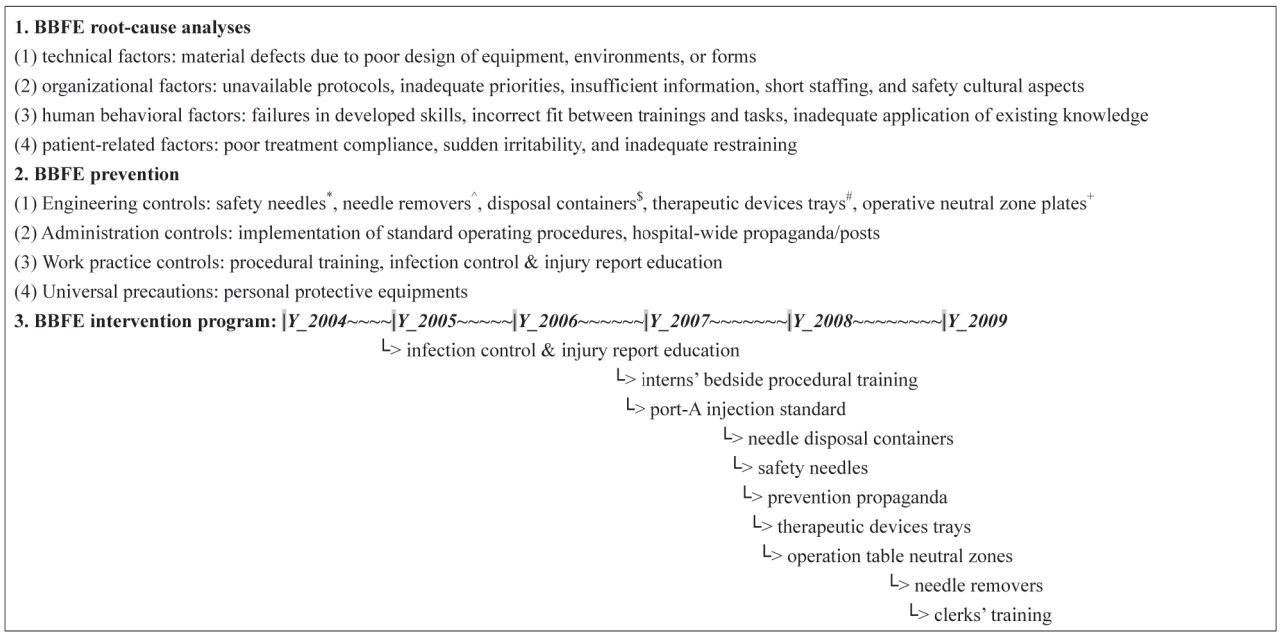

Figure 1 The intervention for blood and body fluid exposure (BBFE) prevention during 2004 to 2008 in response to the root-cause analyses

[Note] safety needles* for IV blood drawing with vacuum tube-connected needles; needle removers' for used needletips discarding with tools; disposal containers$ for used needles and other sharps collecting with plastic or steel containers in sizes different according to the places; therapeutic devices trays# for temporary placement of unused or used devices with plastic trays during practical tasks in patient wards; operative neutral zone plates+ for hand-free collection of used surgical sharps with magnetic iron plates on the tables in operation rooms.

4. Statistical analysis

We analyzed the data by using SAS 9.1.3 (SAS Institute, Cary, NC, USA). BBFE patterns were classified according to variables such as related worker jobs, places, tasks, and procedural steps involving with the use of devices. We evaluated incidences with patterns of BBFE per 100FTE of overall, and among nurses, interns, physicians year by year, before and after the major intervention (July, 2006). Besides, we used the Chi-square (x^2) for trend tests to confirm significantly annular changes with various ongoing intervention measures during this period of time [21]. We also compared our BBFE results with those of other teaching hospitals. This study was approved by NTUH's Institutional Review Board (201105010RC).

Results

Over the 5-year period of observation, this study collected a total of 1,769 cases of BBFE, of which 94.1% were PCI and 5.9% were MCE. The annular incidences of overall BBFE ranged from 17.0 to 13.7 per 100 OB, with a significantly decreasing trend (x^2=4.855, p=0.028). Furthermore, the significantly decreasing trend on the incidence of BBFE per 100 OB was especially noted among nurses (x^2=5.536, p=0.019).

