

Median survival time in patients with malignant ureteral obstruction: A systematic review

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Abstract. Malignant ureteral obstruction (MUO) is a common complication of advanced malignancies and is associated with significant morbidity and poor survival. Despite advances in multidisciplinary care and minimally invasive urinary diversion techniques, the prognosis of patients with MUO remains limited. The present systematic review aimed to summarize available evidence on survival time and survival rates in patients with MUO. A comprehensive literature search was performed using PubMed, Google Scholar, ProQuest and the Cochrane Library from inception to January, 2024. Articles that were duplicates, incomplete, or review-based were excluded from the analysis. A total of 219 records were identified, of which eight studies met the inclusion criteria, encompassing 1,691 patients with MUO. The included studies were predominantly retrospective cohort designs conducted at single-center institutions. Reported median survival times following MUO diagnosis or urinary diversion ranged from 3 to 16 months. Survival outcomes varied according to oncological background, patient performance status, laboratory parameters and post-diversion treatment strategies, particularly the receipt of systemic chemotherapy. Across studies, 12-month survival rates were consistently low, and a substantial proportion of patients succumbed within the first year following diagnosis, highlighting the poor overall prognosis associated with MUO. MUO frequently arises as a consequence of cancer spread to the pelvic region. Given these findings, the involvement of urologists and collaboration across multiple specialties are essential to ensure comprehensive care and to improve outcomes in MUO management.

Introduction

Patients diagnosed with advanced-stage cancer frequently encounter complications, such as malignant ureteral obstruction (MUO). When the urinary tract becomes obstructed on one side, it can severely affect the well-being of a patient, particularly if accompanied by infection. A bilateral obstruction, however, often leads to fatal outcomes. Obstruction of the upper urinary tract has consistently been recognized as an indicator of worsening morbidity in various types of cancer (1,2).

Over the past three decades, the approach to managing MUO has markedly evolved. What was once the responsibility of a single specialist has now shifted to a collaborative model involving general practitioners, urologists, oncologists, palliative care teams and interventional radiologists. This shift reflects a broader trend toward multidisciplinary care in late-stage malignancies. Surgical techniques have also advanced, transitioning from highly invasive, high-risk open surgeries to less invasive, more patient-friendly procedures (3,4). Brin *et al* (5) described the outcomes of open palliative surgery as unsatisfactory, noting that such interventions often led to a steady clinical decline. Notably, urologists appear less inclined than oncologists to recommend urinary decompression in asymptomatic patients who have a poor prognosis (5).

The decision to perform decompression should be tailored to each patient, weighing potential benefits against associated burdens. While major associations, such as the American Urological Association and the European Association of Urology support decompression for certain cases, there remains a gap in strong, consistent evidence to guide clinical decision-making. In fact, cancer-specific guidelines often differ in their recommendations. The National Institute for Health and Care Excellence (NICE), for example, advises medical practitioners to not only offer decompression as an option, but also to openly discuss the possibility of forgoing any intervention (4,6). Given the limited and heterogeneous evidence guiding decision-making in malignant ureteral obstruction, a clear understanding of survival outcomes is essential. Therefore, the present systematic review aimed to summarize median overall survival and survival rates in patients with MUO, with particular attention to survival ranges and clinically relevant prognostic patterns reported in available literature.

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Data and methods

Search strategy. To obtain a comprehensive dataset on all publications evaluating median overall survival in patients with MUO, a systematic literature search was conducted on the PubMed, Google Scholar, ProQuest and the Cochrane Library from database inception to January, 2024. The following Boolean search string was used in PubMed: ('malignant ureteral obstruction' OR 'malignant ureteric obstruction' OR 'MUO') AND ('overall survival' OR 'survival rate' OR 'survival time'). The present study included original articles including case-control, cross-sectional, cohort and randomized control trials discussing the average survival rate in malignant ureteral obstruction patients. The presentation adhered to the PRISMA guidelines (Fig. 1).

The literature search was carried out in English, using specific key words associated with the median survival time in malignant ureteral obstruction patients, with the key words used 'survival rate' AND 'malignant ureteral obstruction' OR 'malignant ureteric obstruction' OR 'MUO'. These key words were used in different combinations to identify articles in which they appeared in either the title or the abstract. The search was restricted to studies published between 2018 and 2024.

