Quality indicators for evaluating the 30-day postoperative outcome in pediatric brain tumor surgery: A 10-year single center study and systematic review of the literature

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Backround

- Haukeland University hospital – Western Norway
- Tertiary referral hospital
- Neurosurgery is centralised
- 1.2 million
- 2 Neurosurgeon – Paediatric cases

AIM

- Analyzing currently applied quality indicators in pediatric brain tumor surgery
- The secondary aim was the identification of risk factors related to unfavorable outcome.
- A systematic literature review regarding quality indicators in pediatric braintumor surgery.

Patients and quality indicators

- Patients
- Inclusion criteria
  - < 18 years
  - Surgery for intracranial tumour
  - 2009 – 202
  - Primary operations
- Excluded:
  - Secondary surgery
  - Pituitary / Craniopharyngioma
  - Incomplete records

- Primary outcome: - Quality indicators
  - 30-days readmission,
  - 30-day reoperation,
  - 30-day mortality,
  - 30-day nosocomial infection
  - 30-day surgical site infection (SSI) rate
  - Length of stay (LOS)
  - CSF Leak
  - Neurological deficits
  - Postoperative hemorrhage

Results

Baseline Characteristics

- 82 patients

PATIENTS BASELINE CHARACTERISTICS		n	%
Age at surgery	Years, median (range)	9.5 (0-17)	-
Sex	Male	51	62.2
	Female	31	37.8
Comorbidities	Neurofibromatosis 1	4	4.9
	Underlying malignant tumors	3	3.7
Preoperative symptoms	Headache	42	51.2
	Nausea, vomiting	36	43.9
	Seizures	21	25.6
	Neurological deficit	20	24.4
	Visual	15	18.3
	Dizziness	6	7.3
	Incidental finding	7	8.5
Time from symptoms to diagnosis	Days, median (range)	30.0 (0-2300)	-
PREOPERATIVE IMAGING CHARACTERISTICS		**n**	**%**
Tumor location	Supratentorial	41	50
	Infratentorial	41	50
Tumor location on preoperative imaging	Cerebrum	32	39
	Cerebellum	16	19.5
	Fourth ventricle	15	18.3
	Brainstem	6	7.3
	Skull base	4	4.9
	Thalamus, basal ganglia	4	4.9
	Pineal gland/tectal	3	3.7
	Pituitary region	1	1.2
	Ventricle	1	1.2
Hydrocephalus on preoperative imaging	Yes	40	48.8
Number of lesions	One	68	82.9
	Two	3	3.7
	Multifocal, ≥ three	11	13.4
Preoperative contrast enhancement	Yes	71	86.6
Preoperative cystic lesion	Yes	38	46.3
Eloquent location	Yes	36	43.9
Tumor volume	cm^3, mean (range)	30.3 (0.2-294.5)	-

Results

SURGICAL CHARACTERISTICS		n	%
Urgency of surgery	Emergency	41	50
	Elective	41	50
Type of surgery	Resection	70	85.4
	Biopsy	12	14.6
Extent of resection	Biopsy	11	13.4
	STR	13	15.9
	NTR	16	19.5
	TR	42	51.2
CSF diversion procedure	Yes	17	20.7
Type of CSF diversion	ETV	8	9.8
	EVD	5	6.1
	Ommaya reservoir	3	3.7
	VP-shunt	1	1.2
Duration of surgery	Minutes, mean (range)	182.8 (43-622)	-

Tumor-specific characteristics	
Tumor type, histology	
Angiocentric glioma	2 (2.4)
DNET	3 (3.7)
Ganglioglioma	6 (7.3)
Hemangioblastoma	1 (1.2)
Meningioma	2 (2.4)
Pilocytic astrocytoma	21 (25.6)
Polymorphous low-grade neuroepithelial tumor of the young	1 (1.2)
Schwannoma	3 (3.7)
Atypical neurocytoma	1 (1.2)
Ependymoma	1 (1.2)
Diffuse astrocytoma	4 (4.9)
Diffuse pediatric astrocytoma	1 (1.2)
Pleomorphic xanthoastrocytoma	1 (1.2)
Anaplastic ependymoma	5 (6.1)
Anaplastic oligodendroglioma	1 (1.2)
Anaplastic pleomorphic xanthoastrocytoma	1 (1.2)
AT/RT	6 (7.3)
Diffuse midline glioma	2 (2.4)
Glioblastoma	1 (1.2)
Medulloblastoma	11 (13.4)
Germinoma	3 (3.7)
Neuroblastoma metastasis	1 (1.2)
PNET	1 (1.2)
Rosette-forming tumor of 4th ventricle	1 (1.2)
T-cell lymphoma	1 (1.2)
Missing	1 (1.2)