The annual characteristics of overall BBFE rate per 10,000 IPD concerning places, tasks, and procedural device-use steps are presented in the Table 1. Overall, the locations in the hospital where BBFE occurred did not differ in the incidence

Table 1 Overall patterns of blood and body fluid exposures (BBFE) related to places, tasks & steps at the hospital during 2004 to 2008

Year	2004	2005	2006	2007	2008	χ^2-value	p-value for trend
Cumulative inpatient days	725,895	731,113	710,690	714,561	676,067		
Overall BBFE	392	365	352	304	356	1.616	0.204
BBFE in patient wards	227	221	220	178	209	0.950	0.330
- in emergency rooms	35	28	23	24	26	1.144	0.285
- in operation rooms	56	54	49	53	62	0.733	0.392
- in outpatient clinics	41	34	32	27	27	2.773	0.096
- in other places#	33	28	28	22	32	0.039	0.843
BBFE due to surgical device use	67	58	55	55	62	0.019	0.892
- due to IV therapy delivery	41	41	50	33	43	0.019	0.891
- due to IV line insertion	37	26	50	49	58	11.956	0.001
- due to IV blood drawing	80	57	67	68	79	0.602	0.438
- due to percutaneous injection	147	153	77	33	46	104.411	<0.001
- due to other tasks+	20	30	53	66	68	41.591	<0.001
BBFE before use of device	9	9	6	10	9	0.068	0.794
- during use of device	108	83	90	89	122	2.572	0.109
- after device use / before disposal	161	157	176	95	118	11.141	0.001
- during device disposal	28	24	24	18	12	5.680	0.017
- after device disposal	37	28	17	32	29	0.190	0.663
- associated with other steps*	49	64	39	60	66	2.773	0.096

[Note] Other places# including laboratory, radiology& pathology examinations, and therapeutic units, etc.

Other tasks+ including device cleaning, deliveries and clinical nursing services, e.g. one-touch blood sugar test, etc.

Other steps* including collecting body fluids, body contacts due to patient's agitation, etc.

significantly. However, BBFE due to percutaneous injection was with a significant diminishing trend (x^2=104.411, p<0.001). The majority (40.0%) of BBFE took place after the device usage or prior to the disposal, was also with a significant reducing trend (x^2=11.141, p=0.001). There was also a significant declining trend on the overall BBFE during the disposal of device (x^2=10.206, p=0.001). Nevertheless, increasing trend of BBFE due to permanent IV line insertion (x^2=11.956, p=0.001) was noted.

As shown in Figure 2, the overall incidence of BBFE per 100 FTE were 7.2, 5.4, 5.2, 4.5, and 5.5 per annum, respectively, with a significant decreasing trend (x^2=20.256, p<0.001). Those among nurses were 8.0, 6.4, 6.3, 6.0, and 6.2, respectively, with a significantly descending trend (x^2=12.579, p<0.001). Those among physicians was 6.0, 5.8, 6.0, 3.5, and 4.6, per annum respectively, with a non-significantly decreasing trend. By contrast, a non-significantly increasing trend in the incidences of BBFE per 100 FTE was observed among interns (x^2=0.491, p=0.484).

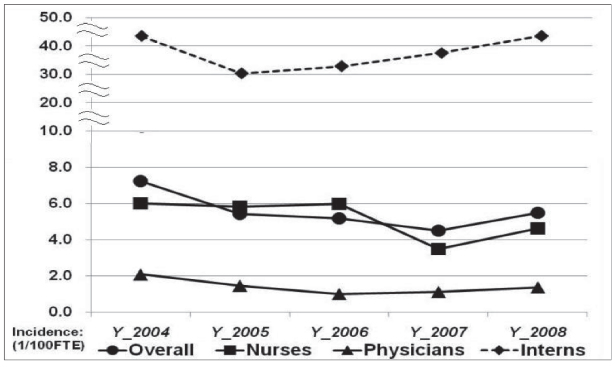

Figure 2 Annular incidences of blood and body fluid exposure (BBFE) of overall, and among nurses, physicians & interns during 2004 to 2008

The mean job-specific incidence changes of BBFE for various tasks, and steps of procedures in divided periods were demonstrated in Figure 3. The mean incidence of BBFE per 100 FTE for physicians (-0.9) and nurses (-1.2) decreased, but those for interns increased (+1.0). Among interns, there were reduced incidences per 100 FTE of BBFE due to percutaneous injection (-6.7), or after-use, before-disposal of the device (-2.2), but raised incidence per 100 FTE of BBFE due to IV blood drawing (+1.4), IV line insertion (+2.9), and other tasks (+3.1), or during the use of devices (+2.7), and other steps (+2.2).