Selection criteria. The titles and abstracts retrieved from the databases were reviewed separately by two independent authors. Studies were included if they met the following criteria: i) Original research articles reporting on patients with MUO; ii) adult populations (≥ 18 years); iii) studies reporting median overall survival and/or survival rates; iv) observational study designs, including cohort and cross-sectional studies; and v) articles published in English.

Studies were excluded if they were reviews, case reports, editorials, conference abstracts, letters, or proceedings; involved pediatric populations; did not report survival outcomes; or lacked accessible full-text data.

Data extraction. Data were collected using a standardized extraction table that recorded the names of the authors, year of publication, study design, study location, the number of participants, type of intervention, and the main outcomes of each study. Articles were identified through key word searches and then screened manually by reviewing the relevance of their titles and abstracts. When eligibility based on inclusion and exclusion criteria was uncertain, the full text was reviewed to confirm suitability, and the relevant information was entered into the extraction table. Survival outcomes were extracted and reported as median overall survival in months, with measures of dispersion (interquartile range or 95% confidence interval) when available. When studies reported survival outcomes using alternative formats or without dispersion measures, the data were presented as originally reported, without transformation. The findings from the included studies were then compared with those reported in other systematic reviews and related literature.

Quality assessment. The methodological quality and risk of bias of the included observational studies were assessed using the Newcastle-Ottawa Scale (NOS). This tool evaluates studies

across three domains: The selection of study groups, comparability of cohorts and assessment of outcomes. Each study was independently assessed by both authors (RA and HBW), and discrepancies were resolved through discussion. Studies scoring 7-9 points were considered high quality, 4-6 points moderate quality, and ≤ 3 points low quality.

Results

Selected studies. The systematic search initially identified 219 articles (Fig. 1). After removing duplicates and re-evaluating the records, 113 articles remained. From these, 34 articles were considered potentially relevant. After thoroughly evaluating the complete articles, eight studies fulfilled the eligibility requirements and were incorporated into the final review (7-14). The results of the database search are displayed in Table I and Fig. 1, whereas Table I also presents a summary of the included studies.

Included articles. Among the eight included articles, seven studies were retrospective studies and one study was a prospective study.

Study populations. In total, the eight included studies involved 1,691 patients. All of the studies were conducted at single-center institutions. Across the eight included studies, the survival outcomes of patients with MUO were consistently poor, although substantial heterogeneity was observed. Median survival following the diagnosis of MUO or urinary diversion ranged from 3 to 16 months. Studies with larger cohorts, particularly those including patients with advanced-stage gastrointestinal and gynecologic malignancies, generally reported shorter median survival times (7,11-14), whereas selected cohorts with access to subsequent systemic therapy demonstrated relatively prolonged survival (8-10).

Survival appeared to be influenced not only by the method of urinary diversion, but also by patient- and disease-related factors. Several studies reported no statistically significant difference in median survival between ureteral stenting and percutaneous nephrostomy, suggesting that the choice of diversion technique alone does not determine prognosis (8,9,11). Instead, outcomes were closely associated with baseline performance status, nutritional markers (such as serum albumin), renal function, and the feasibility of further oncologic treatment following decompression.

The administration of systemic chemotherapy following urinary diversion emerged as a consistent factor associated with improved survival. By contrast, patients who underwent urinary diversion without subsequent anticancer therapy experienced markedly shorter survival, in some cases limited to only a few months (8). Additionally, studies evaluating advanced disease stages or patients with bilateral obstruction reported worse survival compared with those with unilateral involvement (11,13,14).

Risk of bias assessment. Based on the NOS, the overall methodological quality of the included studies was moderate to high (Table II). The majority of studies demonstrated an adequate selection of study populations and clear outcome