WHO grade	
I	39 (47.6)
II	7 (8.5)
III	7 (8.5)
IV	22 (26.8)
NA	7 (8.5)

Følsomhet

Transient: n = 10
Hemiparesis: n=7
Diplopia n=5
Cerebellar mutism n=2
Dysphagia: n=2
Facial nerve affection n=2
Trigeminal nerve affection n=1
Hemianopsia: n=1

Cerebellar mutism – 6,5%
Literature - 11-29%,

TABLE 2. Quality indicators and complications of pediatric brain tumor surgery

Outcome	Cumulative Incidence, n (%)
30-day unplanned reop	8 (9.8)
Postop hemorrhage	1 (1.2)
CSF leak	3 (3.7)
SSI	1 (1.2)
Hydrocephalus	3 (3.7)
30-day unplanned readmission	12 (14.6)
CSF leak	4 (4.9)
SSI	2 (2.4)
Headache, nausea	4 (4.9)
Hydrocephalus	2 (2.4)
30-day mortality	0 (0)
30-day nosocomial infection	5 (6.1)
Meningitis	2 (2.4)
SSI	3 (3.7)
30-day SSI	3 (3.7)
30-day CSF leak	4 (4.9)
New neuro deficit	14 (17.1)
Postop hemorrhage	2 (2.4)
LOS ≥7 days	46 (56.1)

Results

- Reoperation rate – 9.8 %
  - Median time reoperation of 11 days.
  - Main reason for reoperation was CSF leakage and hydrocephalus
- Unplanned readmission < 30 days after discharge – 14.6%
  - Median time 10.5 days
  - Reason : CSF leakage, nausea, vomiting (4 patient each)
- Nosocomial infection 6.1%
  - Meningitis – 2 pts
  - SSI – 3 pts
- New postoperative neurological deficits 17.1% (n = 14)
  - Permanent in 10 pts (12.2%)

Results

Risk factors for outcome variables obtained in univariate analysis

- Unplanned 30-day reoperation (n=8, 9.8%)
  - Eloquent location (p = 0.009)
  - Emergency operation (p = 0.003)
  - CSF diversion procedures (p = 0.002)
- Unplanned 30-day readmission (n=12, 16.6%)
  - Preoperative neurological deficits (p = 0.019)
  - Mean tumor volume (p = 0.008)
- 30-day nosocomial infection (n=5, 6.1%)
  - Mean tumor volume (p = 0.004)
  - CSF diversion procedures (p = 0.025)
- Surgical site infection (n=3, 3,7%)
  - Female (p = 0.024)
  - Eloquent location (p = 0.046)
  - CSF diversion procedures (< 0.001)
- Postoperative CSF leak (n=4, 4.9%)
  - Mean tumor volume (p = 0.005)

Results

Postoperative length of stay		≥7 days n (%)	0-6 days n (%)	p-value
Age at surgery	Years	Mean: 7.9	Mean: 10.3	0.024
Preop nausea/vomiting	Yes	26 (72.2)	10 (27.8)	0.009
	No	20 (43.5)	26 (56.5)	
Preop seizure	Yes	3 (14.3)	18 (85.7)	<0.001
	No	43 (70.5)	18 (29.5)	
Preop visual deficits	Yes	12 (80)	3 (20)	0.039
	No	34 (50.7)	33 (49.3)	
Hydrocephalus, visualized on preop imaging	Yes	32 (80)	8 (20)	<0.001
	No	14 (33.3)	28 (66.7)	
Infratentorial tumor location	Yes	31 (75.6)	10 (24.4)	<0.001
	No	15 (36.6)	26 (63.4)	
Number of lesions	One	34 (50.0)	34 (50.0)	0.037
	Two	2 (66.7)	1 (33.3)	
	≥ Three	10 (90.9)	1 (9.1)	
Preop contrast enhancement	Yes	44 (62)	27 (38)	0.006
	No	2 (18.2)	9 (81.8)	
Eloquent location	Yes	25 (69.4)	11 (30.6)	0.031
	No	21 (45.7)	25 (54.3)	
Emergency surgery	Yes	31 (75.6)	10(24.4)	<0.001
	No	15 (36.6)	26(63.4)	
CSF diversion procedure	Yes	14 (82.4)	3(17.6)	0.014
	No	32 (49.2)	33(50.8)	
Extent of resection	Biopsy	6 (54.5)	5 (45.5)	0.040
	STR	11 (84.6)	2 (15.4)	
	NTR	11 (68.8)	5 (31.3)	
	GTR	18 (42.9)	24 (57.1)	
Duration of surgery	Minutes	Mean: 228.7	Mean: 124.2	<0.001
WHO-grade	1	19 (48.7)	20 (51.3)	0.004
	2	2 (28.6)	5 (71.4)	
	3	2 (28.6)	5 (71.4)	
	4	19 (86.4)	3 (13.6)	