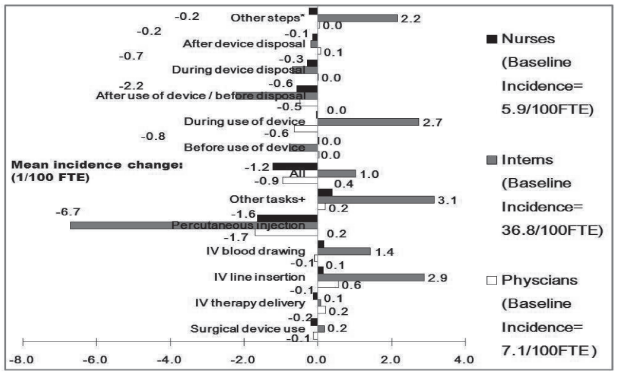

Figure 3 Mean incidence changes of blood and body fluid exposures (BBFE) related to tasks & steps among nurses, physicians & interns after the intervention by the task group during 2004 to 2008

Discussion

The Exposure Prevention Information Network (EPINet) study in Taiwan has shown the highest correlation index with PCI frequency to be IPD as other study suggested [15,16]. This study showed a significant decreasing IPD trend in tasks of percutaneous injection, a stationary trend due to temporary IV therapy or IV blood drawing, albeit

an increase trend in tasks of permanent IV line insertion (e.g. IV catheter, blood transfusion, CVP, Port-A-cath or A line, Swan-Ganz tubing etc.). Since 40% of BBFE occurred during the time of using various devices, this drives us to question if devices could be totally replaced by safety tools in order to prevent BBFE at all, among the safety needles. After all, the significant reduction of BBFE related to the disposal may have to do with engineering controls. However, safety needles are limited to a narrow coverage, such as sick people infected with bio-safety level 3 organisms (e.g., HBV, HCV, and HIV), by the Taiwan national health insurance payment system. There was no safety needle available for some invasive procedures, such as Port-A catheterization, which may make the success experience of safety needles [5,19,22] not be overemphasized.

However, among other engineering measures, the change from steel barrels to plastic containers for the disposal of needles has been successful, as reported in this study with increased number of consumed plastic containers (13 & 26 -liter size), which is marked by its original convenient and safe design [23]. In the patient wards, these bedside containers would allow immediate disposal of sharps and avoid carrying sharps bare-handed. Anyway, sharps disposal containers or safety needles are small parts of a complex interplay of factors leading to accidental sharps injury, and it is noted each individual's behavior is a stronger determinant of needlestick injury [24].

While IPD may be reflective of potential BBFE risk, using FTE generates similar estimates results among hospitals in Taiwan's EPINet statistics [15]. To benchmark behavioral risk of different occupations, FTE is even a better choice than IPD. In the study period there were no significant layoffs occurred. The overall decreasing trend is noted in the FTE (and OB) models, but not in the IPD model. The intervention through administrative activities, such as a competition for the design of posters, four consecutive weeks of educational courses in conjunction with quizzes (with awards) following the lectures over the internet, and the attractive posters on the walls of clinics and ward stations for a period of time, are also regarded as a successful strategy in another study [17] and may explain for the incidence reduction of BBFE due to percutaneous injection in staff nurses followed by physicians, which parallel their activity participating rate.

Interns, on the other hand, have demonstrated a high incidence of BBFE, 30～45 %. Part of the increase was due to increased MCE reporting. The higher BBFE incidents is also noted for medical students (in third and fourth year) in Germany, Singapore and St. Louis, USA, which showed 30～41% of them had sustained at least one needlestick injury [25]. Being young and poor training in occupational risk prevention may account for interns' BBFE risk level [6]. However, since in this study interns' BBFE is increasing in insertion of permanent devices or operating non-routine tasks than due to blood drawing, such repeated routine techniques training still are recognized as beneficial [24]. However, safety training should not lean on simple procedures only, and to promote interns' readiness for the clinical duty [26], we have extended their clinical

skill training to five weekends (a total of 10 days) through the Objective Structured Clinical Examination (OSCE) since 2008. The number of interns' duty was also suggested to decrease since extended work hours and night shifts also tended to increase their risk of injury [27]. We also suggested to substitute interns with professional phlebotomists, limit their blood drawing load, and offer tailored courses to decrease the risk from unfamiliar, high risk procedures.