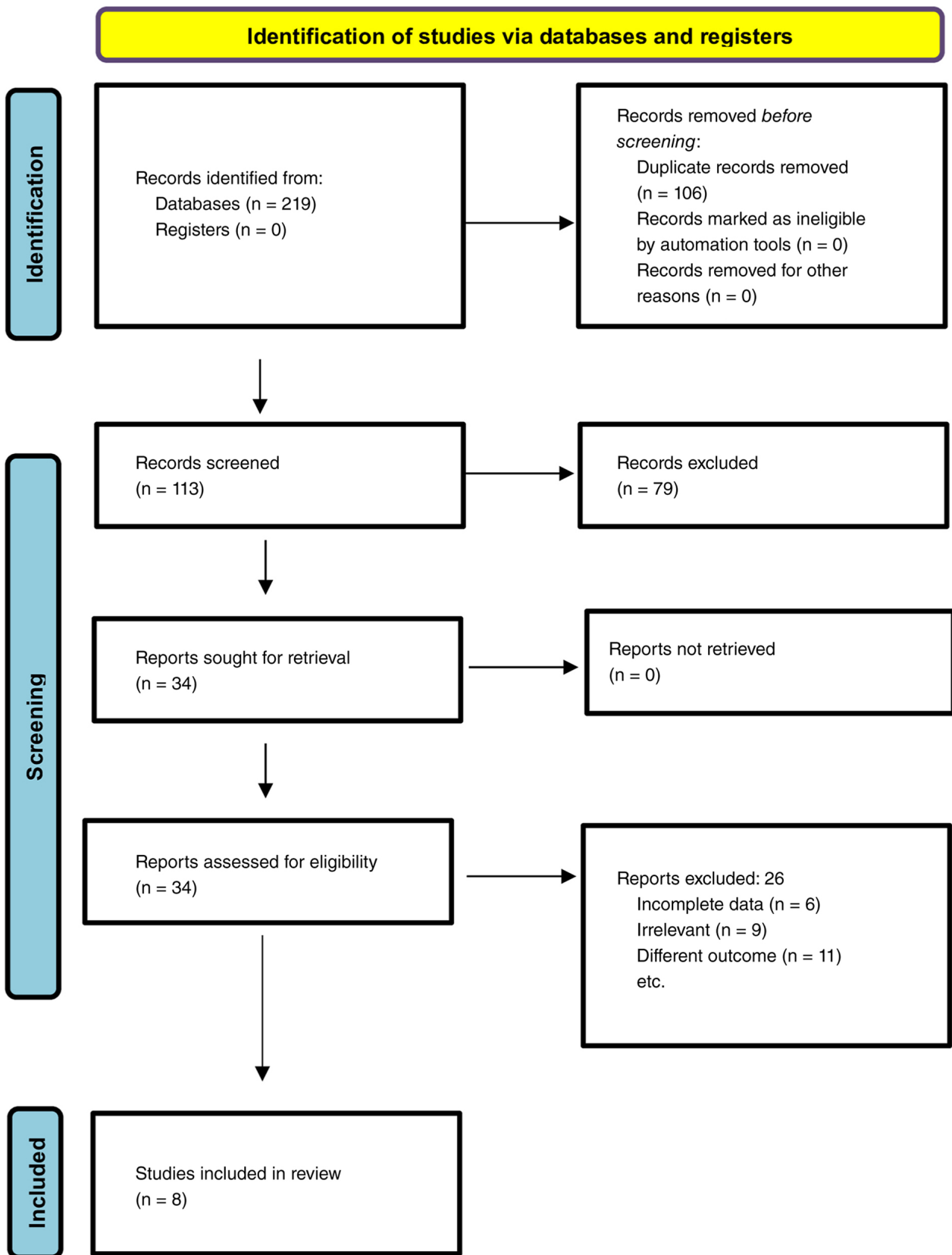


Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) literature flow chart.

assessment. Comparability between study groups was the most common source of potential bias, largely due to limited adjustment for confounding variables. No study was classified as low quality.

Discussion

Urinary blockage is a frequent side-effect of cancer metastases to the pelvic region and urogenital malignancies (15,16).

Table I. Characteristics and findings of the included studies.

