The NNI External Ventricular Drain Pathway A Pragmatic Multi-site Risk Stratification Pathway to reduce Ventriculostomy-related Infection

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INTRODUCTION

Patients with external ventricular drain (EVD), a commonly performed neurosurgical procedure, is at risk of infection. Ventriculostomy-related infection (VRI) is usually associated with serious morbidity and mortality. Studies have demonstrated that implementing protocols can reduce VRIs. However, a protocol approach is not translatable to the National Neuroscience Institute (NNI) model due to its complex sub-speciality multi-site organization and different stake holders involved.

OBJECTIVE

We developed a pragmatic risk stratification EVD pathway to harmonize surgical and nursing practices across all hospitals served by NNI neurosurgery department with the aim of delivering an ethos of 'fair access to best EVD practices from the point of entry' for any patient presenting to a NNI neurosurgeon regardless of their inpatient location. We examined if a pragmatic risk stratification pathway, allowing for surgical decision-making, could be as effective as an EVD protocol in reducing the rate of VRIs.

METHODS

Ethics approval was obtained from the SingHealth CIRB. We performed two studies concurrently. The first study was a formal retrospective one-year audit from January to December 2014 of VRI rates and outcomes in our units across SGH, TTSH and CGH. We also performed a prospective one-year audit from January to December 2015 during the implementation of the pathway across the three sites. The pathway was constructed using current evidences in EVD literature.



		EVD care and Ai ↓ variation in multiple ↓ errors in san drainage an deteri							
Wound care ¹	EVD care ^{1, 2}	CSF infection cohort ³	CSF sampling ³	Removal ⁴	Blockage ^{2,3}	Revision ¹			
an sea a sé		성상수 없는 것							
Wound care:		CSF infection coh	orts:	Removal: - Aim to remove EVD in ≤ 10 days					
- Change dressir	 Change dressing if soiled, wet or 		ected						
dressing integrity breached.		ventriculostom	y-related infection	if clinica	if clinical circumstances allow.				
 Full elective dressing change 		or ventriculitis	riculostomu	- Consider removal if at 20 cmH ₂ 0, drainage if < 100 ml per 24 hours					
every ≤ 4 days. - Use strict aseptic technique		related infectio	n and ventriculitis	 Clamp to wean or transduce ICP if attending consultant agrees. 					
 Clip hair if needed to allow new 									
dressing to adhere.		Attending consult	ant to indicate	- Consider early					
		preference: Lozie	r 'A' or Lozier 'B'.	ventrici	lioperitoneal s	nuntir			
1926년 2012년 11년									
EVD care:		CSF Sampling:		Blockage:					
 No unnecessary manipulation of 		- Lozier 'A' - rout	ine sampling to be	 Minimize flushing of catheter. Use aseptic technique if flushing required (by Neurosurgical staff <u>ONLY</u>). May attempt aspiration 					
3-wat tap, Replace cap of any tap (connector following		Thursdays only	vioridays and Tailows for timely						
manipulation.		actions to be ta	ken if necessary).						
 Clamp drainage tap when 									
switching betw	switching between pressure		outine sampling	- If no dr	ainage, CT bra	in to be			
monitoring and	d CSF drainage.	unless clinical s	uspicion of	performed to determine catheter					
 Drain/change drainage bag when % full 		infection and a	ttending	position Bernow	and ventricul	ar size.			
when 4 rull.		LUIISUILAIL AGR		NetHOVE	The Alac as a b	nopilate			