To reduce sharps injuries during surgery procedure, the engineering methods of blunted suture needles, hands-free zone, double glove wearing and magnets use [28] were ever proposed, and there is also room for behavioral improvement for operating room personnel. Examples may include magnet pad in the hands-free neutral zone and safe sharp remover that are yet to be accepted by surgeons, since some surgeons even strongly proclaim that sharp injuries are inevitable [29].

One potential limitation of this study is the under-reporting as previously noticed [30]; thus the interpretation needs to be treated with caution. The under-reporting phenomenon was a widespread public health problem with rates ranging from 17% to 97% [31]. By the cross-sectional survey study in one American tertiary care and referral medical center [31], the rate of under-reporting of BBFE among the clinical medical students was rather higher than those among resident physicians and nursing staff. In this way, the health care workers should be educated more rigorously regarding the hazards of occupational exposures and instructed to report these exposures in a more appropriate fashion since their studenthood.

As summarized in Table 2, the overall incidence of BBFE in this study is higher than countries such as Australia, Korea, Pakistan and Japan [18-20,32-33], but not as high as that in America [14]. According to Taiwan EPINet survey, in this study the incidence is closer to the national estimate [30] and should minimize the reporting bias. Reporting of BBFE

Table 2 Incidence of blood and body fluid exposures (BBFE) at selected teaching hospitals in different countries

Sources	Countries	Time periods	Kinds	Incidences	Overall	Nurses	Interns	Physicians	References
EPINet	USA	2004- 2007	PCI	1/100OB	34.49- 33.19	N.A.	N.A.	N.A.	Perry J, et al. [14]
EPINet	Taiwan@	2004- 2006	PCI	1/100OB 1/100FTE	6.22 4.50	2.43	0.23 (Interns & Physicians)		Shiao JS, et al. [15]
UCHC	USA	1997- 2002	PCI	1/100FTE	N.A.	9.2- 2.7	7.9- 2.6	N.A.	Cardoso MT, et al. [17]
MMH	Taiwan	2001- 2003	BBFE	1/100FTE	2.30- 1.62	3.58- 2.35	6.41- 3.27	2.10- 0.85	Hsieh WB, et al. [18]
PAH	Australia	2000- 2006	NSI	1/100FTE	3.23	2.71	4.69 (Interns & Physicians)		Whitby M, et al. [19]
PNUH	Korea	2001- 2006	NSIs	1/100FTE	2.6	2.6	17.7	3.7	Park S, et al. [20]
AKUH	Pakistan	2002- 2007	NSI	1/100FTE	4.6- 2.5	13- 5	27- 12 (Interns & Physicians)		Zafar A, et al. [32]
KYH	Japan	1997- 2004	SI	1/100OB	3.6				Nagao Y, et al. [33]
NTUH	Taiwan	2004- 2008	BBFE	1/100OB 1/100FTE	17.0-13.7 7.2- 4.5	6.5- 3.7 6.0- 3.5	6.1- 4.6 43.5- 30.2	3.9- 3.4 8.0- 6.0	Wu JY, et al. et al. [present]

[Note] BBFE: blood and body fluid exposures, namely percutaneous needlestick with other sharps and mucocutaneous injuries, including such as PCI: percutaneous injuries, (2) NSI: needlestick injuries, (3) NSIs: needlestick and other sharps injuries, (4) SI: sharps injuries;
OB: occupied beds, FTE: full-time equivalent employees; @: the statistics not only at the teaching hospitals but also at the non-teaching hospitals;
NA: the data not available.

after 2009 in Taiwan is considered a compliance duty instead of a stigma since the responsibility of preventing BBFE has become compulsory by the amendments of Occupational Health and Safety Law, a decade behind the United States when her Needlestick Safety Act was enacted.

Conclusion

This study has shown the organized team for BBFE monitoring and intervention programme is generally effective. We believe that improvements in these indices have to great extent been made possible by improvements in the safety of the hospital. Nonetheless, encouraging continual reporting to follow the trend and revise the strategy is indispensible. For interns, less experienced nurses and surgeons who largely remain at higher risk, engineering control, risk communication with adequate pre-and post occupational training, on site propagation and administration support are all critical. Finally, it is not suggested to over interpret the BBFE incidence as safety performance indicators because it may eventually obstruct the willing of reporting and bury the truth of health care workers' occupational injuries.

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