Authors, year of publication	Design	Country	No. of subjects	Age (years)	Tumor type	Treatment	Survival rate	(Refs.)
Felice <i>et al</i> , 2024	Retrospective cohort	USA	115	69.01±14.95	Gynecological (41.7%); urological (19.1%); gastrointestinal (19.1%); lymphoma (11.3%); others (8.7%)	Retrograde ureteral stent Antegrade nephrostomy	141 days (IQR, 37.5-442.5)	(7)
Artiles Medina <i>et al</i> , 2024	Retrospective cohort	Spain	188	65 (52-74)	Prostate (17.6%); bladder (16.5); rectal (11.7%); colon (7.4%); cervical (5.9%); ovarian (5.9%); gastric (5.3%); UUT (5.3%); endometrial (4.3%); sarcoma (3.2%); testicular (3.2%); lymphoma (2.7%); unknown origin (2.7%)	Double-J stenting (48.9%); percutaneous nephrostomy (44.7%)	After hydronephrosis: 6.43 months (interquartile range, 1.91-14.81 months). Urinary decompression: 8.67 months (IQR, 2.99-17.28 months)	(8)
Dhani <i>et al</i> , 2023	Retrospective cross-sectional	Indonesia	189	51 (27-75)	-	Ureteral stent; percutaneous nephrostomy	After ureteral stent: 11 months (8.45-13.56); after percutaneous nephrostomy: 15 months (13.01-16.98)	(9)
Carmona <i>et al</i> , 2023	Retrospective cohort	Israel	186	65 (52-74)	Gynecological (50.5%); gastrointestinal (30.6%); genitourinary (11.3%); hematology (4.8%); other (2.7%)	Tandem ureteral stent (TUS); percutaneous nephrostomy (PCN)	Median time of 16 months (IQR, 8.25-21.25) and 41.8% out of drainage failure group died	(10)
Heo <i>et al</i> , 2021	Retrospective cohort	Korea	778	57 (47-65)	Upper gastrointestinal (40.6%); lower gastrointestinal (22.6%); gynecological (23.3%); other (13.5%)	Ureteral stenting (67.1%); percutaneous nephrostomy (32.9%)	708 (91%) died, with a median overall survival of 5 months (IQR, 2-12 months) after urinary diversion	(11)
Liu <i>et al</i> , 2019	Prospective cohort	Taiwan	104	Single ureteral stenting: 63.6±13.5 Tandem ureteral stenting: 63.0±11.8	Gastrointestinal (45.2%); genitourinary (22.1%); others (32.7%)	Single ureteral stenting (53.8%) Tandem ureteral stenting (46.2%)	The mean survival time was 272.0±33.6 days for patients with single ureteral stenting and 361.8±56.4 days for patients with tandem ureteral stenting	(12)
Asakawa <i>et al</i> , 2018	Retrospective cohort	Japan	92	66 (24-90)	Gastrointestinal (54.3%); gynecological (33.7%); urogenital (4.3%); other (7.6%)	Polymeric stent (38%); metallic stent (62%)	The median survival time for the 92 patients in our study cohort was 258 days. The stent patency rate was 70.9% at 1 year, regardless of stent type	(13)

Table I. Continued.

Authors, year of publication	Design	Country	No. of subjects	Age (years)	Tumor type	Treatment	Survival rate	(Refs.)
Ohtaka <i>et al</i> , 2018	Retrospective cohort	Japan	39	70 (40-89)	Gastrointestinal (61.5%); gynecological (28.2%); lung (2.6%); prostate (2.6%); unknown primary (5.1%)	Retrograde ureteral stent (RUS)	-	(14)

IQR, interquartile range; UUT, upper urinary tract.

When MUO is first diagnosed, it frequently indicates severe illness or signals the beginning of the course of the disease. After receiving a diagnosis of MUO, patients typically have a 3-to-7-month median survival rate and may spend up to 30% of their remaining time in the hospital (17,18). Urologists are frequently contacted for examination and possibly surgical therapy, regardless of the initial location of cancer. Decompressing the blocked upper urinary tract is a complex choice that necessitates multidisciplinary collaboration to synchronize oncologic treatment regimens with MUO management and collaborative decision-making to take the goals of care of the patient into account (1,3).

According to retrospective data, individuals with MUO who are carefully selected can be monitored without risking their lives, and some of them may never require urinary decompression. Moreover, morbidity and a lower quality of life may result from urinary decompression using a percutaneous nephrostomy tube (PCN) or ureteral stent (US). Although PCN provides effective external drainage, its disadvantages include infection, displacement of the drainage tube, and pain from the catheter and bag, all of which have a negative effect on the quality of life of patients with MUO (19,20). Surveys indicate that clinicians may prefer ureteral stenting due to perceived patient comfort; however, this preference is not uniformly supported by comparative quality-of-life data. Nevertheless, evidence from smaller-scale studies suggests that in cases of MUO, stenting does not lead to a meaningful improvement in quality of life when compared with PCN (21).