Prognostic factors for outcome

Multivariate analysis revealed independent risk factors

- for the manifestation of a nosocomial infection
  - greater tumor volume
  - the performance of a CSF diversion procedure

- for occurrence of CSF leakage
  - Greater tumor volume

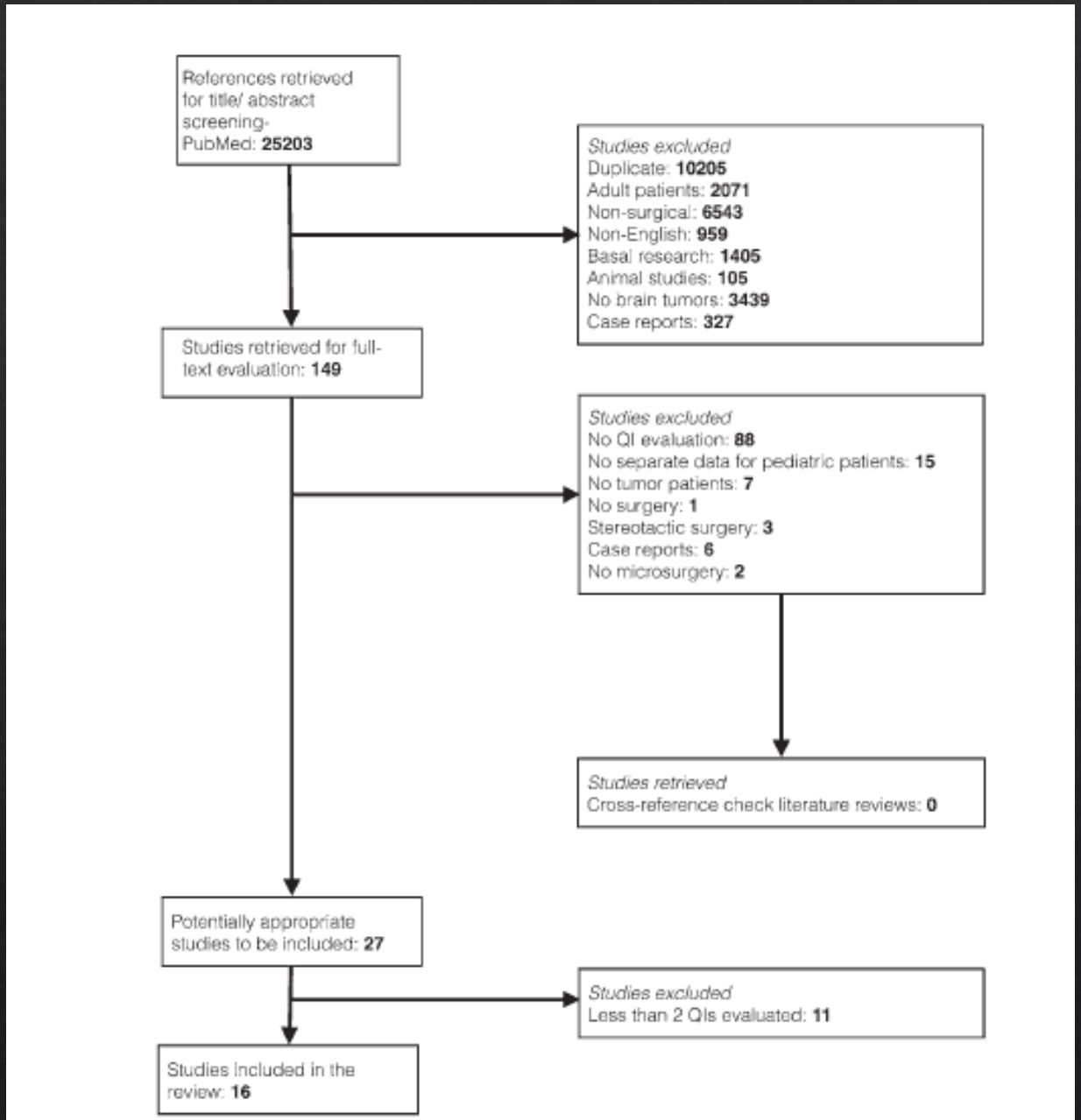

FIG. 1. Flowchart of the study screening and selection process. QI = quality improvement.