Justification: Justification: Justification: - Specific - Reflects the Silver - Reflect antibacterial trial cohort ¹ - Reduct properties - Peak of CSF - Reduct - Cost justified Plain EVD may be used If patient or EVD-d if ↑ blockage/revision or EVD-d	Iver Iver Iver Iver Iver Provide the set of the se	ation: ects both trial orts ^{1,3} uces risk of ction ent for revision of dependent	 EVD tunnelling and anchorage: EVD is tunnelled ≥ 5cm EVD is to be anchored with 2 anchoring sutures, one on each side of the scalp where the EVD exits the scalp. Interlocking Roman sandal ties are recommended. 	the connector as required to elevate pressure point.		Revision: - In case of catheter displacement or complete blockage, new EVD is to be inserted on the same site if safe. This is to protect possible clean insertion options for	
rate is expected may consider either catheter (Silver ↓ cost option) 1. Keong NC, Bulters DO, Richards HK, Farrington M, Sparrow OC, Pickard JD, Hutchinson PJ, Kirkpatrick PJ. The SILVER (Silver Impregnated Line Versus EVD Randomized trial): a double-blind, prospective, randomized, controlled trial of an intervention to reduce the rate of external ventricular drain infection. Neurosurgery. 2012;71(2):394-403; discussion 403-404. 2. Lozier AP, Sciacca RR, Romagnoli MF, Connolly ES Jr. Ventriculostomy-related infections: a critical review of the literature. Neurosurgery. 2020;51(1):170-81; discussion 181-182. 3. Zabramski JM, Whiting D, Darouiche RO, Horner TG, Olson J, Robertson C, Hamilton AJ. Efficacy of antimicrobial-impregnated external ventricular drain catheters: a prospective, randomized, controlled trial. Journal of neurosurgery. 2003 Apr;98(4):725-730.		 Korinek AM, Reina M, Boch AL, Rivera Neurochir (Wien). 2005;147(1):39-45; discus Dasic D, Hanna SJ, Bojanic S, Kerr RS. Ext literature. Br J Neurosurg. 2006;20(5):296-30 Lozier AP, Sciacea RR, Romagnoli MF, Co 2002;51(1):170-81; discussion 181-2. Keong NC, Bulters DO, Richards HK, Farrii Line Versus EVD Randomized trial): a dou ventricular drain infection. Neurosurgery. 201 	AO, De Bels D, Puybasset L. Prevention of external ventricular drainrelated ventriculitis. Acta sion 45-6. ternal ventricular drain infection: the effect of a strict protocol on infection rates and a review of the 0. onnolly ES Jr. Ventriculostomy-related infections: a critical review of the literature. Neurosurgery. hgton M, Sparrow OC, Pickard JD, Hutchinson PJ, Kirkpatrick PJ. The SILVER (Silver Impregnated ble-blind, prospective, randomized, controlled trial of an intervention to reduce the rate of external L271(2):394-403: discussion 403-4.	 Korinek AM, Reina M, Boch AL, Neurochir (Wien). 2005;147(1):39-43 Dasic D, Hanna SJ, Bojanic S, Kerr literature. Br J Neurosurg. 2006;20(5) Lozier AP, Sciacca RR, Romagnoli 2002;51(1):170-81; discussion 181-2 Keong NC, Bulters DO, Richards HI Line Versus EVD Randomized trial veotricular denia infection. Neurosurg. 	 (Neurosurgical or Nursing staff allowed) or proximal 3-way tap (only Neurosurgical staff allowed). No evidence for ro exchange Consider routine E there is organism. EVD duration > 21 Korinek AM, Reina M, Boch AL, Rivera AO, De Bels D, Puybasset L. Prevention of external ventricular drain-related Neurochir (Wiet). 2005;147(1):39-45; discussion 45-6. Dasic D, Hanna SJ, Bojanic S, Kerr RS. External ventricular drain infection: the effect of a strict protocol on infection rates a literature. Br J Neurosurg. 2006;20(5):296-300. Lozier AP, Sciacca RR, Romagnoli MF, Connolly ES Jr. Ventriculostomy-related infections: a critical review of the literat 2002;51(1):170-81; discussion 181-2. Keong NC, Bulters DO, Richards HK, Farrington M, Sparrow OC, Pickard JD, Hutchinson PJ, Kirkpatrick PJ. The SILVER (Line Versus EVD Randomized trial): a double-blind, prospective, randomized, controlled trial of an intervention to reduce t 		

RESULTS

	CGH				SGH			TTSH		
	Baseline (n=49)	Pathway (n=47)	Р	Baseline (n=43)	Pathway (n=40)	Р	Baseline (n=73)	Pathway (n=102)	Р	
Age, vears	57 (51-63)	57 (47-67)	0.95	56 (46-69)	62 (52-67)	0.32	59 (47-68)	56 (49-68)	0.54	
Male, n (%)	35 (71.4)	24 (51.1)	0.04	24 (55.8)	23 (57.5)	0.88	37 (50.7)	62 (60.8)	0.18	
Primary diagnosis, n (%)										
SAH	8 (16.3)	15 (31.9)	0.07	9 (20.9)	12 (30)	0.34	34 (46.6)	31 (30.4)	0.03	
IVH	12 (24.5)	2 (4.3)	< 0.01	3 (7.0)	5 (12.5)	0.39	3 (4.1)	20 (19.6)	< 0.01	
ICH	18 (36.7)	21 (44.7)	0.43	17 (39.5)	16 (40)	0.97	20 (27.4)	20 (19.6)	0.23	
Tumor	2 (4.1)	2 (4.3)	0.97	7 (16.3)	6 (15)	0.87	4 (5.5)	13 (12.7)	0.11	
ТВІ	2 (4.1)	1 (2.1)	0.58	1 (2.3)	0 (0)	0.33	1 (1.4)	3 (2.9)	0.49	
Others	7 (14.3)	6 (12.8)	0.83	6 (14.0)	1 (2.5)	0.06	11 (15.1)	15 (14.7)	0.95	
Type of EVD, n (%)										
Plain	7 (14.3)	5 (10.6)	0.59	12 (27.9)	4 (10)	0.04	26 (36)	9 (9)	< 0.001	
Antibiotic-impregnated	42 (85.7)	36 (76.6)	0.25	14 (32.6)	29 (72.5)	< 0.001	47 (64.4)	81 (79.4)	0.03	
Silver-impregnated	0 (0)	6 (12.8)	0.01	17 (30 5)	7 (17 5)	0.03	0 (0)	12 (11 8)	< 0.01	





Conclusion

We designed a pathway for EVD management to reduce VRIs which was multi-disciplinary and comprehensive but allows for different EVD strategies within a structured framework without increasing infection rates. The pathway is implementable across multiple sites and different hospital stakeholders. We were able to provide all NNI neurosurgery patients 'fair access to best practices in EVD management' regardless of their location and point of entry of consulting the neurosurgical service.

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