Survival rate and time. Felice *et al* (7) reported that 8.7% of patients had succumbed, while 76.5% were presumed dead. The median interval between the diagnosis of MUO and death was 141 days (IQR, 37.5-442.5). Additionally, 17.4% of patients either succumbed during their initial hospitalization or were directly transferred to the hospital at that time. Artilles Medina *et al* (8) emphasized that overall survival was influenced by the general health condition of the patient. In their cohort of 188 patients with cancer diagnosed with hydronephrosis, the median overall survival was 6.43 months (IQR, 1.91-14.81 months). The survival rates at 12 and 24 months following diagnosis were 14.8 and 34.1%, respectively. On average, patients were followed for 4.16 months (IQR 0.96-12.93 months). Among 48 of the 188 patients who underwent urinary diversion, the median survival after the procedure was 8.67 months (IQR, 2.99-17.28 months). Their 12- and 24-month post-diversion survival rates were 38.7 and 13.4%, respectively (8).

The most extensive investigation on urinary diversion was carried out by Heo *et al* (11) and included 778 participants. After undergoing diversion, the median overall survival was reported as 5 months (IQR, 2-12 months), and 91% of the patients (708 individuals) succumbed during the observation period. Patients who received no additional therapy had a notably shorter survival, with a median of only 2 months (IQR, 1-5 months). Conversely, those treated with chemotherapy following urinary diversion exhibited a marked survival benefit, reaching a median of 9 months (IQR, 4-16 months), a difference that was statistically significant (P<0.001) (11).

Following up on a group of patients with MUO, Lapitan and Buckley (22) evaluated the results of two groups: Those

Table II. Risk of bias assessment using the Newcastle-Ottawa Scale (NOS).

Authors, year of publication	Selection	Comparability	Outcome	Total	(Refs.)
Felice <i>et al</i> , 2024	****	*	***	8/9	(7)
Artiles Medina <i>et al</i> , 2024	****	**	***	9/9	(8)
Dhani <i>et al</i> , 2023	***	*	**	6/9	(9)
Carmona <i>et al</i> , 2023	****	*	***	8/9	(10)
Heo <i>et al</i> , 2021	****	**	***	9/9	(11)
Liu <i>et al</i> , 2019	****	**	***	9/9	(12)
Asakawa <i>et al</i> , 2018	****	*	***	8/9	(13)
Ohtaka <i>et al</i> , 2018	****	*	***	8/9	(14)

The number of stars indicate the following: Selection (maximum 4 stars), comparability (maximum 2 stars) and outcome (maximum 3 stars). Higher scores indicate a lower risk of bias (maximum 9 stars).

who had decompression and those who did not. There appears to be an initial survival advantage, with 38% of those who had decompression against 28% of those who did not survive at 6 months. Nonetheless, the 12-month survival rates of both groups were 16%. According to the available treatment choices, patients were separated into two groups; the group without treatment options had a 12-month survival rate of 0% and a median survival of 38 days (22).

A previous review of prognostic models indicated that patients with no more than one risk factor generally achieved improved outcomes, exhibiting a median survival of ~9-13 months and a 12-month survival rate ranging from 20 to 78% (23). Individuals categorized with 'intermediate' risk factors experienced shorter survival, with a median ranging from 5.77 to 8.2 months. By contrast, those with two or more risk factors had the poorest prognosis, with median survival reduced to 1.7-2.6 months and a 12-month survival rate between 0 and 12% (23). In a systematic review of 63 studies, Prentice *et al* (23) evaluated survival outcomes, quality of life, and the clinical challenges associated with MUO. Their findings revealed that only 23% of patients remained alive at 1 year following diagnosis, with an overall median survival of 6.4 months (23).