Results

Quality indicators and complications of pediatric brain tumor surgery

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Headache, nausea	4 (4.9)
Hydrocephalus	2 (2.4)
30-day mortality	0 (0)
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30-day SSI	3 (3.7)
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Postop hemorrhage	2 (2.4)
LOS ≥7 days	46 (56.1)

Quality indicators	Literature review	This study
30 day reoperation rate	1.5% - 12%	9.8%
30 day readmission rate	Not reported	14.6%
30 day mortality rate	0% - 9.3%	0%
SSI rate	3.9%	3.7%
CSF leakage	0 – 17.4%	4.9%

Results
Risk factors

- Only 4 studies
- Posterior fossa location for CSF leakage

Conclusion

- The 30-day outcomes in our department were comparable to published outcomes.
- The most relevant factors related to unfavorable outcomes are tumor volume and location in addition to CSF diversion procedures.
- This evaluation of quality indicators reveals concerns related to the unclear and non-standardized definitions of outcomes.
- Standardized outcome definitions and documentation in a large and multicentric database are needed in the future for further evaluation of quality indicators.

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JNS PEDIATRICS

CLINICAL ARTICLE

Quality indicators for evaluating the 30-day postoperative outcome in pediatric brain tumor surgery: a 10-year single-center study and systematic review of the literature

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OBJECTIVE Surgery is the cornerstone in the management of pediatric brain tumors. To provide safe and effective health services, quantifying and evaluating quality of care are important. To do this, there is a need for universal measures in the form of indicators reflecting quality of the delivered care. The objective of this study was to analyze currently applied quality indicators in pediatric brain tumor surgery and identify factors associated with poor outcome at a tertiary neurosurgical referral center in western Norway.

METHODS All patients younger than 18 years of age who underwent surgery for an intracranial tumor at the Department of Neurosurgery at Haukeland University Hospital in Bergen, Norway, between 2009 and 2020 were included. The primary outcomes of interest were classic quality indicators: 30-day readmission, 30-day reoperation, 30-day mortality, 30-day nosocomial infection, and 30-day surgical site infection (SSI) rates; and length of stay. The secondary aim was the identification of risk factors related to unfavorable outcome. The authors also conducted a systematic literature review. Articles concerning pediatric brain tumor surgery reporting at least two quality indicators were of interest.

RESULTS The authors included 82 patients aged 0–17 years. The 30-day outcomes for unplanned reoperation, unplanned remission, mortality, nosocomial infection, and SSI were 9.8%, 14.6%, 0%, 6.1%, and 3.7%, respectively. Unplanned reoperation was associated with eloquent localization ($p = 0.009$), primary emergency surgery ($p = 0.003$), and CSF diversion procedures ($p = 0.002$). Greater tumor volume was associated with unplanned readmission ($p = 0.008$), nosocomial infection ($p = 0.004$), and CSF leakage ($p = 0.005$). In the systematic review, after full-text screening, 16 articles were included and provided outcome data for 1856 procedures. Overall, the 30-day mortality rate was low, varying from 0% to 9.3%. The 30-day reoperation rate varied from 1.5% to 12%. The SSI rate ranged between 0% and 3.9%, and 0% to 17.4% of patients developed CSF leakage. Four studies reported infratentorial tumor location as a risk factor for postoperative CSF leakage.

CONCLUSIONS The 30-day outcomes in the authors' department were comparable to published outcomes. The most relevant factors related to unfavorable outcomes are tumor volume and location, both of which are not modifiable by the surgeon. This highlights the importance of risk adjustment. This evaluation of quality indicators reveals concerns related to the unclear and nonstandardized definitions of outcomes. Standardized outcome definitions and documentation in a large and multicentric database are needed in the future for further evaluation of quality indicators.

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KEYWORDS pediatric brain tumor surgery; quality indicator; readmission; reoperation; surgical site infection; outcome; pediatric glioma; medulloblastoma; mortality; surgical complications; oncology

Takk til KSSB