Dhani *et al* (9) further strengthened the evidence by categorizing patients into different risk groups and analyzing outcomes according to the treatment approach. Their findings revealed no significant difference in median survival rates between patients treated with ureteral stents (11.0 months; 95% CI, 8.45-13.56) and those who underwent percutaneous nephrostomy (15.0 months; 95% CI, 13.01-16.98) (P=0.749). A similar trend was observed in stage 3B disease, where survival was 11.0 months for stent placement (95% CI, 8.47-13.53) and 16.0 months for nephrostomy (95% CI, 13.07-18.92), with no statistically meaningful difference (P=0.589). In advanced disease (stages 4A and 4B), both procedures resulted in comparable outcomes, with a median survival of 13.0 months for nephrostomy (95% CI, 10.22-15.77) and 13.0 months for stent insertion (95% CI, 4.27-21.75). When examining survival rates, 6-month survival was 71% for patients with stents and 82% for those with nephrostomy. At 12 months, survival favored nephrostomy (70%) over stents (46%). By 18 months,

however, survival rates became nearly identical; 25% in the stent group and 23% in the nephrostomy group (9).

Another study compared the performance of metallic and polymeric stents (12). The median survival duration for the 92 patients was 258 days, and only 19 patients (20.7%) made it to the year mark. Therefore, the treatment of MUO in this clinical group would benefit from the increased patency rate offered by metallic stents, which are expected to have an indwelling length of 1 year (12).

The consistently short survival observed across studies confirms that MUO represents a late manifestation of systemic disease rather than an isolated urological problem. Although reported median survival times ranged from 3 to 16 months, this variation appears to reflect differences in patient selection, underlying malignancy, and the availability of subsequent oncologic treatment rather than the effectiveness of urinary diversion alone. Notably, even studies reporting relatively longer survival involved highly selected patients with preserved performance status and access to chemotherapy, underscoring that the prognosis of patients with MUO is largely driven by the underlying cancer biology.

Notably, survival rates declined sharply within the first year following the diagnosis of MUO, with the majority of studies (22-25) reporting 12-month survival <25%. This finding suggests that MUO may serve as a clinical inflection point, marking transition to end-stage disease in many patients. From a clinical perspective, these survival data emphasize that prolongation of life following MUO is modest and often limited, reinforcing the need for realistic goal setting and early palliative discussions.

Impact of urinary diversion on survival. Across the included studies, no consistent survival advantage was observed between ureteral stenting and percutaneous nephrostomy (7,8,11,22). While urinary diversion can temporarily restore renal function and allow the continuation of systemic therapy, the absence of clear survival differences suggests that diversion should be viewed as a supportive rather than curative intervention. The benefit of decompression appears to be indirect, primarily enabling chemotherapy or symptom relief, rather than extending survival by itself. While ureteral

stenting is frequently considered more comfortable, existing evidence does not conclusively show superior quality-of-life outcomes compared with percutaneous nephrostomy, and findings remain heterogeneous.

Of note, patients who underwent urinary diversion without subsequent anticancer treatment experienced particularly poor outcomes, with survival often limited to weeks or a few months. This observation highlights that urinary diversion in isolation may offer limited value in patients with no remaining oncologic treatment options. Therefore, the decision to decompress should not be routine, but instead carefully individualized, taking into account the likelihood that diversion will meaningfully alter the disease trajectory of the patient.

Factors associated with survival rate and time. Lapitan and Buckley (22) reported that several clinical parameters were strongly linked to unfavorable outcomes in patients with MUO. These factors included reduced serum albumin levels, limited therapeutic options, recurrent cancer-related complications, such as pleural effusion, ascites, or distant metastases, electrolyte disturbances such as hyponatremia, the presence of metastatic spread, and an Eastern Cooperative Oncology Group (ECOG) performance status of ≥ 2 (22). In line with these findings, Artiles Medina *et al* (8) emphasized that severe hypoalbuminemia, hyponatremia, extensive cancer-related events and poor functional performance on the ECOG scale were major determinants of survival.

In addition, Heo *et al* (11) reported several factors associated with a shorter survival. These included the male sex, a history of receiving chemotherapy without radiotherapy, the progression of malignant complications, a reduced baseline kidney function (estimated glomerular filtration rate, <60 ml/min/1.73 m²), low hemoglobin levels (<10 g/dl), decreased serum albumin levels (<3 g/dl), and the lack of further chemotherapy following the diagnosis of obstruction. They also observed that patients who developed MUO following chemotherapy generally had worse outcomes, indicating that the disease progressed rapidly despite previous systemic treatment (11).

Pradhan *et al* (24) investigated the impact of hydronephrosis laterality on survival among patients with advanced-stage cervical cancer. The results of their study revealed that those with bilateral hydronephrosis had a significantly shorter survival than those with unilateral involvement. Furthermore, hydronephrosis itself, regardless of whether it was unilateral or bilateral, was found to negatively influence patient outcomes. Age also played a crucial role: Patients aged >60 years of age at the time of diagnosis generally experienced a poorer survival, likely due to disparities in treatment access and the tendency toward under-treatment in elderly populations (24).

Oncological background. Gynecological, urological and gastrointestinal cancers represent the most frequent primary tumor origins leading to MUO. Among urological malignancies, prostate cancer stands out as the predominant cause. This pattern was reaffirmed by the findings in the recent study Felice *et al* (7), who reported that gynecological cancers accounted for 41.7% of MUO cases, followed by urological (19.1%), gastrointestinal (19.1%), lymphomas (11.3%), and other less common malignancies (8.7%).

The detailed breakdown by Artiles Medina *et al* (8) further illustrates the diversity of primary tumors causing MUO. Their study identified prostate cancer as the most frequent etiology (17.6%), followed by bladder (16.5%), rectal (11.7%), colon (7.4%), cervical and ovarian cancers (each 5.9%), gastric (5.3%), upper urinary tract tumors (5.3%), endometrial (4.3%), sarcoma and testicular cancers (each 3.2%), lymphoma (2.7%), malignancies of unknown origin (2.7%), pancreatic (2.1%), breast (2.1%), lung (1.6%), kidney (1.6%), and a variety of other rare cancers (1.1%) (8).

In terms of treatment outcomes, Carmona *et al* (10) investigated how the type of primary cancer influences the failure rates of temporary ureteral stenting. Their findings revealed that stent failure occurred in 41.4% of patients with gynecologic cancers, 38.6% with gastrointestinal cancers, 19% with genitourinary tumors, and 11% with hematological malignancies. Notably, the overall distribution of tumor origins did not exhibit a significant difference between patients with failed stents and those with successful placements ($P=0.137$) (10).

Taken together, the findings suggest that the management of MUO should prioritize patient-centered outcomes rather than survival alone. Factors such as performance status, nutritional reserve, renal function and patient preferences are critical in determining whether urinary diversion will provide tangible benefit. The heterogeneity in survival outcomes further supports a multidisciplinary approach, in which urologists collaborate closely with oncologists and palliative care teams to align intervention strategies with overall goals of care.

Rather than asking whether urinary diversion prolongs survival, clinicians should consider for whom and under what circumstances diversion is appropriate. In selected patients with good functional status and planned systemic therapy, diversion may serve as a bridge to further treatment. By contrast, for patients with advanced disease, poor performance status, or limited life expectancy, conservative management may better preserve quality of life.

The present systematic review has several limitations that should be acknowledged. First, the majority of the included studies were retrospective and single-center in design, which may introduce selection bias and limit the generalizability of the findings. Second, substantial heterogeneity existed across studies with respect to patient populations, underlying malignancies, diversion strategies and outcome reporting, precluding quantitative synthesis and meta-analysis. Third, survival outcomes were reported using varying formats and levels of detail, and not all studies provided measures of dispersion or adjusted analyses for potential confounders. Finally, decisions regarding urinary diversion are inherently influenced by clinical judgment and patient condition, which may further contribute to unmeasured confounding. These limitations highlight the need for prospective, multicenter studies with standardized outcome reporting to better inform clinical decision-making in malignant ureteral obstruction.

In conclusion, MUO frequently develops as a complication of advanced-stage cancers, particularly those spreading to the pelvic region. The cancers most often linked to MUO include gynecological, urological and gastrointestinal malignancies. Patients with MUO generally have limited survival prospects, with median survival times reported between 3 and 16 months. Furthermore, these patients may spend as much as 30% of their

remaining lifespan in hospital care. Considering these circumstances, the role of urologists as part of a multidisciplinary team is crucial for optimizing management approaches and ensuring more patient-centered outcomes.

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Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

RA and HBW jointly developed the study concept and design. RA collected the data, while HBW carried out the data analysis. Both RA and HBW contributed to writing the initial draft of the manuscript as well as revising it critically. Both authors (RA and HBW) confirm the antigenicity of all the raw data. Both authors have read and approved the final version of the manuscript.

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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